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Towards sustainable modern wood energy development

Stocktaking paper on successful initiatives in developing countries in the field of wood energy development

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Abbreviations

AEDE	Agence pour l'Energie Domestique et l'Environment (Household Energy and Environment Agency)
ASCPF	African Sustainable Charcoal Policy Framework
AUC	African Union Commission
BEA	Biomass Energy Agency
BMUB	Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit (Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety)
BEST	Biomass Energy Strategies
BPF	Bioenergy Policy Framework and Guidelines
CBFM	Community-based Forest Management
CDM	Clean Development Mechanism
CILLS	Comité permanent Inter-Etats de Lutte contre la Sécheresse dans le Sahel
CILSS	Permanent Inter-State Committee for Drought Control in the Sahel
ESMAP	Energy Sector Management Assistance Program
EU	European Union
FAO	Food and Agriculture Organization (UN)
FLEG(T)	Forest Law Enforcement and Governance (and Trade)
FMU	Forest Management Unit
FRA	Forest Replacement Association
GACC	Global alliance for Clean Cookstoves
GBEP	Global Bioenergy Partnership
GDP	Gross domestic product
GEF	Global Environment Facility
GDP	Gross Domestic Product
GIE	Groupement d'intêret économique (forest user group)
GIS	Geographic Information System
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
HRD	Human Ressource Development
ICS	Improved Cook Stoves
IEA	International Energy Agency
IFEU	Institut für Energie- und Umweltforschung, Heidelberg (Institute for Energy and Environmental Research)
IFPRI	International Food Policy Research Institute
IRENA	International Renewable Energy Agency
ITTO	International Tropical Timber Organization
JFM	Joint Forest Management
KCJ	Kenya Ceramic Jiko
LDC	Least Developed Countries
LEAP	Long-range Energy Alternatives Planning
LPG	Liquefied Petroleum Gas
MINFOF	Ministère des Forêts et de la Faune (Cameroon)
MSME	Mikro, Small or Medium Enterprises
NAMAs	Nationally Appropriate Mitigation Actions
NFWP	Non Forest Wood Products
NGO	Non-governmental Organisation
NTFP	Non-Timber Forest Products
ODA	Official development Assistance
OECD	Organisation for Economic Co-operation and Development
PES	Payments for Environmental Services
PFM	Participatory Forest Management
PPP	Public-Private Partnership
PREDAS	Regional Programme for the Promotion of Household and Alternative Energies in the Sahel
ProPSFE	Promotion du Programme sectoriel forêt et environnement
REDD	Reducing Emissions from Deforestation and Forest Degradation
REAP	REDD+ Energy and Agriculture Programme
RWEDP	Regional Wood Energy Development Programme
RWM	Rural Woodfuel Market
SEW	Sustainable Energy Production through Woodlots and Agroforestry in the Albertine Rift Project

SFM	Sustainable Forest Management
SNV	Stichting Nederlandse Vrijwilligers (Netherlands Development Organisation)
SSA	Sub-Saharan Africa
SSU	Strategic Support Unit
TOF	Trees outside forests
UBA	Umweltbundesamt (Federal Environment Agency)
UNEP	United Nations Environment Programme
UNF	United Nations Foundation
WHO	World Health Organization
WISDOM	Wood-fuel Integrated Supply/Demand Overview Mapping
WSMP	Woodfuel Supply Master Plans

Abstract

Wood energy currently makes up more than 65% of the global share of renewable energy. In some developing countries, more than 90% of the people rely exclusively on fuelwood, charcoal and crop residues for cooking and heating.

The traditional use of woodfuel is often not sustainable as it is energy inefficient and contributes to deforestation (mainly around urban centres for charcoal production). Furthermore, the resulting indoor air pollution is a considerable health hazard.

The International Energy Agency predicts that the poor in developing countries will continue to rely on wood energy in the next decades due to the lack of affordable alternatives. Other reasons are the availability and accessibility of woodfuel in rural areas and its wide applicability. Habits and customs further explain its continued use. Due to population growth the absolute number of people depending on wood energy is projected to rise from 2.6 billion to 2.7 billion by 2030.

In industrial and emerging countries, woodfuel is used to produce heat and/or electricity in order to reduce CO_2 emissions and to diversify energy supplies. It is expected that electricity production from wood will double by 2020 in Europe and triple in North America by 2030. Countries such as China, India, South Africa are also considering large-scale co-firing of woodfuel with coal. While the majority of current wood trade is still between OECD countries, a rising global demand for woody biomass raises concerns among international stakeholders about its potential negative impacts on the natural resource basis in developing countries.

This study on modern wood energy development, commissioned by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) on behalf of BMZ, presents a number of successful practices that allow that allow for an ecologically sustainable production of wood energy, with positive impacts on the incomes of rural populations in developing countries.

The aim of this study is to inform the Activity Group 4 “Towards sustainable modern wood energy development” of the Global Bioenergy Partnership (GBEP).

GBEP was established to implement the commitments taken by the G8 plus 5 in the 2005 Gleneagles Plan of Action to support “biomass and biofuels deployment, particularly in developing countries where biomass use is prevalent”.

GBEP promotes a global policy dialogue on bioenergy and facilitates international cooperation. It suggests rules and tools to promote sustainable biomass and bioenergy development.

To date, GBEP Partners comprise 23 countries and 14 international organisations and institutions. A further 26 countries and 11 international organisations and institutions are participating as Observers.

Summary

In developing countries, fuelwood and charcoal account for the largest share of household energy consumption. Wood energy is primarily used for cooking and space heating (household energy) but also for industrial purposes.

Compared to their main fossil alternative – LPG – fuelwood and charcoal are not competitive when it comes to their energetic properties. However, they hold **numerous comparative advantages** such as their relative accessibility, affordability and easy handling. In addition, wood, unlike other renewable energies (e.g. wind and solar energy), allows decentralised and flexible production as well as the possibility to be used as base-load energy.

90 % of people in the poorest African, Asian and Latin American countries rely exclusively on fuelwood, charcoal and crop residues as their solely available source of energy. For decades to come wood energy will be the main source of domestic energy in the developing world, especially for the poorer shares of the population. While the proportion of the population still relying on biomass is projected to drop from 52% to 42% by 2030, the absolute **number of people relying on biomass, currently at 2.6 billion, is expected to increase to 2.7 billion by 2030** due to population growth. The share of charcoal in households' energy mix is expected to increase considerably, in particular due to the expected increase in urbanization. Consequently, the **demand for solid woody biomass will grow** at an annual rate of 1.9% up to 2030, with most of the projected increase to occur in Asia and Sub-saharan Africa.

Woodfuel originates from a wide range of forestry and agricultural land-use systems, including agricultural plantations, agroforestry, trees outside forests, tree plantations, secondary and primary forests. It is either produced as a by-product of sustainable timber production or as a forest management objective in itself. In 2011, more than half of the annual worldwide logging volumes of roundwood was used for fuel. In most developing countries, wood energy use is more important and exerts far more significant impacts on forest resources than commercial timber use.

As far as the economic potential of wood energy is concerned, in many countries, the value of the charcoal value chain outreaches many of the main agricultural (export-) commodities. Fuelwood and particularly charcoal are important sources of household income on a global level, especially in Africa and Asia, and hold tremendous potential to create employment for rural and urban dwellers.

Promoting a "modern" wood energy value chain can evidently **mitigate damage to the health, especially of women and children** caused by traditional use of wood energy with simple, highly inefficient, and strongly polluting cookstoves. In addition, women play a key role in the wood energy sector as users, producers, collectors and sometimes traders of woodfuels, which offers manifold opportunities for promoting gender equality.

When it comes to environmental benefits, sustainable provision of wood energy can create a strong incentive for forest protection. Soundly designed wood energy projects, involving careful and integrated land use planning, can contribute **to carbon sequestration and reduce emissions** from fossil fuel combustion, forest degradation and deforestation. Within the value chain there is ample opportunity for technical improvements, in particular regarding charcoal-production efficiency and the dissemination of improved cookstoves.

One challenge will lie in bridging the gap between the increasingly positive image and societal approval of renewables as energy carriers in the OECD context – specifically when from proven sustainable production –, and the still widespread discard or disregard of the seemingly 'outdated' wood energy in the main consumption countries. In the industrialised world, the political arena today offers a much more receptive platform for promoting the subject than 20 years ago. More and more industrialised countries adopt new, 'green' energy policies giving way to an increased utilisation of wood energy within their energy mix. Wood energy is **progressively penetrating the energy markets of industrialised countries** as a clean and locally available alternative to fossil fuels. The considerable knowledge gained and disseminated in recent years by international donor-driven initiatives, energy agencies, environment departments, forestry services and private companies will lead to a better understanding of wood energy systems. This, together with fresh and more reliable data is expected to contribute to overcoming the main barriers and to promote the development of more sustainable woodfuel production systems in developing countries.

The present comparative overview that is supported by case studies across across numerous locations reveals governance as the dominant issue to be addressed. Integrated policies, coherence among policy areas, regulation and enforcement are need to be introduced to the woodenergy sector – a sector that is as yet prototypically informal, unregulated and partly unnoticed. Although woodfuels contribute substantially to the total energy supply in most developing countries, their value is generally not adequately reflected in GDP figures. The unregulated charcoal trade involves substantial forgone tax revenues. Reliable baseline data on the woodfuel value chains are still largely missing and the sector, being located at the interface of forest and energy policy, is characterised by **insufficient intersectoral cooperation and coordination and a lack of adequate consideration in sector policies**, mainly due to capacity deficits.

Insufficient framework conditions (lack of regulatory mechanisms or tenure arrangements etc.) fail to provide incentives for sustainable management of woodfuel resources. Generally, woodfuel prices often do not reflect the actual production costs within the frame of sustainable resource management.

Fair market competition for sustainably produced energy can only be reached when, by means of adjusted framework conditions, such as tax systems, the costs of sustainable production are internalised. Only then will producers of e.g. "green charcoal" arrive at viable profit margins. Other factors affecting the formalisation and sustainable development of the wood energy value chain include weak law enforcement capacities, corruption and oligopolistic structures of the value chain.

An analysis of existing wood energy interventions in Africa, Asia and Latin America revealed (inter-alia) the following **lessons learnt with respect to policies, institutional setups, incentives, financing mechanisms, and measures along the wood energy value chain** from feedstock management to woodfuel consumption: most wood energy interventions tackle either the supply or the demand side without applying a value chain approach and are not designed to promote structural changes in the sector. At the political level, national woodfuel or biomass strategies lack commitment and ownership from respective governments and thus receive little support from the international donor community. In addition, framework policies insufficiently integrate high quality data and information, also due to deficiencies in data collection capacities.

As far as the institutional setup is concerned, the creation of autonomous agencies interacting in the fields of household energy and environment proved to be more able to resist the pressure of political and institutional changes as it was the case for entities that are part of a ministry. A consistent devolution of responsibility, land tenure and/or user right security, paired with economic incentives turned out to be the prerequisite for community and/or private investments in boosting sustainable woodfuel supply.

It can be shown that secure tenure/user rights and good producer prices for woodfuel encourage reforestation activities and investments in sustainable forest management. In contrast, the woodfuel price in many countries does not reflect the replacement costs as fuelwood/charcoal producers are not obliged to replace the trees that they extracted. This means that financial transfers for reforestation and/or sustainable forest management have to be shouldered by public or external funds.

In this context, the introduction of a differential taxation system and efficient law enforcement proved to be effective in counteracting open-access exploitation of woodfuel, while ensuring equity between managed and unmanaged producers and securing finances for forest programmes and law enforcement.

As far as financing mechanisms are concerned, tree planting subsidies can be a self-financing investment, as at a later point in time the government can at least partly recover its contribution by generating taxes on the income. Harnessing carbon finance has not yet shaped up as being very effective, mainly because those mechanisms commonly support isolated links of the woodfuel value chain (especially improved cookstoves) but are not designed to engender structural changes of the regulatory framework. When it comes to individual links of the wood energy value chain, for the first one (wood production) there exists a large body of proven experience in the field of participatory forest management. The potential of agroforestry schemes and the use of wood residues to contribute to the sustainable woodfuel supply however are not really exploited and warrant further development. More attention should be allocated to charcoal production as it has a high leverage effect to improve the woodfuel supply situation but requires regulatory measures, systematic training and additional research.

At the marketing level, the creation of a network of rural and urban charcoal markets offers excellent opportunities for formalising the woodfuel sector and channelling additional income to the producer and the government. In this context, specific attention must be paid to the entrenched interests of powerful and influential players in the woodfuel sector. As far as woodfuel consumption is concerned, improved stove programmes have proved to be most successful when targeted at specific areas where woodfuel prices or collection time are high.

The analysis of existing information and experiences in the field of sustainable wood energy development allows to derive a set of **recommendations for "greening" the wood energy value chain** and putting it on an ecologically, economically and socially sound basis while guaranteeing security of energy supply.

Unsustainable wood energy use roots in more systemic deficits related to land tenure, fiscal and incentive policies, corruption, urban energy markets, and misallocation of forests and crop-land— problems associated with the policy and regulatory frameworks. Addressing these issues independently will not achieve the required value chain improvements. Instead, the shift to a modernised wood energy supply and use system requires a structural change providing incentives for sustainable production and efficient use of wood energy. A key element of this **holistic approach** is the introduction of a differential taxation system internalising sustainable production costs, encouraging producers to engage in sustainable production, and increasing the price for wood energy which gives an incentive to the consumers to modify their behaviour and use woodfuel more efficiently.

Creating a positive image of wood energy is a precondition for stakeholders' involvement in the structural change process and conducive policy reform. Wood energy should be promoted as a renewable, climate friendly, environmentally sound and technologically adapted option in the energy mix of the country. It should also be stressed that if wood energy is used is used applying modern technology it could substantially contribute to future economic development and poverty alleviation for generations to come. Changing the negative image of wood energy would include 1) Linking modern wood energy promotion to high-level internationally recognised processes, 2) Fostering scientific practical experience and further dissemination of lessons learned, 3) Promoting science and research and 4) Supporting the collection, processing and publication of reliable data.

Promoting enabling policy framework conditions in partner countries is key to promoting wood energy development. This includes strengthening of inter-agency communication and cross-sector coordination the creation of an adequate institutional setting, in particular a strong national entity as well as effective procedures. National (and sub-national) strategies should take up a holistic modernisation approach and should be developed in a more systematic participatory way comprising stakeholder consultation, participation, and capacity-building at all levels in order to create ownership. When it comes to the operationalisation of wood energy strategies, stakeholders should harness existing tools for data collection and planning.

In order to enable effective policy implementation, an **adequate regulatory framework** is needed. This comprises in particular the establishment of secure tenure or use rights in the context of decentralisation and devolution of power, accompanied by capacity building and organisational development at subnational level. In addition, incentive measures (e.g. differential taxation) and control and law enforcement systems are needed in order to foster economic benefits for sustainable producers and discourage non-formalised wood energy production.

In general, it is strongly recommended to **consider the entire wood energy value chain**, from production over conversion, transport and marketing to consumption, in terms of a value chain approach. The support of the value chain should intervene at two levels. On the one hand, institutional development will serve the purpose of formalising the value chain and includes the organisation and capacity building of stakeholders, the creation of networks of rural and urban wood energy markets and support to wood energy depots. On the other hand, technology improvement is put forward, taking advantage of existing advances and promoting further development of technologies (kilns, stoves, fuel types).

1 Introduction and approach

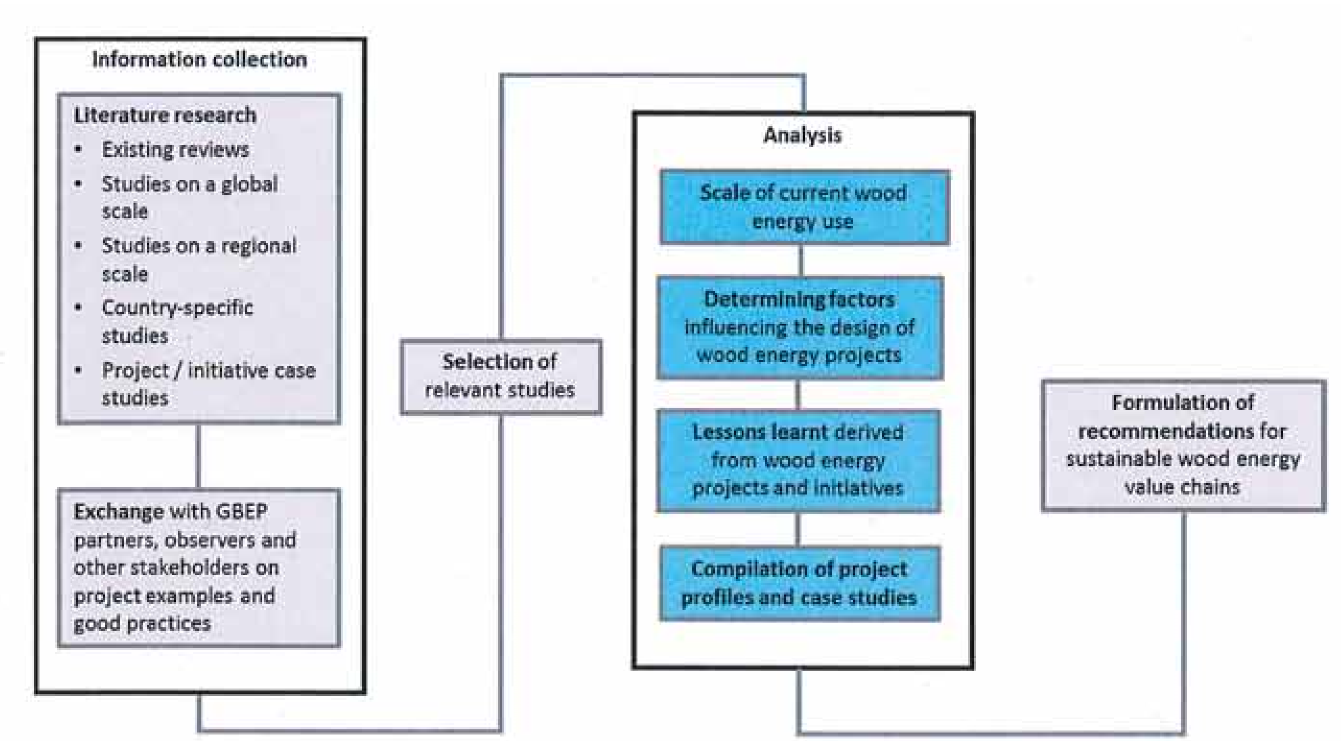
In December 2013, the Global Bioenergy Partnership (GBEP) Working Group on Capacity Building for Sustainable Bioenergy agreed to establish the Activity Group 4 — "Towards sustainable modern wood energy development". As the first of several planned activities, the Activity Group decided to collaborate on a stock taking paper providing an overview about successful initiatives on solid biomass development in countries that rely heavily on traditional biomass as the main source of energy. The focus is meant to be on lessons learned from successful examples in terms of wood energy supply chains covering the sustainable production and use of wood energy for household and productive local uses in developing countries.

The objective of this present stocktaking paper, commissioned jointly by GIZ, FAO and UNF/GACC to inform the GBEP Activity Group on wood energy, is to provide a basis for fostering sustainable production and use of wood energy for local purposes in developing countries. It will inform, inter alia, a forthcoming workshop (webinar) on experiences and lessons learned. Simultaneously, the Global Alliance for Clean Cookstoves is undertaking a study and developing a guide that addresses wood energy production and use for cooking.

The **approach in this study** (Figure 1) included a stepwise information retrieval. First, literature, including reviews and studies on various scales (global, regional, national, project level) was reviewed. In a second step, interviews and written exchange with resource persons allowed for gathering of complementary information. Relevant studies and cases were selected based on the following criteria a) availability of comprehensive information, b) their value in terms of lesson learned and c) their potential to serve as an example for future wood energy interventions.

The analysis is comprised of a compilation of current data on the scale of wood energy production and use and their relevance in terms of economic and social dimensions. In a further step, determining factors influencing the design (and success) of wood energy interventions were identified, including political, institutional, economic, ecological and technological aspects. An assessment of factors causing success and failure in past and current wood energy initiatives formed the basis for the development of lessons learned and a compilation of project profiles and case studies in the annex of this report. The final step of this study involved the compilation of a set of recommendations for a sustainable, "green" development of wood energy, with a particular focus on a value chain approach.

Figure 1: Approach of the study



Source: adapted from (Stecher et al. 2013)

2 Scale and scope of wood energy consumption and supply

2.1 Types of wood energy

Wood energy refers to any energy source that comes from woody biomass, including, fuelwood (sometimes used synonymously with firewood), charcoal, industrial wood residues, wood pellets, cellulosic ethanol, and other advanced forms of bioenergy. The focus of this study is on solid woody biomass in developing countries where traditional biomass makes up the largest share of household energy consumption.

In the developing world, most **fuelwood** for domestic uses comes from dead woody material and small trees. Fuelwood is harvested and used directly, without further conversion. It is predominantly used by households for cooking and/or space heating.

Box 1: Terminology

In this report "wood energy" - synonymous for energy derived from woodfuels - denotes fuelwood and charcoal. According to the glossary of the Unified Bioenergy Terminology (FAO 2004), firewood is a term reserved to describe, "cut and split oven-ready fuelwood used in household wood burning appliances" whereas the term fuelwood describes "where the original composition of the wood is preserved".

Charcoal is a woodfuel made from burning wood in a low-oxygen environment (pyrolysis). The black solid that results is a carbon-rich energy carrier, which contains about 1.8 times more energy per kilogram than fuelwood. Charcoal is generally sold as a commodity primarily in urban and peri-urban areas and its production requires a certain investment. This implies that the charcoal sector constitutes a different set of stakeholders from those of fuelwood (Mwampamba et al. 2013). A major challenge with charcoal is that the lower transportation cost (relative to fuelwood) makes illegal harvesting and production of charcoal profitable far away from the market. This includes trade across national borders as for example in the case of illegal charcoal trade in Eastern Africa run by the Islamist group al Shabaab to fund its terror-related activities in Somalia[1].

Switching from fuelwood to charcoal has proven to be more conducive for most urban lifestyles as charcoal is more convenient to use, produces less noxious fumes when burnt and is easier to transport. For the poorer segment of the population, it is important that it can be purchased in small quantities for very little money on a daily basis. Even those households who have switched to fossil fuels (mainly LPG) continue to use woodfuel occasionally, often for specific traditional preparations such as tea, BBQ).

Fuelwood and charcoal are also used for catering and handicraft industries such as restaurants, bakeries, beverage production, brick or chalk production, tobacco curing in forges and aluminum foundries etc. In some regions, such as parts of South America, industrial and commercial use of charcoal is a major driver of demand, as well as an important source of income along production chains. At the continental scale, South America is second only to Africa in total and per capita charcoal use (FAO 2010b). In Brazil the industrial sector consumes around 8.7 Mt of charcoal, representing 90.5% of total national consumption (Rose et al. 2009). Brazil thus belongs to the most important charcoal consumers in the world.

The use of **wood pellets** or wood chips for heating or cooking purposes still has no significant market penetration in the less developed countries. However, the growing appreciation of renewable energy by a distinct majority of OECD countries – triggered a renaissance of wood energy against the backdrop of looming climate change and technical innovation. In 2010, the global wood pellet production reached 14.3 million tons, thus recording an increase of more than 110% if compared to 2006 (Cocchi 2011). Driving factors are the increasing amounts of industrial pellets for co-firing, cogeneration or combined heat and power (CHP) and district heating, and pellets for residential heating. The European pellet industry still covered 81% of the EU demand in 2010; however, the gap between production and consumption in EU is steadily growing, the period between 2008 and 2010 has seen a more than 8-fold increase. Hence, imports to the EU might be increasing. The EU is very likely to remain the largest wood pellet consumer in the world, but East Asia is going to show a very strong growth and may be a close second by 2020 The members of IEA Bioenergy Task 40 "Sustainable Bioenergy Trade" postulate the following additional sourcing areas under a high-demand scenario (Cocchi 2011):

Box 2: Pellet/woodchips characteristics

Pellet fuels are made from compressed biomass and their high density permits compact storage and rational transport over long distances. Densification increases the energy density of biomass by approximately 10 to 15 percent compared to raw wood. Woodchips are a medium-sized solid material produced by cutting, or chipping, larger pieces of wood. They are less expensive than wood pellets and more energy efficient because less energy is required for manufacturing and processing.

1 In 2013, the annual report of the UN Monitoring Group on Somalia estimated that al Shabaab's charcoal exports from eastern Africa could be as high as 24 million sacks per year, for an overall international market value of \$360 to \$384 million. Source: http://www.trust.org/item/20140326164355-aswmt/

- Brazil rapidly increases production of (additional) short-rotation (i.e. 2-3 years) eucalyptus plantations from 2014 onwards to produce 2 million tons of wood pellets/yr. in each of the following states: Bahia, Rio Grande do Sul and Minas Gerais.
- Similarly, in Uruguay, 2 million additional tons are produced from eucalyptus plantations.
  In the West African countries of Liberia, Sierra Leone, Ivory Coast and Ghana, it is assumed that a total of 3 million tons of wood pellets will be produced by 2020 from fast growing tree species.
- Similarly, we assume that also in Mozambique a supply of 3 million tons of wood pellets could be established between 2014 and 2020.

Concerning **wood chips**, it is estimated that less than 10% of annually reported wood chip trade volumes are energy-related[2]. Energy-related wood chip trade in form of chips (virgin wood chips), crushed (waste) wood, or as roundwood takes almost exclusively place to and within the EU.

Outside the EU, wood chip trade occurs to Japan and Turkey from Canada and the Southeastern US. However, Asia could evolve into one of the key drivers for an increase in international wood chip trade for energy if respective policies are implemented in the future. It can be expected that wood chips (e.g. from Vietnam) will rather be used locally. Africa, driven e.g. by companies from Sweden and Denmark has ramped up wood chip production, also for energy use, but end-use markets remain offshore which favours the conversion of chips into pellets prior to transport (Lamers, et al. 2012). As an example, the current largest international trade flows to the EU, 60 ktonnes in 2011, are rubberwood chips from Liberia, destined for the Swedish energy utility Vattenfall (Vattenfall 2010; Eurostat 2012).

Wood harvesting and processing residues[3] have a huge potential to generate energy but are often dumped, burnt at industry site or traded over short distances. The key region for international wood waste trade is currently Europe where differences in renewable energy policy support schemes have led to a flourishing EU-wide exchange of waste wood streams, mainly in the form of (at least partly) crushed wood. Waste wood combustion, partly in co-combustion with wood chips and industrial pellets has become common practice in many EU Member States (Lamers, et al. 2012).

The most promising potential comes from timber residues, for instance saw dust, which could be tapped on a relatively large scale given the importance of the timber industry. A recent study on logging operations in Central Africa suggests that around 67 percent of wood residues are recoverable (de Gouvello et al. 2008).

However, even if there is an enormous untapped potential of using waste wood for energy generation in Africa, it cannot, according to the Global Environment Facility's recent assessment (GEF 2013) be concluded that Africa will play a major role in filling the growing gap between the world's supply and demand for wood (energy). In fact, Africa experiences a growing wood supply crisis, particularly near population centers close to the coast, which will lead to a price increase of wood and wood products across the African continent. According to GEF, Swaziland and South Africa have already experienced a doubling of prices for waste wood over the last four years, partially driven by the domestic demand for biomass energy. This will amongst other things, necessitate to improve waste management and attain more efficiency along the entire value chain from forestry operations to the consumption by end users.

2 The majority of wood chip trade is covered by high quality pulp chips.

3 Residues from logging operations: including tree branches, tops of trunks, stumps, branches, and leaves. Residues from wood-processing: log cores, wood slabs, end pieces, bark, and sawdust (CIWMB (1999)) amount of fuel would needed to produce the equivalent amount of useful energy from 1 kg of LPG

2.2 Demand trends and consumption patterns

2.2.1 Comparative advantages of wood energy

Compared to their main fossil alternative – LPG – fuelwood and charcoal are characterised by the following features:

Table 1: Useful energy contents

	Unit	LPG	Fuelwood		Charcoal	
Energy content	MJ/kg	46	16		29	
Type of stoves		Standard	Traditional	Improved	Traditional	Improved
Efficiency[1]		45%	12%	20%	20%	28%
Useful energy (MJ)[2]	MJ	20.7	1.92	3.2	5.8	8.12
Replacement (kg)[3]	kg	1.0	10.8	6.5	3.6	2.5

[1] *quantity of energy in the desired form (output energy) divided by the quantity of energy put in for conversion (input energy)*
[2] *energy which is an input in an end-use application, in this case heat*
[3] *amount of fuel would needed to produce the equivalent amount of useful energy from 1 kg of LPG*

With respect to energy density, combustion efficiency, heat-transfer efficiency and heat control characteristics, LPG clearly assumes the leading position among the most important energy carriers in developing countries. Depending on the type of wood-fuel and cookstoves, between 10.8 (3.6) and 6.5 (2.5) kg of wood (charcoal) would be required to provide the same amount of effective cooking energy found in one kg of LPG. When considering the low efficiencies of the traditional kilns (12% on average) the amount of raw material required to replace one kg of LPG boosts up to around 30 kg of wood.

However, the technological advantage of LPG is to be seen in relative terms when certain typical constellations of the consumer side are considered. Among the comparative advantages of wood-fuels are (CRC-PREDAS 2006; Richter et al. 2014):

- their relative affordability and accessibility, especially to underprivileged and poorly monetised populations in rural and semi-urban areas: e.g. firewood can generally be collected free of charge
- the possibility to buy them in small quantities and on a daily basis
- their easy handling
- their multiple end uses such as cooking, house and water heating, lighting, ironing
- local preferences for the preparation of traditional dishes
- the relatively easy and cheap access to required cooking equipment

In addition, wood has important comparative advantages over other renewable energies (e.g. wind and solar energy) in that it allows decentralised and flexible use as base-load energy, irrespective of either external factors (e.g. weather, day/night time) or the existence of public energy infrastructure. Wood fuel is not only a globally important source of renewable energy, it is also the most decentralised source of energy in the world (FAO 2012a).

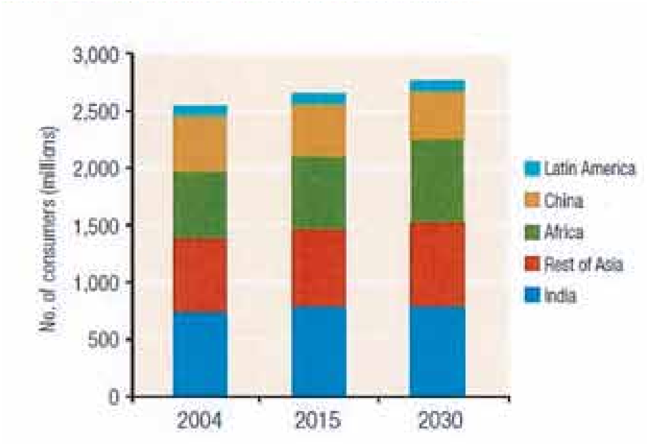
Wood energy is primarily used for cooking and space heating (household energy), industrial purposes and up to now only marginally significant for power generation.

2.2.2 Lasting dependence on wood energy

The use of solid biomass for fuel has the longest tradition globally. In developing countries biomass remains the **dominant source** of energy to the present day, because large segments of society are cut off from other energy sources and are acutely dependent on biomass. 90 % of people in the poorest African, Asian and Latin-American countries rely exclusively on fuelwood, charcoal and crop-residues as their solely available source of energy (UNEP undated). Continuous price increases for fossil fuels deepen this dependence. However, chapter 2.1 sets out clearly that wood energy is not only a fuel for poor countries or poor people. Rich countries (e.g. EU, Japan) and large-scale consumers with huge purchasing power already use vast amounts of wood energy and intend to use even more; amounts that they may not be able to produce themselves.

The share of biomass energy in total energy consumption varies among countries, but in general the poorer the country the higher the dependence on biomass energy. Prognoses by the IEA have largely become reality during the last ten years. In 2006, the IEA's World Energy Outlook projected the share of the population still relying on biomass to drop from 52% to 42% by 2030, in the developing world as a whole.

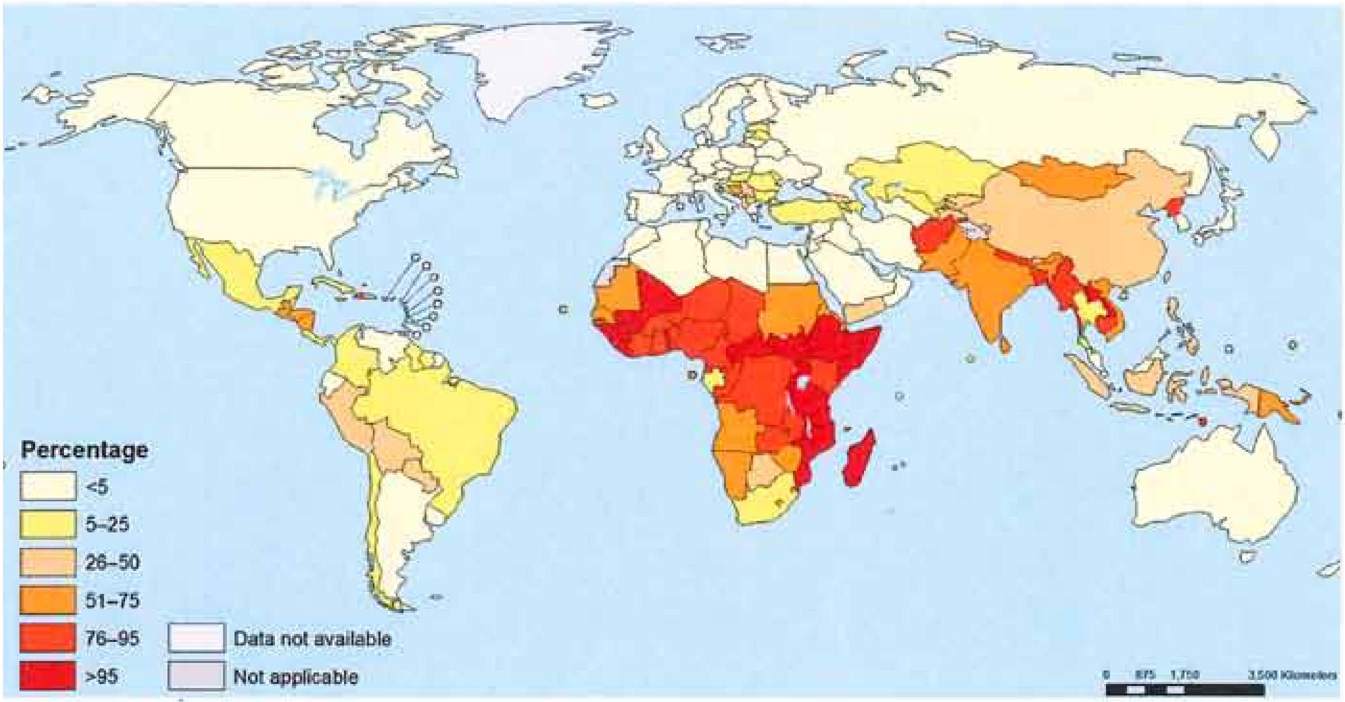
Figure 3: Number of people relying on biomass energy



Source: (IEA 2006)

At the same time the absolute number of people relying on biomass was projected to increase to over 2.6 billion by 2015 and to 2.7 billion by 2030, due to population growth from 6.1 billion in 2000 to approximately 8.3 billion in 2030 (UNEP 2009). For 2013 already, the IEA, based on data by the World Health Organisation (WHO), has documented an estimated 2.6 billion people who rely on the traditional use of biomass for cooking (IEA 2013).

Figure 2: Population using solid fuels (%), 2012



Source: (WHO 2013)

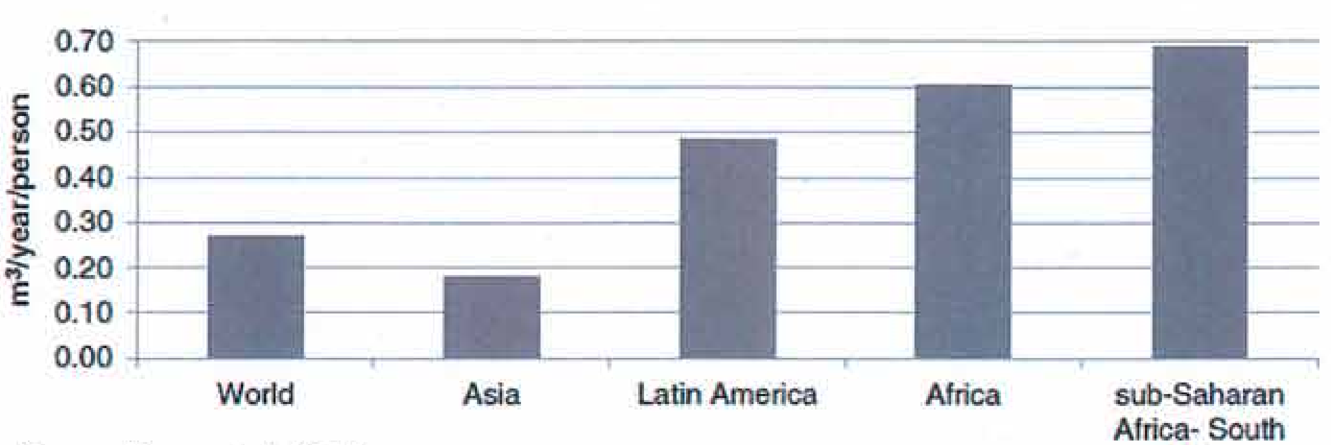
The International Renewable Energy Agency (IRENA) finds that demand for solid biomass will grow at an annual rate of 1.9% to 2030, far higher than projected in the Reference Case and in the historical increase of 1.3% per year between 1990 and 2010 (2014). This means that population growth currently outweighs the rate of shifts to alternative energy carriers. The main reason is that alternative fuels such as LPG, natural gas, or electricity are often not available, accessible and/or affordable. In countries, per-capita incomes are not expected to increase sufficiently to allow for switching away from traditional biomass to any significant degree (IEA 2006). This is particularly true for SSA.

Quantities of woodfuel consumed per person vary considerably between regions. In respect to the regions, sub-Saharan and South Africa are the most important woodfuel consumers. FAO (2012b) estimates an average fuelwood consumption of 0.99m^3/person per year for Central Africa, whereas in Dry Africa the consumption is only about half, given the scarcity of the resource.

Also within a country, the amount of woodfuel consumed per person displays important sub-regional variations. The average household woodfuel consumption in Tanzania, for example, has been analysed frequently over the past decades. It displays significant variations, from 0.73 tons per capita annually to 1.50 tons, depending on the location of the survey and the season in which the survey was carried out (Wiskerke 2008). For Malawi similar variations are displayed depending on the region (see Figure 5). The estimated rural (urban) per-capita annual consumption of firewood is 601 kg/yr (292 kg/yr.) and for charcoal 7,2 kg/yr. (94 kg/yr.) (EUEI-PDF/GTZ 2009).

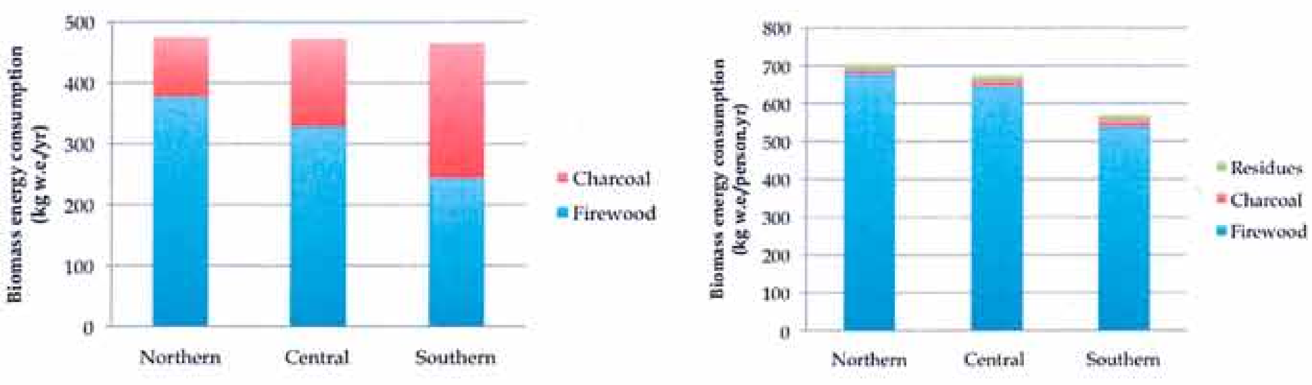
The quantities of woodfuels consumed depend on a variety of parameters which are described in the following chapter.

Figure 4: Regional comparison of per capita woodfuel consumption in 2011



Source: (Iiyama et al. 2014)

Figure 5: Urban (left) and rural (right figure) per capita household consumption of biomass energy by region in Malawi



Source: (EUEI-PDF/GTZ 2009)

2.2.3 Energy consumption patterns

The **consumption patterns** differ between urban and rural households, between high and low income groups and – as shown above – within a country as well as among countries in a region. Countries such as Niger still use fuelwood predominantly; others rely on charcoal; and again others have switched to other energies to a great degree (e.g. Maghreb countries).

Fuel choice and consumption level are determined by a number of parameters. Evidence from many countries does not support the notion that transition from wood to modern fuels followed a regular pattern. Rather it displays a complex process in which economic and technical aspects are interlinked with social and cultural issues (see Table 2).

On the other hand, there is evidence that, in countries where local **prices for modern energies** have been adjusted to the recent high international level, the shift to cleaner, more efficient fuels and cooking equipment has actually slowed and even reversed (IEA 2006). Conclusive evidence is provided by the country examples of this study which document that, as the price of LPG reached a certain threshold people returned to using woodfuels. In Senegal, large numbers of consumers reverted to wood-based biomass for cooking after subsidies for LPG were removed (Sander et al. 2011). In Madagascar the upper middle class has become increasingly unable to afford LPG due to a price increase of more than 55% between 2009 and 2013, forcing them to revert to charcoal.

Table 2: Determinants of stove/fuel choice

Social/cultural	Economic	Technical
• Family size	• Household income	• Efficiency
• Sex of household head	• Stove price	• Safety
• Age of household head	• Usage costs	• Emissions
• Education level	• Fuel costs	• Stove quality/durability
• Taste of food	• Fuel /ICS availability	• Functionality/Speed of cooking
• Cooking habits/customs	• Use as "Back-up "Stove	• Convenience/portability
• Convenience of fuel		• Aesthetic features
• Food preferences		

Source: (GIZ 2014)

With regard to resource availability and accessibility, there is evidence that limited access (imposed by the location of the resources or land tenure issues) to woodfuel affects the level of consumption. Limited access favors a more economical and alternative sources of energy.

Price is also an important factor, but it is noticeable, that the demand for woodfuel is often **relatively inelastic** meaning that price increases do not easily lead to fuel switching. Evidence is provided by investigations from Burkina Faso explaining why substitution and price policies have weak impacts on wood energy demand (Ouedraogo 2013). Cooking with woodfuels is deeply ingrained in many local cultures so that other fuels have little appeal, even when potential health and environmental benefits are recognised.

Noteworthy is also the case of Dar es Salaam where the number of households using charcoal for cooking increased from 47 percent to 71 percent, while the use of LPG declined from 43 percent to 12 percent (World Bank 2009b).

The prospects for **fuel switching by households** and for effective government interventions are distinctly different for urban and rural areas. In an **urban setting** availability of substitution energies (LPG, Kerosene), higher education levels and thereto-related higher household incomes provide the momentum for fuel switching. In sub-Saharan Africa increased urbanisation accelerates the demand for charcoal since it is the fuel of choice for most urban residents (Sander et al. 2011). In this region, the switch from firewood to charcoal is estimated at a rate of 4% to 10% per year. This will put additional pressure on the natural environment as twice the amount of wood is needed for the same final amount of energy when the low efficiency of charcoal production is taken into account.

Also in **rural areas** substitution of fuelwood by charcoal is increasing whenever people can afford it. The poorer segment of the population switches to crop residues, cow dung and other burnable materials when woodfuel becomes scarce.

However, several household surveys have shown that households do not simply substitute one fuel for another but start using multiple fuels alongside one another (and keep especially charcoal), also known as **fuel stacking** (Ruiz-Mercado et al. 2011). This can be regarded as a response strategy by households to avoid complete dependence on a single fuel or technology which would render them vulnerable to price variations and unreliable services.

Women play an important role in decision of a household about the choice of food and its mode of preparation as well as about type of fuels and stoves. They transfer respective preferences and skills to the next generation.

2.3 Importance of wood energy production

2.3.1 Production amounts

In 2011, more than half (ca. 1.9 billion m^3) of the annually worldwide logging volumes of roundwood (ca. 3.5 billion m^3) was used for fuel (FAO Stat 2014). In developing countries, use for energy outpaces all other uses by a large margin. Of the respective total logging outputs, wood energy production is 90 % in Africa, 67 % in Asia and 56 % in Latin America. These figures illustrate that wood energy use in most developing countries is more important than commercial timber use. Arguably, it exerts similar or even more significant impacts on the forest resources.

Absolute numbers of the quantities of wood energy production by continent are displayed in the figures below (see Figure 6).

Fuelwood production is difficult to estimate due to the informal character of its production. However, trends are obvious: In Africa there is an increase in fuelwood production whereas Asia experiences a decrease.The global production of charcoal was estimated at 47 million tons in 2011. Since 2003, the global production of charcoal has increased by 11% (FAO Stat 2013).

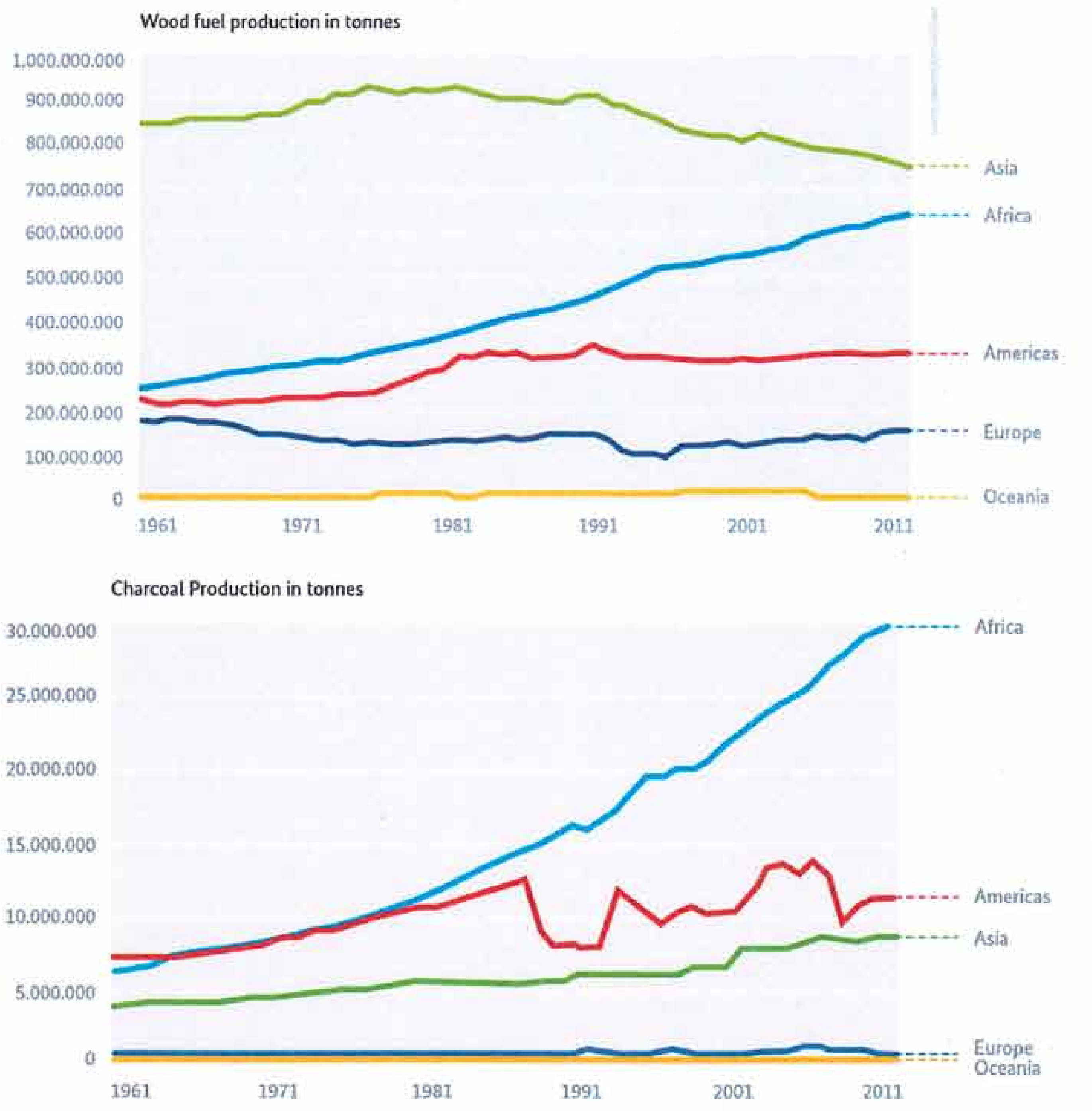
In Latin America and the Caribbean the production of charcoal dropped almost by 30% between 2004 and 2009. This was strongly influenced by Brazil. Its production accounts for nearly half of the charcoal production in the region where charcoal is mainly used in the steel and iron industry. In the wake of the economic downturn production decreased, but latest national data indicate that the production has recovered almost entirely.

Brazil is still the largest charcoal producing country in the world; 6.9 million tons were produced in 2011.
India and China are the most important charcoal producers in Asia and their charcoal production levels have been stable in the past 10 years (FAO Stat 2013).

The importance of biomass for energy supply is also displayed by its share in the total energy production from renewables. It has to be noted that wood energy is the bulk of biomass for energy production.

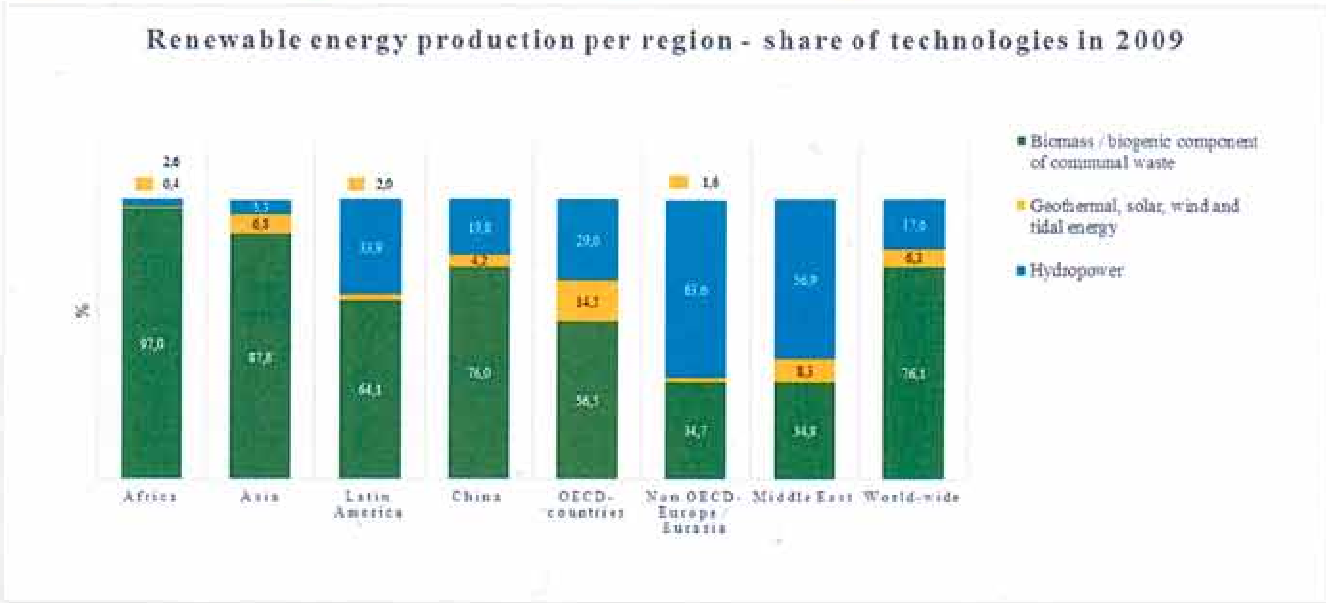
Model analyses examining the biomass energy potential of the forest and agriculture sectors concluded that – in theory – it is possible to sustainably satisfy 18% (or 14% if primary forests are excluded) of the world's primary energy consumption in 2050 by woody biomass (Lauri et al. 2014). Currently, bioenergy provides about 10% of global primary energy supply (OECD/IEA 2012). The theoretical model starts from mere biomass availability and regeneration, neglecting external determinants such as production factors and infrastructure. Therefore it does not, in actual terms, lend itself as a benchmark nor for comparison with existing figures. The ratio of sustainably supplied biomass energy will regularly fall short of its potential – due to many consumption centres' distance from production sites, with long transports spoiling the overall energy balance sheet and the financial returns.

Figure 6: Fuelwood and charcoal production by continents



Source: GIZ 2014 adapted from FAO Stat 2013

Figure 7: Share of technologies in the renewable energy mix in different regions



Source: (Adapted from BMU 2012)

2.3.2 Various production systems – varying potentials

Woodfuel originates from a wide range of forestry and agricultural land-use systems, including agricultural plantations, agroforestry, trees outside forests, tree plantations, secondary forest management and primary forest management. Sustainable woodfuel production takes two forms; either as a by-product of sustainable timber production, or as a forest management objective in itself (Figure 8). The manner in which wood for energy use is produced depends on climate conditions, vegetation cover, local demand, infrastructure, and crucially on land ownership and land-use rights (Sylla 2010). In all production systems **women** play an important role as producers, collectors and sometimes traders.

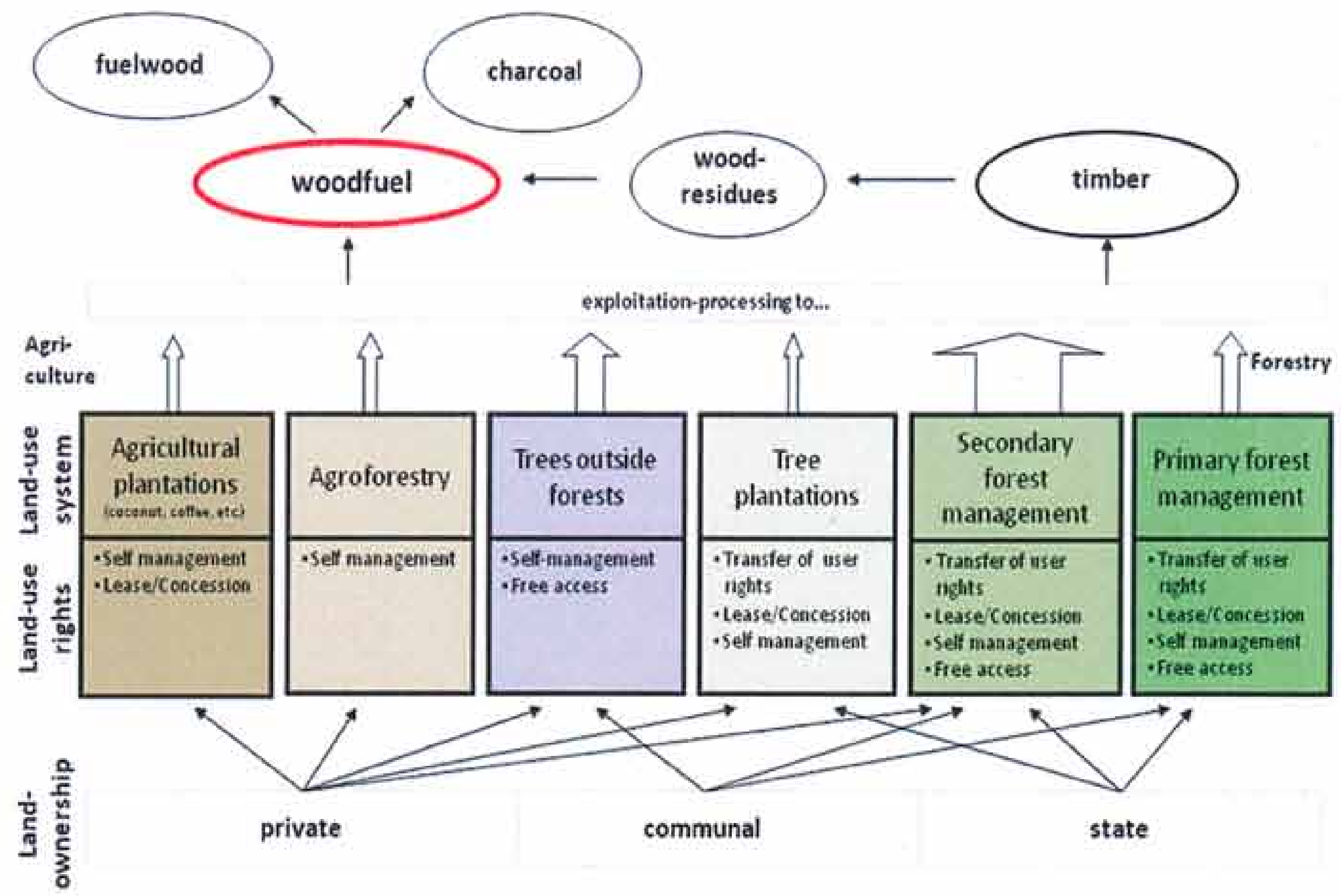
In **Agricultural plantations** the main objective of which is to produce fruit or other cash crops such as coconuts, coffee, bananas, etc. wood residues are frequently produced as a by-product that can be used for energy purposes (Sylla 2010).

In Agroforesty systems woody perennials and crops and/or livestock are deliberately integrated (e.g. silvopasture, forest farming). Woodfuel is either produced from multi-purpose trees, such as fruit trees and hedges prunings or from fast growing hardwoods which can be harvested in a coppice system (Sylla 2010).

Trees outside forests (TOF) comprises trees that are located outside forest areas[4], for example on agricultural land, in home gardens, along roads and on public places in cities and villages. Even though it is widely recognised that they represent an important source of woodfuel, particularly in areas with low forest cover (FAO 2000), their contribution to energy supply still remains underestimated in many countries. Surveys in several African countries have shown that TOF contribute to about 20% to 50% to the rural population's domestic energy supply (Diop 2011; Richter et al. 2009; Louppe 1991; Ohler 1985). In Asia, where the forest area per inhabitant ratio is low, trees grown outside of forests (TOFs) account for upwards of 50 % of the wood energy used (FAO 2001) whereas on a global scale 30 % can be assumed (Smeets and Faaij 2006). For example, in Northern Bangladesh it is estimated that 90% of the fuelwood requirements are met from village homesteads (Roy et al. 2013) or comes from farmland.

4 Forests are defined as areas of more than 0.5 hectare and a canopy cover of more than 10% (FAO 2005)

Figure 8: Origins of woodfuel



Source: (Sylla 2010)

Forest plantations dedicated to the production of wood for energy have existed in many countries for some time and are becoming increasingly common in some countries. With increasing pressure on natural forests, alternative sustainable approaches are needed to keep pace with the growing demand for woodfuel.

Unlike Africa, where most woodfuel production is on a small scale, uses poorly developed technology and generally focuses on supplying fuelwood for local consumption, much of the woodfuels in Asia come from plantations. Of an estimated 8 million hectares of woodfuel plantations worldwide, 6.7 million are located in Asia, most of them in India and China (FAO 2010c). As far as Latin America is concerned, Brazil is increasingly turning to eucalyptus plantations to meet its demand for industrial charcoal (Mugo and Ong 2006).

There is evidence that rapid expansion of biomass energy in the global North is fuelling demand for wood and increasing interest in tree plantations in Africa, South America and Southeast Asia. Already, several companies are moving to service or replant existing tree plantations for this purpose, as for example in Ghana and Liberia (Cotula et al. 2011).

Woodfuel plantations have faced a number of problems such as a lack of available land, insufficient tenure security and governance deficits for preventing unregulated access. Furthermore, woodfuel plantations have in many cases gradually been shifted towards production of forest products with higher market value (e.g. poles, construction timber) since wood based fuels are frequently underpriced or not commercialised at all.

Secondary forests are 'forests regenerating largely through natural processes after significant human or natural disturbance of the original forest vegetation at a single point in time or over an extended period, and displaying a major difference in forest structure and/or canopy species composition from the nearby primary forests on similar sites' (Chokkalingam and de Jong 2001).

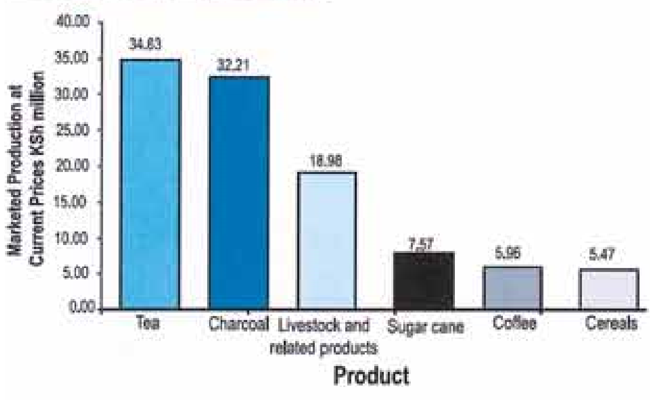
They are estimated to account for 60% of the total tropical forest area (ITTO 2002) and provide a large variety of forest products, with woodfuel as the most important one especially in savannah regions.

Primary forests have 'never been subject to human disturbance, or have been so little affected by hunting, gathering and tree-cutting that their natural structure, functions and dynamics have not undergone any changes that exceed the elastic capacity of the ecosystem (ITTO 2002)'. Woodfuel from primary forests generally represents a by-product from timber production, a potential that remains untapped.

2.4 Economic dimension of the wood energy value chain

The contribution of woodfuels to the economy of countries in development still tends to be under-estimated. As documented by the World Bank for several African countries, the contribution of woodfuels to the economy even surpasses that of other economic sectors – such as the total export value of coffee or the total value of maize production (World Bank, 2011). In Kenya or Tanzania the wood energy sector has been shown to correspond to or even outreach the important coffee and tea industries (see Figure 9). In Ivory Coast – known as a timber exporting country – the wood energy value chain is worth three times as much as the timber industry (Louppe and N'Klo 2013).
Concerning **charcoal**, the amount of charcoal consumed throughout Africa is estimated to be worth between approximately US$ 9.2 billion and US$ 24.5 billion annually (UNEP 2014). In terms of value, char-coal even outreaches many of the main agricultural (export-) commodities. The consumption of charcoal in Phnom Penh alone represents an estimated US$ 25 million USD yearly market, with at least 5,000 families engaged in producing charcoal in the surrounding provinces (Müller et al. 2011).

Figure 9: Charcoal in comparison with other products in Kenya: Gross marketed production at current prices

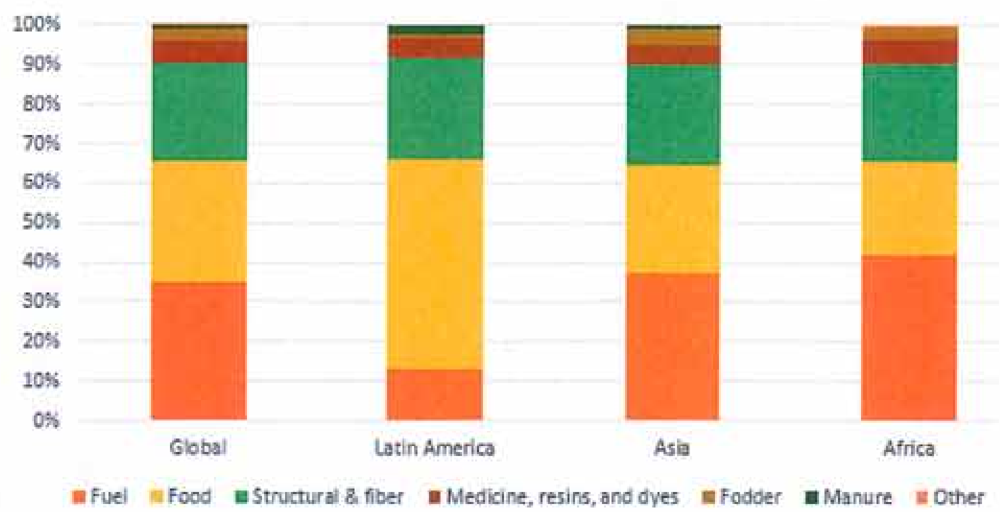


Source: (Mutimba and Barasa 2005)

However, although woodfuels contribute substantially to the total energy supply in most developing countries, their value is not adequately reflected in GDP figures. For Rwanda an estimated value for fuelwood and charcoal (combined) has been calculated at five percent of the GDP (World Bank, 2011). In contrast, the official contribution of forests and woodlands to the country's GDP is 1.3 percent (World Bank 2012). Governments and decision-makers on the national level tend to neglect this policy field.

As far as **household income from forests** is concerned, woodfuels are the dominant category accounting for 35.2% of forest income, and representing about 7.8% of total household income (cash and in-kind) on a global level. Most of this is fuelwood, while charcoal makes up roughly 11%. The share of woodfuel related forest income, compared to that from wood and NTFP, is particularly important in Africa (42%) and Asia (37%). In Latin America, some specialty high-value food products (e.g., Brazil nuts, Acai fruits) raise the food share in forest products and reduce the woodfuel share (Angelsen et al. 2014).

Figure 10: Main products providing forest income



Source: adapted from Angelsen et al. 2014

2.5 Key messages

- In developing countries, fuelwood and charcoal make up the largest share of household energy consumption.
- While the use of LPG is expedient as far as its energetic properties are concerned, wood energy holds numerous comparative advantages (accessibility, affordability, handling etc.).
- For decades to come wood energy will be the main source of domestic energy in the developing world, especially for the poorer shares of the population. The share of charcoal in households' energy mix is expected to increase considerably, in particular due to the expected increase in urbanisation.
- Demand for solid biomass will grow at an annual rate of 1.9% up to 2030, with most of the projected increase to occur in Asia and sub-Saharan Africa.
- In Africa, the value of the charcoal value chain outreaches many of the main agricultural (export-) commodities. Fuelwood and charcoal make up a dominant share of forest income.
- Women play a key role in the wood energy sector as users of energy sources, producers, collectors and sometimes traders of woodfuels and as educators concerning the collection, management and use of fuels.

3 Challenges, rationale and opportunities for wood energy promotion

3.1 Challenges

3.1.1 Lack of data

Reliable baseline data on an economy's woodfuel value chain are essential for shaping conducive policy decisions. For wood energy, FAO Stat is globally the most cited database. However, many countries lack data on wood supply and consumption and respective information about the value chain.

Despite its contribution to the national economy, wood energy is predominately produced and traded in the informal sector and thus escapes official statistics. The data provided by the different countries to FAO are often incomplete and/or erratic and do not accurately reflect reality.

Box 3: Impediments to accurate woodfuel information

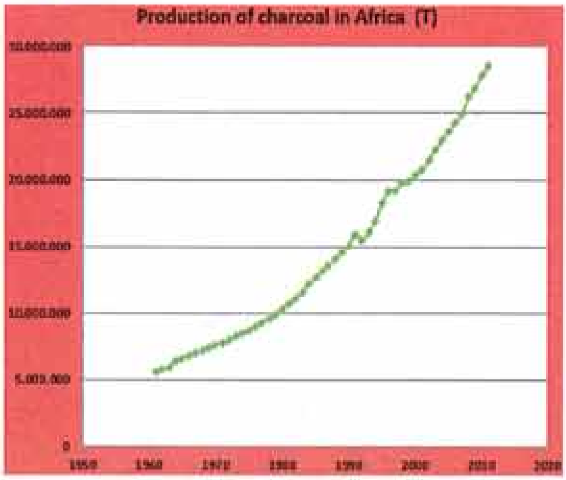
The main causes are:

- High intensity surveys are necessary to collect accurate information since woodfuel production and consumption vary greatly across locations and at different times of the year.
- Woodfuel is mostly collected for the collector's own use and not sold in specific locations, such as markets, shops or factories, which would facilitate collection of information.
- Because of the low price of woodfuel in most countries, the sector is of little economic importance and investment in collection of statistics is therefore considered of little value.
- Many countries do not have the financial and human resources required to collect woodfuel information –especially since those countries that rely most on woodfuel are the poorest at the same time.
- There is often poor coordination between institutions with an interest in the sector (e.g. government agencies dealing with agriculture, forestry, energy and rural development), and the benefit of information collection may be insufficient for any one agency.
- Many governmental forestry agencies focus their efforts on commercial wood production and neglect non-commercial forestry outputs.
- Information about woodfuel suffers from a lack of clear definitions, measurement conventions and conversion factors, which creates difficulties in comparing statistics across regions and over time.
- Because of widespread illegal logging, production may be under-declared and therefore the extent of wood residues available for energy use may be underestimated.

Source: Broadhead et al. cited by FAO 2008

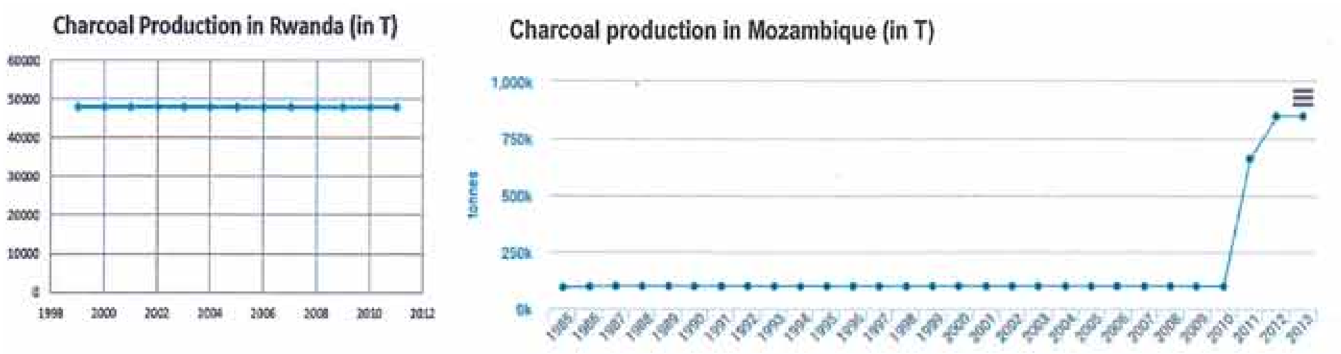
Although FAO Stat data display an overall significant increase in charcoal consumption for Africa of more than 3% per year, between 1960 and 2011, certain countries remain silent about their annual charcoal consumption and/ or communicate the same/ inconsistent data year after year. For Rwanda the FAO database reports a mere 48,000 tons – which is already consumed by the capital of Kigali alone. The Biomass Energy Study of Mozambique (EUEI/GIZ 2012) estimates the urban consumption at 600,000 tons whereas FAO Stat displayed a mere 100,000 tons until 2010, before presenting more plausible figures. Similar inconsistencies in FAO statistics are reported from Peru (Bennett-Curry et al. 2013). The strive towards more consistent, comprehensive data provision and/ or levying is decidedly to be felt. But all sides might arguably profit from a somewhat tougher supervision by FAO to encourage countries to provide data that are more reliable.

Figure 11: Increase of charcoal production in Africa 1960-2011



Source: (FAO Stat 2014)

Figure 12: Implausibility of charcoal data displayed by FAO Stat



3.1.2 Non-conducive image, policies and regulatory mechanisms

In addition to the lack of data, also the **lack of political** hampers the development of an enabling policy framework for wood energy. The wood energy sector is located at the interface of two main policy fields: Forestry and Energy, which are normally placed under different ministries and too often work without any cooperation and coordination. Several national **forest** policies have been remarked to fail to address issues concerning woodfuel (as a forest product of seemingly low economic interest). **Energy** policies, on the other hand, tend to label wood-based fuels as a 'backward' and 'primitive' source of energy – one that is to be replaced by fossil fuels or electricity as soon as possible. In consequence, the issue of "wood energy" is commonly overlooked – even discriminated against – in forest and energy policies alike.

Box 4: Inability of policies – the Kenya charcoal ban

The annual income from charcoal is around 32 billion Kenya Shillings (USD 400 million) almost equivalent to the income generated from Kenya's tea industry. Despite a charcoal ban, the charcoal business in Kenya continued to thrive but the Kenya Revenue Authority lost an estimated 5.1 billion Kenya shillings in taxes annually. Therefore, it can be concluded that the Kenyan government policy of a ban on charcoal production has not achieved any meaningful gain, but instead the state continued to lose billions in revenue while at the same time losing its forest cover to charcoal production. The ban has been lifted in December 2013.

However, there are two significant problems with the widespread policy emphasis on substitution: first, it runs counter to reality and therefore fails to offer a valid framework for planning; second, it is based on outdated perceptions that portray biomass energy in a disproportionately negative light (Owen et al. 2013).

Regulatory mechanisms dealing with woodfuel are either missing or poorly enforced in most countries. Institutions are mainly operating in informal environments that tend to be based upon customary rules, which allows diverse parties to be involved, but also leads to substantial unsustainable and unofficial production, corrupt practices and loss of tax revenues (Schure et al. 2013). Furthermore, practical implementation, enforcement and monitoring of forest governance are often generally insufficient even if in some countries decision makers may declare their intent to align national policies with international standards of forest governance. This general deficit of good governance in the sector is even worse concerning access to firewood and charcoal. In most developing countries, this sub-sector is not at all regulated in practice, and the resource not managed in a sustainable manner. Under these conditions, some individuals or groups are able to profit enormously at the expense of environmental degradation and exclusion of the local population (see also Larson and Ribot 2007). Governments still show a serious lack of political will to engage in any control of the wood energy sector.
They often deliberately leave it to the informal sector and abstain from measures to fight corruption and the abuse of power by forest officials. Sudden interventions such as banning charcoal (e.g. in Chad, Kenya, Tanzania) proved to be counter-productive and did not stop charcoal production but drove the industry further into informality escaping public regulation and revenue collection (World Bank 2009a).

A main problem is that authorities charged with enforcement often suffer from serious capacity deficits in terms of funds and personnel. This problem is often exacerbated by half-hearted or insufficiently coordinated decentralisation. Such institutional weaknesses lower the moral of local staff and clear the way for corruption (Ribot 2005).

3.1.3 Low woodfuel producer prices

Woodfuel prices often do not reflect their **real value** since wood is illegally harvested (as an open-access resource) and licenses and levies – where they exist – are largely evaded (Sander et al. 2011). Failure to capture the real economic value of trees including all entailed costs of sustainable forest management cheapens wood with the following consequences (Sepp 2008b):

- **Tree growing approaches remain ineffective**, as planting and maintenance cost must be taken into account, when competing with open access resources. Significant subsidies (e.g. Reforestation in Madagascar: 200 to 300 €/ha) are necessary to provide enough incentive. This holds also true for any investments in natural forest management.
- **Investment cost for improved kilns (metal chimneys etc.) do not pay off** as long as wood remains a free resource. Despite training support, charcoal burners eventually abandon the improved technology. This is the main reason why the improved and superiorly efficient Casamance kiln has been disseminated for 20 years throughout Africa without major success.
- **Dissemination of improved stoves succumbs, as woodfuel prices remain low**. Additional incentives are required to increase the dissemination rate. Development agencies estimate that successful stove dissemination entails cost of 7 to 10 USD a piece.
- **Substitute fuels such as LPG must be highly subsidised to be competitive**, as is the case in a number of countries (e.g. Ivory Coast, Chad). On the one hand, the need for substantial subsidies creates a long-term foreign exchange burden and tilts a country's trade balance. On the other hand, only the wealthier segments of society benefit. Furthermore, state subsidies for substitute fuels create perverse incentives, which further discourage investment into tree planting or forest management by communities or the private sector.

It may appear that low woodfuel prices favour the poor urban consumer who pays less for the charcoal but, in real terms, the cost would be much higher if issues of environmental services and replacement cost were adequately captured (Nketiah 2008).

In this context it should also be noted that isolated dissemination of improved stoves can be counterproductive as their energy saving characteristics would enforce the consumers' widespread perception that woodfuel is a low-value commodity, resulting in a slackening demand for substitution energies.

In addition to the inadequate market price for woodfuel, in the current system the profit margin for the local population as potential main producers is low: In most African countries, the Forest Service traditionally had the exclusive right to assign commercial exploitation permits for harvesting of forest products. Predominantly urban-based traders obtain exploitation permits resulting in an oligopolistic woodfuel market that created a system of unsustainable and inequitable forest exploitation. Communities in the proximity of the forests allocated for exploitation do not benefit at all. Consequently, the local population refrains from applying any caretaking obligations to sustainably manage and protect forests. Transporters/ wholesalers dominate the woodfuel supply chain and reap disproportionately large profits. Thus, producers encounter unequal distribution of benefits vis-à-vis the traders and wholesalers, which is sometimes reinforced by the permit and quota systems allocated to traders.

3.1.4 Insufficient expenditures to promote wood energy

Although wood energy is an economic sector with the potential to generate revenues and to be economically sustainable, initial investments are needed to initiate the switch from an unsustainable to a sustainable management system and from an informal to a formal market.

Information on public expenditure is difficult to obtain. However, in almost all of the cases reviewed by Fowler et al. (2011) only a small proportion of the national budget is allocated to the forest sector and much less to wood energy. In countries like the D.R. Congo, Niger or Ethiopia the Government allocates less than 1% of the **national budget** to the forest sector. Only in one case (Vietnam), the proportion of public expenditure allocated to forestry has been found significantly higher than its contribution to the agricultural GDP. Forest departments remain under-resourced relative to their mandate despite the sector's importance for local and national economies. The main challenges to mobilise funding are: (i) low political priority, (ii) insufficient recognition of the full value of forests and trees, (iii) unawareness of cross-sectoral linkages, and (iv) low level of capacity especially at the decentralised levels (Indufor Oy 2013).

Global ODA disbursement (bilateral and multilateral) for forests has increased considerably since 2002 by 125% to an amount of 1.260 million USD for the 2008-2010 period (AGF 2012). The major recipients of funding disbursements are China, Vietnam, India and Brazil.

In many countries (e.g. Burkina Faso, Cameroon, Congo, Mali) national **forest funds** made up of royalties, taxes, concession fees etc. have been established to serve as a mechanism to provide long term reliable and sustainable financial support to reforestation and sustainable forest management (Gondo 2012). The 2012 study on forest financing (AGF 2012) sees the development and incorporation of national forest funds into national forest programs and forest policy and legislation as an effective option to address sector financing needs. However, procedures can impose bureaucratic barriers that are insurmountable for potential recipient stakeholders and many important projects go unfunded or unimplemented. Furthermore, in most countries wood energy measures are not a political priority.

Besides national forest financing and bilateral/multilateral support there are other financing mechanisms like private grants, multilateral funds or forest investment funds which can be used to finance wood energy initiatives and projects. Decentralised project oriented funds are also an accurate mechanism of efficient financial support. They have a small scope but save nearly all transaction costs compared to other mechanisms. Due to the great variety of providers of financial support it is not possible to mention numbers.

But they open windows of opportunity to finance forest activities in addition to the opportunities shown above. That kind of financial support often is independent from national governmental processes and can be obtained either from official projects but also from private initiatives (Charpin et al. 2013).

The most important on-location obstacle is to elaborate the capacities of local stakeholders to apply for that kind of support and assure financial and technical management (Charpin et al. 2013).

3.1.5 Unsecure land tenure, user rights and land use

It is widely recognised that **security of 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 (USAID 2007).

The problems and negative impacts associated with unregulated (=open) access to forest resources and unchecked exploitation finally leading to deforestation and degradation of forests, (see Figure 13), are directly linked to a lack of ownership or long-term user rights. Legal insecurity constitutes a formidable disincentive against any kind of commitment or long-term investment.

Tenure arrangements are highly specific to a country's political and legal system, social order and historic development. Forest land ownership with full property rights (see box) frequently rests with the state. Rural households or communities often have a wide range of rights of access, management and use (both statutory and customary), but often limited and not secured.

Figure 13: Impacts of unregulated access to forest resources

Box 5: Property rights

Full property rights are characterised as a "bundle of rights" to resources, namely:

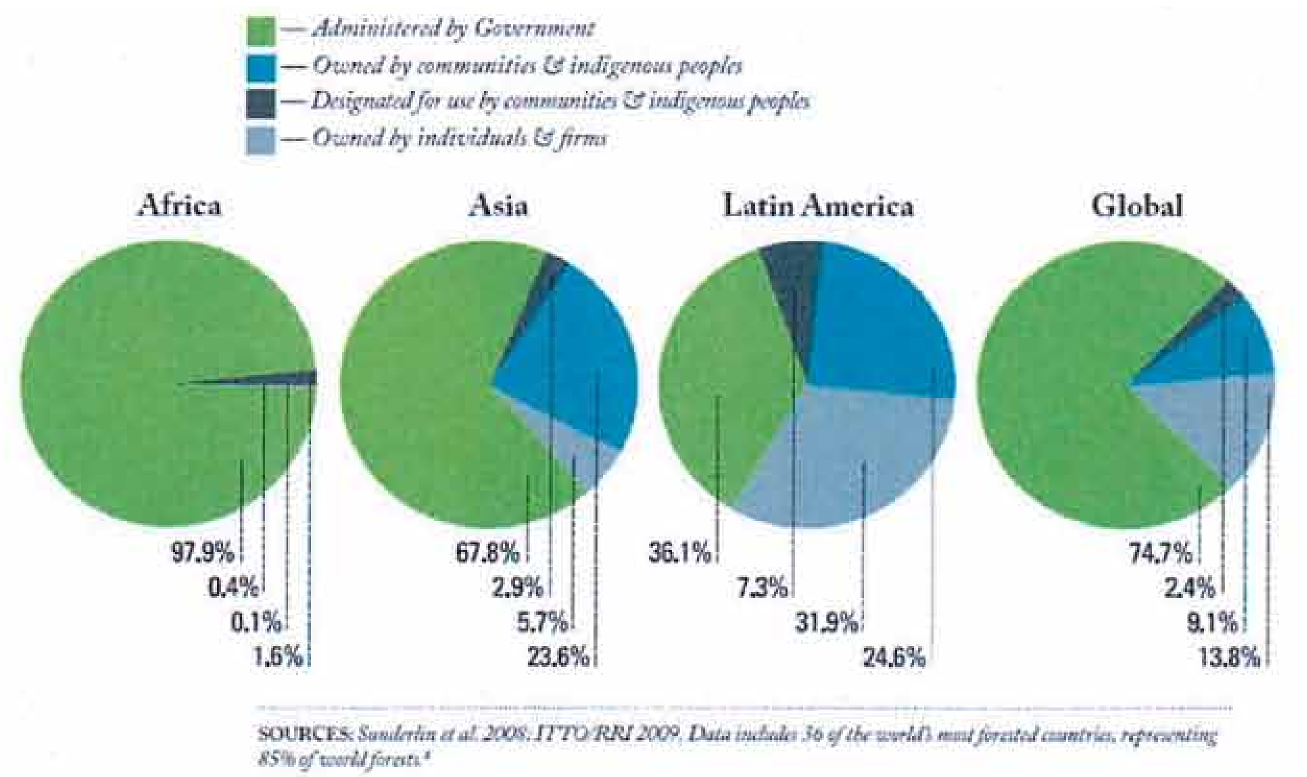
- Access (e.g. entry): the right to enter a physically defined property
- Withdrawal: the right to obtain products from a resource
- Management: the right to regulate use, improve and transform a resource
- Exclusion: the right to determine who will have access rights and how that right may be transferred
- Alienation: the right to sell or lease either or both the rights to management and exclusion.

Source: Schlager and Ostrom, 1992

Today, it is estimated that of the 3.9 billion hectares of the world's forests, 86% are publicly owned. This includes approximately 200 million hectares of tribal and community-managed forests. There are, however, large discrepancies in forest tenure among world regions, as shown in the figure below.

Recent research suggests that characteristics of forest tenure influence the ability of rural households to extract forest products and obtain income from forests. The sources of income – in terms of subsistence and marketable forest products – can be construction wood, raw processable wood and NTFP but also woodfuels. In this respect the following study is also informative for wood energy production. Jagger et al. (2014), in a study covering 271 villages in 20 countries in the three major tropical regions of Asia, Latin America and Africa investigated how forest tenure influences the ability of rural households to obtain income from forests.

Figure 14: Forest tenture in different regions of the world



Their analysis explores the role of three fundamental aspects of forest tenure, namely forest ownership (state, community, or private), varying levels of enforcement of rules, and the degree of overlap between use by formal owners and other resource users (congruence), for forest incomes realised by rural households (small-holders).

The findings suggest that state-owned forests account for high forest incomes compared to privately owned and community forests. Income from community forests was found to be by far the lowest. The authors linked this to the fact that processes of transferring rights from state-owned forests to communities often concern low-value and/or degraded forest areas (Mustalahti and Lund 2009; Ribot 2005).

While state-owned forests included in the study generated more cash than subsistence income, privately owned forests – in most of Latin America as in Africa and Asia – are characterised by a relatively low ratio of cash to subsistence income. The authors argue that this can be attributed to the aspect of distance, implying that many subsistence products are collected from forests closer to homesteads.

The study also explored how law enforcement tends to effect on the income smallholders gain from a specific tenure type. In private forests, moderate to high enforcement had the main impact that non-tenants were shut off from the resource. This effected a protection of the resource against degradation and thereby higher overall incomes for the rural households, through protecting household benefit streams over time. In state and community forests, on the other hand, increased enforcement prevented people from accessing the forest and reduced the overall rural households' income.

The degree of overlap between use by formal owners and other resource users appears to have significant influence on rural households' income. Tenure reforms seeking to eliminate overlapping claims to forests, or limiting resource use to the state, for example are likely to have negative implications for local people as they are excluded from the resource. Granting use rights for local people who are not forest owners, favors income generation for smallholders. In contrast, limiting use rights to formal owners (state, community) can have negative implications for smallholder forest income.

Apart from legal aspects of land use, practical land use plays an important role. As firewood production competes with more commercially 'valuable' – and sometimes physically vital – land uses, such as agriculture or timber production, firewood production can be implemented in a more straightforward way where substantial tracts of degraded or otherwise marginal land are available. Acute food-deficit situations will most likely preclude the establishment of firewood plantations (or any other afforestation activity), because the need for food will motivate communities to cultivate even hitherto unfarmed barren land and fallow.

Existing anthropogenic pressures that lead to forest degradation and deforestation include the expansion of cropped land and pasture, illegal logging, overexploitation, road construction, forest conversion for settlements, forest fires etc. At the bottom of these human-induced pressures are frequently insufficient legal frameworks and policies that result in participation, access and tenure issues (FAO 2010a). Among the leading factors for deforestation are: (i) Cheap land, labour, and government subsidies leading to an expansion of the agricultural area, and (ii) poorly implemented environmental regulations encouraging the conversion of forests.

Biomass energy is land intensive and thus interacts strongly with the local patterns of land tenure and resource use. The links between food security and energy for example have become quite evident in the last few years, especially at the time of the latest increases in oil prices which consequently led to the rapid increase in food prices. A specific challenge is to apply a "Nexus" approach (see the Nexus energy-food-water promoted by the FAO), i.e., an approach which involves the management and governance of several sectors and levels. Such an approach can facilitate the transition to a green economy, which aims, amongst other things, at the efficient use of resources and greater consistency in policies (Hoff 2011).

Development of wood energy programs requires an understanding of the land tenure systems determining how land resource rights and duties are distributed among individuals and groups within a given community. The incentives for managing biomass resources are embedded in such rights, and these will ultimately determine the success of bioenergy systems. They will determine whether biomass feedstock can be sustainably provided to a given wood energy project over the long term and how this can be done in a manner that ensures that other local resource related needs continue to be satisfied. No blueprint or easy options are available to solve tenure related problems and challenges. In each case, tailored solutions must be designed through careful analysis of the prevailing political, legal-regulatory, administrative, socio-economic, socio-cultural, and historical contexts. However, guidance can be deducted from The "Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security". This document was elaborated in a broad consultation process, led by FAO, with stakeholders from the public and private sector, civil society and academia. It sets out principles and internationally accepted standards for responsible tenure practices.

Several actions in regard of land tenure and land use need to be taken to support the strategic shift from demand-driven exploitation of wood energy to production-oriented management:

- Identification, documentation and subsequent reconciliation of claims to forest areas,

- Mapping, demarcation and cadastral[5] registration of forest areas, including those dedicated to sustainable production of wood-fuel,

- Clear assignation of rights, obligations and responsibilities (including decision-making authority) in respect of forest resources, both within communities (for both men and women), and pertaining to third parties,

Multi-stakeholder consultations can help foster ownership, and reduce the potential for land-use conflicts.

In order to display full impact, tenure reform and security should go hand in hand with a number of accompanying measures, especially:

- 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 owners' associations, cooperative arrangements, Public-Private Partnerships (PPP)

- Incentive systems (regulatory as well as financial), and gaining public support through advisory and assistance schemes, credit schemes, tax-holidays, payments for environmental services (PES)

- Capacity development through a diverse range of measures ranging from community empowerment and advocacy to practical management training and organisational / marketing support (e.g. through design and promotion of value chains etc.).

3.1.6 Poor institutional setting

When regarding the institutional situation of countries highly depending on woodfuel the main observation is, that the **responsibility for managing woodfuel** is of no focal concern to any of the related administrations and/or institutions. It is mostly treated as side aspect of other environmental/ energy concerns such as development of electricity/petrol, nature protection, climate change, agriculture and/or timber production. In Mozambique for example, 6 ministries are affected by biomass energy issues. Hence it is not surprising to learn that the coordination between the ministries and other relevant institutions barely exists (EUEI/ GIZ 2012).

There is frequently no culture of integrated planning in terms of supply and demand. This lack of integrated planning is evident by the lack of availability of any meaningful information about woodfuel consumption as well as woodfuel supply. For example the promotion of the development and planting of trees/forests for wood energy production is often subject to the ministries governing the forest or agricultural sector with only limited coordination.

Although in many countries woodfuel is the number one energy source merely none of the government authorities has established specialised agencies to coordinate this socio-economic important field of action. This is contrary to the multiple agencies created to develop the electricity and/or petrol sector.

3.1.7 Low enforcement capacities

Forest service's supervision and law enforcement remain ineffective and arbitrary. Although there are – in most cases – **conducive and clear laws and regulations**, Governments conspicuously fail to enforce them, thus permitting traders to produce woodfuel illegally in open access areas. The poor tax collection ratio is an indicator of a weak system of checks and balances, and ineffective accountability mechanisms. In addition, NRM contracts are not monitored, management plans remain outdated (e.g. Niger, Madagascar), and offenses against the forest code as well as petty corruption are the order of the day. The causes are manifold: **Structural adjustment programs** have significantly weakened forestry institutions, leading to a lack of confidence and morale of the forest officers. Furthermore, lack of material and financial resources – especially on the local level – leaves forest officers unable to carry out their duties without assistance by projects. This may be ascribed, at least in part, to the low political priority given to woodfuel. Furthermore, donors are noticeably reluctant to directly engage in, and address forest control and law enforcement, even though the significance of law enforcement as a key component of forest conservation and management is widely acknowledged. Instead, comprehensive institutional as well as ecological monitoring systems (which can serve as a sound basis for supervision) have been developed on project level. However, no efforts were made to mainstream them into a national and/or regional M&E System, and to provide respective capacity building support to forest officers. In Niger, the national monitoring unit closed down after the projects expired, as forest administrations are unable to enforce sustainability criteria and exercise effective control of forest dues (Sepp 2009).

5 Documenting land ownership, by producing documents, diagrams, sketches, plans, charts, and maps

3.1.8 Corruption

Widespread corruption is greatly affecting the economics of the wood energy sector as it affects production, transportation and trade, thus all segments of the value chain, reducing the financial benefits.

Corruption is a major constraint specifically affecting the natural resource management institutions. Especially, authorities charged with law enforcement often suffer from serious capacity deficits in terms of funding and personnel. Irregular salaries (around 80 USD/month e.g. in Mozambique), bad working conditions and lack of transport erode the forest service's capacity and invite extortion, fraud and corruption (sidestepping regulations, irregular issuing of permits, obstruction of punishment, etc.). Policy makers often seem to be well aware of this situation but are not willing/able to induce a change. The result is a bustling underground economy of the charcoal sector obstructing a desired formalisation of the woodfuel chain.

The REDD Report for Ivory Coast (2013), for example, mentions an annual deforestation rate of 3,5% between 1980 and 2008 with woodfuel production as the main direct cause after the conversion to agricultural land. The practice of extorting woodfuel transporters at each roadblock has virtually replaced the payment of taxes arising between 200 and 300 FCFA per bag of coal. These road blocks are put up by agents of the security forces (Police, Gendarmerie, Army, Customs, Forest etc.). As a consequence, the charcoal supply chain is being appropriated in private taxation (bribes) paid to public officials along the rural-urban supply chain leading to a loss of around 8 million USD annually in foregone taxes. Such cases are reported from several other countries such as Malawi (Macqueen and Korhaliller 2011), Mozambique (EUEI/GIZ 2012), Kenya (Mutimba and Barasa 2005), Rwanda (Ndegwa 2010).

Figure 15: Profits along the charcoal value chain (Narok-Kenya)

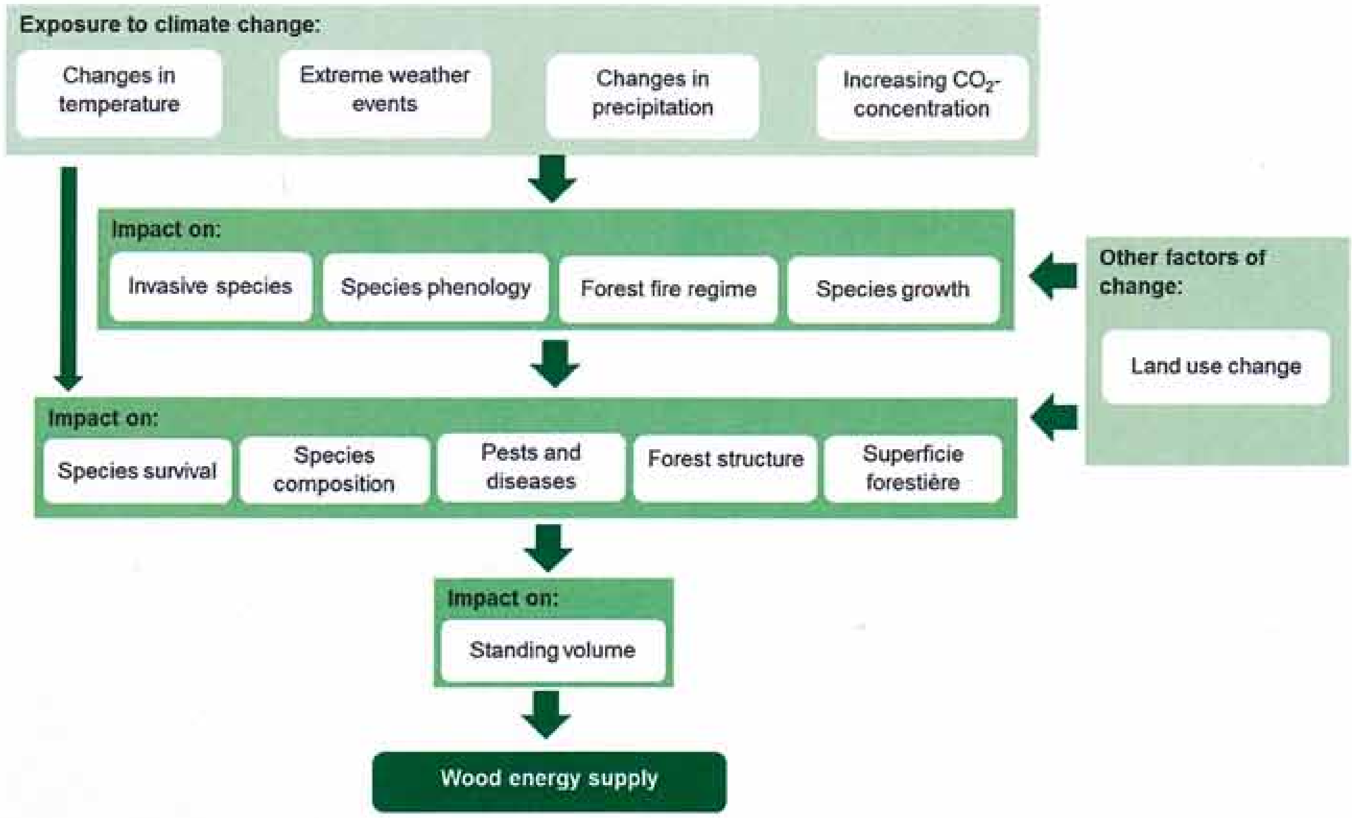
Under such an unregulated policy environment and a forest administration that is unable to enforce sustainability criteria and exercise effective control, trees for wood energy are regarded as a 'free' good and open access areas still prevail. Such unregulated extraction regimes lead to market prices, which usually only reflect extraction costs and not the costs for sustainable production such as silvicultural measures, planting material, forest protection etc. This results not only in rapid depletion of forest resources, but impedes the development of an important market which could bring income and employment to the poorest and most vulnerable segments of society in remote areas and generate taxes.

Furthermore, there is evidence that powerful stakes among key actors of the value chain and government authorities try to maintain the ignorance in favour of exercising personal advantages. The informality of the sector entails that no uniform standards are applied. Every actor of the value chain tries to draw personal advantages (EUEI/GIZ 2012).

3.1.9 Climate change impacts

When it comes to already observed and expected climatic changes, the impacts of changing temperature and precipitation regimes, extreme weather events and effects related to the concentration of CO_2 on the productivity of forest resources as a factor limiting the supply of wood energy, need to be taken into account. Stress factors attributed to climate change might in many cases not be the most prominent factor of concern but rather exacerbate existing anthropic pressures, such as the expansion of cultivated land and grazing land, the over-exploitation of timber, forest conversion into residential areas, causing both a deforestation and degradation of forests (see for example Rafanoharana et al. 2012). However, changes experienced by forest ecosystems due to environmental degradation and climate change can have an impact on energy security (see IUCN 2013). Figure 13 (adapted from CIFOR, World Agroforestry Centre & USAID 2009) gives a schematic overview of the potential impacts of climate change on wood energy supply.

Figure 16: Potential impacts of climate change on the sustainable supply of wood energy



Source: adapted from CIFOR, World Agroforestry Centre & USAID 2009

3.2 Rationale for increased investment in the wood energy sector

3.2.1 Contribution to national and local economy

Energy and energy systems have a central role in social and economic development and human welfare at all scales, from household and community to regional and national (Erakhrumen 2011).

Wood energy has the potential to be **an important economic sector** of the **national as well as local economy** - if regulated and formalised. Table 3 displays some of the rare data available to give an indication of the economic value of the wood energy sector in several African countries. Of special importance for the national level is the fact that the informal character of the wood-energy sector and unregulated charcoal trade involve substantial **forgone tax revenues**. Forgone tax revenues from clandestine charcoal production and trade in Tanzania, Kenya and Malawi are estimated to be about US$ 100 million, US$ 65 million and US$ 7 million respectively (Bart Minten et al. 2010). The unregulated charcoal trade alone is estimated to involve a direct loss of revenue for African countries of between $1.5 billion and $3.9 billion annually (UNEP 2014).

At local level sustainable production of woodfuels can in particular serve as an engine for **sustainable rural development**: Wood resources are locally available and display a high potential for decentralised production and processing. Often they are the only opportunity for some additional income.

The **employment and income** effect of wood energy production is much bigger than that of LPG, Kerosene (as the most important alternatives to wood energy) or electricity.
Studies from Kenya and Madagascar confirm that around 15.3 (Bailis 2005) to 17[6] person-days are needed to produce one ton of charcoal when applying a kiln conversion efficiency between 14% to 20%. This is equivalent to the World Bank/ESMAP estimates. Thereafter charcoal creates between 200 to 350 jobs per TJ of energy consumed whereas electricity only creates between 80 to 100 jobs, LPG only 10 to 20 jobs and kerosene only 10 jobs for the same amount of energy consumed (Barnes et al. 2005).

6 Research results of PGME-GIZ Madagascar 2014

Table 3: estimated annual value of the wood energy value chains (in million USD)

	Charcoal (Market commodity)	Fuelwood (Only partially marketed)	Forgone taxes/ bribes	Source
Ivory Coast	301	760	8	(Sepp 2014a)
Kenya	1.600		65	(MEWNR 2013) (Sander et al. 2011)
Tanzania	650		100	(Sander et al. 2011)
Malawi	41,3		5-8	(Macqueen and Korhaliller 2011)
Mozambique	250-300		50	(EUEI/GIZ 2012)
Burundi	45	316		(Sepp 2014b)
Togo	103	302		ibid
Ethiopia	63	391		ibid
Madagascar	150	340		ibid

The figures suggest that promoting charcoal can create more jobs than any other fuel. In Sub-Saharan Africa it is estimated that 13 million people are employed in the biomass energy sector (Openshaw 2010). If substitution of biomass with LPG is encouraged, then people will have to find alternative employment. This bears the risk of even increasing deforestation and greenhouse gas emissions as people would clear more forests and woodlands for agriculture and pastoralism.

Especially during the last 10–15 years, a large body of research has focused on **forest income** showing that in Africa, Asia, and Latin America forest income makes significant contributions to livelihoods in rural settings. A recent global comparative analysis of environmental income[7] from approximately 8000 households in 24 developing countries collected by research partners in CIFOR's Poverty Environment Network (Angelsen et al. 2014) estimated the average share of forest income in total household income at 22.2% or, in absolute terms, an annual US$ 440. In line with numerous previous studies, the findings suggest that environmental income shares are higher for low-income households and that poor households rely more heavily on subsistence products. However, the authors observed notable regional variation. While for the Latin American sites, forest income constitutes 28.6% of average household income, the shares in Asia and Africa are 20.1% and 21.4%, respectively.

7 In the cited study, "Environmental income" refers to extraction from non-cultivated sources such as natural forests, other wnon-forest wildlands such as grass-, bush- and wetlands, fallows, but also wild plants and animals harvested from croplands.

The economic importance of wood energy is not limited to developing countries: It is interesting to note that Minnesota's Department of Energy and Economic Development noted that 1USD spent in Minnesota on petroleum energy generates 34 cents of additional economic activity, while 1USD spent on biomass generates an additional 1.50 USD of local economic activity (personal notification).

3.2.2 Improving public health

Inefficient use of wood energy causes significant damage to the health especially of women and children. Each year, upwards of 1.5 million people die of diseases caused by indoor pollution, two thirds of whom in Southeast Asia and sub-Saharan Africa (WHO 2006).

People in developing countries often use traditional cookstoves, which are primitive, highly inefficient, and strongly polluting. Besides GHGs, wood burning, especially in case of incomplete combustion, is an important source of air pollutants such as particulate matter (PM1, PM2.5, PM10, total suspended particles, elemental and black carbon) and heavy metals, non-methane volatile organic compounds, persistent organic compounds, and carbon monoxide. Health risks effects of pollutants from biomass combustion include premature death, lung damage, chronic bronchitis, allergies, asthma and lung cancer. These health problems disproportionately affect women and children. According to the WHO (2011), indoor air pollution was responsible for about 2 million deaths annually including over 1 million deaths from chronic obstructive pulmonary disease and almost another million deaths from pneumonia in children under the age of 5.

Health impacts depend on a range of parameters related to the fuel properties, the type of stoves used, the kitchen environment and cooking behaviour. Generally, the emission from burning fuelwood generally has a higher negative impact on health than charcoal or LPG, which are considered relatively clean-burning fuels. A complete transition to charcoal would reduce the incidence of acute respiratory infections by 65% (World Bank 2009a). LPG stoves emit 50 times fewer pollutants than traditional biomass burning stoves (Schlag and Zuzarte 2008).

Research over the last few years shows improved cookstoves reduce both particulate matter (PM[8]) and carbon monoxide (CO) from burning woodfuel by around 24% to 70% (Dutta et al. 2007; Pennise et al. 2009; Roden et al. 2009). A recent meta-analysis of 25 studies (including Africa, China and Latin America) shows that compared to cooking with clean fuels or improved stoves, cooking with biomass increases the risk of pneumonia by 80% (Bruce 2008).

8 Including black carbon (= PM ≤ 2.5 µm)

3.2.3 Promoting gender equality

The difference in men's and women's engagement in the wood-fuel flow mechanism has been described in the FAO report titled "Gender Aspects of Fuelwood Flows in Sri Lanka" (RWEDP 1999). In the report, "heavy" work is defined in relation to the activities exclusively performed by men. The nature of the hard work involved in fuelwood collection is perhaps better portrayed by the fact that the average fuel load carried in sub-Saharan Africa by women is 20kg, although loads of 38kg have also been recorded (IEA 2006). From Laos similar loads (15-20 kg) are documented with a frequency of 120 – 150 of such loads per year (Prathoumvanh 2000).

The relationship between energy and women's work and wellbeing is evident in women's role as users of energy sources, producers of traditional biomass fuels and educators concerning the collection, management and use of fuels. In addition, collecting fuelwood is also associated with child labour (Blackden and Wodon 2006). In Tanzania, many children, especially girls are withdrawn from school to attend domestic chores related to biomass use, reducing their literacy and restricting their economic opportunities (IEA 2006). In places where there is reduced vegetation cover, women and children have to travel long distances in search of fuelwood. However, it has to be noted that collecting fuelwood does not always imply women. In Madagascar, men spend almost twice as much time as women (Blackden and Wodon 2006).
In Lao surveys showed that when women became more active contributors to the family income, through activities such as weaving and sewing, the division and pattern of family labour between husband and wife changed. Men became more involved in domestic tasks such as cooking, collecting firewood and collecting water, tasks that were traditionally the reserve of women (Prathoumvanh 2000).

The Biomass Energy Strategy from Mozambique (EUEI/GIZ 2012) displays the significant involvement of women in the charcoal value chain (see table 4). Similar high involvement of women in the commercial value chain can be reported from other countries such as Ivory Coast, Togo etc. (Sepp 2014b).

3.2.4 Contribution to forest protection and climate change mitigation

Sustainable provision of wood energy can potentially create a strong incentive **for forest protection:** Mounting scarcity of fuelwood – on national (deforestation and forest degradation, need to expend foreign currency for the purchase of substitute energy carriers) as well as individual/household levels (cost increases, longer supply-distances) – provides a strong case for sustainable forest management. Numerous success stories confirm that rural user groups eagerly pursue wood-energy production as a critical (and all too often the only) income source, and willingly accept management rules and procedures geared towards sustainable use. Arguably, improved wood-energy practices and investments may provide a significant contribution to the "green economy" concept. However, these national and international investments are expected to have far-reaching ecological (plantations) and socio-economic (poverty, food security, tenure rights and access to resources) consequences (Cotula et al. 2012).

As far as the issue of **climate change** is concerned, reduced greenhouse gas emissions are one of the main policy rationales for promoting woodfuels through reforestation. Woodfuel value chains that provide for the livelihood and energy needs of the local population, while at the same time reducing emissions from forest degradation, are being developed (Schure et al. 2014).

Woodfuels can reduce carbon emissions in two ways (Kartha 2006). First, over their life cycle, woodfuels absorb and release carbon from the atmospheric pool without adding to the overall quantity of circulating carbon (in contrast to fossil fuels). Second, they displace the use of fossil fuels. Nevertheless, it has to be considered that the production of woodfuels does in most cases involve consumption of non-renewable fuels. Higher use of mechanisation and fertilisers during production create emissions, and transport of processed fuels is another potential contributing factor. In many cases, these additional emissions may be relatively small compared to the avoided fossil emissions, and such transportation and production emissions are also present in other energy production chains as well (e.g. fossil fuel production, solar/wind equipment production, etc.).

Table 4: Number of women involved in the commercial charcoal value chain in Mozambique

	Production	*Transport*	*Wholesaling*	*Retailing*	*Total*
Nbr. of people	95.092	5.660	11.482	101.885	214.119
Nbr. of women	17.461	57	3.202	91.697	112.416
Share	18%	1%	28%	90%	53%

Source: adapted from EUEI/GIZ (2012)

While policy-makers and bioenergy producers have underlined the potential role of bioenergy in reducing global emissions of greenhouse gases, its contribution to climate change mitigation has also been contested, especially in relation to greenhouse gas emissions resulting from (indirect) land use change. UNEP (2012) examined how bioenergy policies relate to the REDD+ mechanism and found that there is considerable potential for conflict between these two approaches to climate change mitigation. On the one hand, the increasing demand for bioenergy adds to the demand for agricultural land, and thus potentially competes with other land uses, (including for REDD+) and exerts pressure on forest. On the other hand, REDD+ policies may reduce access to land for bioenergy development. In order to overcome trade-offs and create synergies between the two approaches and to maximize effectiveness of climate change mitigation while at the same time creating positive outcomes for forest conservation and forest users, careful and integrated land use planning is needed. As far as climate change adaptation is concerned, several stakeholders (e.g. GIZ, World Bank) have already engaged in promoting resilient wood energy value chains. Efforts in Togo and Burkina Faso for example aim at reducing vulnerability at all segments of the value chain and include concrete adaptation measures (e.g. use of drought resistant tree species). At the same time, numerous measures targeting the creation of a modern and efficient value chain hold potential for reducing vulnerability. The diversification of wood energy sources for example contributes to reducing the pressure on natural forests and therefore reduces their sensitivity. The introduction of information systems for the value chain will also provide analysis for public decision makers allowing stakeholders of the sector to adapt better (Richter et al. 2014, Charpin et al. 2014).

3.3 Prospects for implementation

3.3.1 Encouraging policy arena

In recent years, many industrialised countries have adopted new energy policies giving way to an increased utilisation of wood energy within their "energy mix". Wood energy is progressively penetrating the energy markets of industrialised countries as a clean and locally available alternative to fossil fuels. The considerable knowledge gained and disseminated in recent years by energy agencies, environment departments, forestry services and private companies is leading to a better understanding of wood energy systems and is expected to contribute to overcoming the main barriers and to promoting the development of more sustainable woodfuel production systems also in developing countries (Trossero 2002).

Several international donor-driven initiatives aim at promoting sustainable wood energy value chains, for example:

- The Global Bioenergy Partnership's Working Group on Capacity Building for Sustainable Bioenergy which, through its FAO, UNEP and UNF/GACC –led Activity Group 4 "Towards sustainable modern wood energy development", focuses on sustainable production and use of wood energy for household energy access and productive local uses - primarily in developing countries.

- The Dutch-German-Norwegian-Australian-British-Swiss Partnership Energising Development (EnDev): a global sector initiative cooperating with several partner countries in Africa, Latin America and Asia promoting access to sustainable energy for all.

- The Energy Sector Management Assistance Program (ESMAP), a global knowledge and technical assistance program administered by the World Bank. Its mission is to assist low- and middle-income countries to increase know-how and institutional capacity to achieve environmentally sustainable energy solutions for poverty reduction and economic growth.

- In the Action Plan for World Bank engagement seven major themes are addressed one of it is the sustainable production and value chain development for woodfuel and charcoal industries (World Bank 2012).

3.3.2 Large potential for technical improvements

Technical improvements are possible all along the value chain. Besides improved plantation and forest management techniques, the largest potential for improvements lies in charcoal production and end consumption.

It has to be pointed out that investments in **charcoal-production efficiency** have received the least attention of all woodfuel value chain components. There have been many more improved cook stove programs than there have been kiln efficiency improvement projects (Mugo 2014). Charcoal kilns are generally characterised by low energy efficiency: Carbonisation of wood into charcoal generally takes place in traditional earth kilns that are constructed underground or above ground with an energy efficiency of around 8-15 %. Thus, the present transition to charcoal in Africa's urban centres puts enormous pressure on peri-urban wood resources. Improved, more efficient, kilns may yield up to 30 %. However, despite many efforts, such kilns are not being adopted for several reasons, including higher investment costs, complexity of construction, and the need for special training.

For example, the Casamance Kiln developed in southern Senegal that was introduced in Burkina Faso has not been adopted due to associated costs and lack of suitable raw materials. The Metal Kilns introduced by CILLS, also in Burkina Faso, were not suitable for wet weather conditions and rusted. Furthermore, wood for charcoal is mainly obtained in a non-sustainable manner from forests at no cost. Whole trees or branches are cut down, rather than the twigs and dead wood needed for fuelwood. Access to 'free' wood hampers the introduction of improved efficiency kilns, by making them less economically attractive. During transport, up to 20 % of the charcoal is lost due to breakage. Several attempts have been made to use the charcoal 'fines' (dust) by introducing briquetting technologies, but with little success to date.

In contrary, a lot of support was provided to the dissemination of **improved cookstoves**. In recent years, various stakeholders including governments, non-governmental organisations, and international development agencies are focusing on improving access to affordable and reliable modern forms of energy services for cooking e.g. (SE4ALL and Global Alliance for Clean Cookstoves). A wide range of improved stove designs can be found, and reported fuel savings vary from 10% to 60%. Examples are the Kenya Ceramic Jiko and the Ethiopian Lakech. These stoves save up to 40 % of the charcoal that would be used in traditional stoves. One of the reasons for this success might be that households have to purchase charcoal, and using efficient stoves to save fuel directly saves money.

Overall, the use of improved cook stoves (ICS) to reduce woodfuel consumption remains low in most African countries. In Ouagadougou/Burkina Faso e.g. the dissemination of ICS started by GIZ in the early 80ies and since then has been continued not only by GIZ but also by other development agencies. Today, an estimated 9.6 per cent of households use ICS (IOB 2013). Similar results are reported from DRC Kinshasa and Kisangani, where only four and three per cent of households respectively use improved stoves (Schure et al. 2011). Control trials conducted in rural Orissa. India, showed that households fail to use the stoves appropriately. Households did not make the necessary investments to maintain the stoves properly. Their use ultimately declined (Hanna et al. 2012). Other recent research results confirm that the expected effects concerning a reduced exposure to indoor air pollution, GHG emissions, preservation of forests and associated ecosystem services, and in reducing emissions that contribute to global climate change could not be achieved (Jeuland et al. 2012).

The only real success story to be mentioned is the **Kenyan Jiko.** The Ceramic Jiko, an improved ceramic stove suitable for more efficient burning of charcoal, was very successfully introduced in Kenya. It gained widespread use and popularity, partly because it was designed and produced by local artisans ensuring to meet local consumer preferences. When it was initiated in the neighbouring country Tanzania it failed to meet these demands.

In general, the adoption of improved cook stoves has been **below expectations.** However, if greater dissemination rates were reported this was attributed to (Ekouevi and Tuntivate 2011): (a) an effective marketing strategy with tailored information and educational campaigns; (b) profit-making strategies developed to support stove producers; and (c) actual recognition by consumers that improved stoves help them effectively reduce fuel consumption and ultimately save money.

3.4 Key messages

- Reliable baseline data on the woodfuel value chains, e.g. on their contribution to national economy, are essential for shaping conducive policy decisions and yet they are still largely missing.

- The wood energy sector is located at the interface of forest and energy policy and is characterised by insufficient intersectoral cooperation and coordination and a lack of adequate consideration in sector policies.

- Where regulatory mechanisms governing wood-fuel production and use are put in place, they are often poorly designed and implemented due to capacity deficits of authorities in charge and deficiencies in decentralisation.

- Tenure security is one of the most significant framework conditions necessary for sustainable forest management and thus for the production of wood energy. The incentives for managing biomass resources, conditioned by patterns of land tenure and resource use, will ultimately determine the success of bioenergy systems. Open access and unregulated use allow the growing scarcity of wood resources to go unnoticed – or else obscured until overexploitation has exhausted forest resources to the point of deforestation and economic non-feasibility.

- Factors affecting the formalisation of the wood value chain and putting it on a sustainable basis include price, convenience and reliability of supply but also corruption and oligopolistic structures of the value chain.

- Fuelwood and particularly charcoal are important sources of household income on a global level, especially in Africa and Asia. The charcoal value chain holds an enormous potential to create jobs, more than any other fuel.

- Woodfuel prices often do not reflect their real value since the costs of environmental services and sustainable resource management are not adequately captured.

- Modernisation of the wood energy value chain can significantly mitigate damage to the health especially of women and children caused by traditional use of wood energy with primitive, highly inefficient, and strongly polluting cookstoves.

- As far as environmental aspects are concerned, sustainable provision of wood-energy can potentially create a strong incentive for forest protection. Wood energy production significantly influences surrounding ecosystems, enhancing or suppressing biodiversity.

- The link between wood energy and climate change is twofold: on the one hand, soundly designed wood energy projects have a huge potential to contribute to carbon sequestration and reduce emissions from fossil fuel combustion, forest degradation and deforestation. On the other hand, forest resources are vulnerable to climate change which potentially impacts the supply of wood energy.

4 Wood energy projects in practice – lessons learned

4.1 Delivery modes

Most wood energy projects are implemented in the framework of **bi- and or multilateral cooperation agreements** or through **NGO engagement**. It is noticeable that most of them do not apply a holistic approach, (addressing framework conditions and the entire value chain) but often support only one or few segments (e.g. BEST, reforestation, CBFM, or improved cookstoves etc.). This impedes the desired synergetic effects along the entire value chain and the policy and regulatory framework. Interventions following a holistic approach would by nature be long-term commitments and would require solid anchoring within the partner countries' political and institutional setting. However, existing projects are often designed for one phase only, with a duration of three years on average. Though such interventions may pave the way for punctual sustainable reform they are insufficient for achieving the necessary impacts. Initiatives in the wood energy sector are too often project-driven and do not foresee long-term support by specially trained facilitators and catalysts after the project's expiry. This assigns a crucial role to forest administrations and NGOs who need to gain ownership through adequate participation.

The principal **avenues of governments** in support of wood energy are through enabling regulatory and fiscal frameworks. In SSA, governments opted for a systematic **transfer of management responsibility** of state-owned forests to communities. This has paved the way for local populations' empowerment, with positive effects on the future sustainable development of forests. **Government subsidies** for tree planting and reforestation as practiced in Latin America as well as in Asia, are reported to have been very successful (see chapter 4.5).

As far as the Indonesian experience is concerned, the Reforestation Fund, a national forest fund financed by a volume-based timber levy to support reforestation and forest rehabilitation established in 1989, has largely been ineffective. The problems encountered comprise on the one hand a serious lack of financial governance which led to mismanagement and misuse of the funds means for politically favoured projects outside the Fund's mandate (Barr et al. 2010). On the other hand, the example shows that **funding for forest management** needs to be embedded in a broader approach of promoting enabling framework conditions. Important challenges such as insecure forest land tenure, limited access for locals to forest resources, limited capacity of human resources in managing forests, and inconsistency in forest law, regulations and management scheme, were not adequately taken into account and as a consequence the program fell well short of targets (Low 2010).

Another delivery mode, known as 'outgrower schemes' concerns the private industry. It entails companies entering into long-term partnerships with small growers. The companies provide financing (loans) and inputs such as seedlings and extension support for the establishment and maintenance of the woodlots.

For the companies, these schemes address the need to develop long-term timber/woodfuel supplies without tying up large amounts of capital in land holdings when all they require is wood. This also comprises contract tree growing on estate land by neighbouring farmers (e.g. the Malibi NGO in Ivory Coast).

One of the greatest private initiatives in Africa is the large-scale reforestation program of Green Resources in Tanzania, Uganda and Mozambique. The company, established in 1995, is a private Norwegian company with 80 shareholders. It employs more than 3,600 people, with a total investment sum of USD 120 million in its African operations (Green Resources 2012). Green Resources aims to establish over 100,000 ha of plantations, among others for the growing regional and global bio-energy sector. In Tanzania Green Resources paid a 99-year land lease to the Tanzania government for tree plantations, then developed and sold carbon credits. This provoked questions as to the land tenure policy of the Government where the access of communities to their traditional land was blocked without local consent. Criticism by national and international groups centers on the keywords land grabbing /carbon grabbing /green grabbing (Ardenti 2013; Ernsting 2014; Lyons and Westoby 2014).

4.2 Wood energy policy shaping

4.2.1 National wood energy policy and strategy development

A number of institutions have supported the drafting or review of **wood energy policies or strategies**. An early example is the FAO-implemented Regional Wood Energy Development Programme which assisted 16 countries in Asia to assess their wood energy situation and develop strategies (RWEDP-FAO 1997). The Permanent Inter-state Committee for Drought Control in the Sahel (CILSS) supported through its Regional Programme for the Promotion of Household and Alternative Energy Sources in the Sahel (PREDAS) the development of a series of Household Energy Strategies in Mauritania, Senegal, Cape Verde and Guinea-Bissau. All these strategies experienced no real buy-in by the Governments and were eventually shelved. **Low priority on the political agenda**, including lack of further support through the international community are only few of the explanations.

To date, a leading example is the **Partnership Dialogue Facility of the European Union Energy Initiative (EUEI-PDF)**, initiated and funded by several EU member states and the European Commission. Its objective is to support the development of policies and strategies for the promotion of access to energy at national and regional level. As part of this mission, EUEI-PDF supports countries in SSA to design action-oriented strategies that create an enabling environment and platform for government, private sector and donor-funded investments in improved energy access (EUEI-PDF/GIZ 2014).

A key component of this effort has been the provision of technical assistance for the development of national **Biomass Energy Strategies** ("BEST"). In response to government requests, such assistance has so far been provided to Botswana, Lesotho, Malawi, Rwanda, Mozambique, Ethiopia and Tanzania. While the strategies subsequently drafted have sought to highlight the missed opportunity of biomass, the partner governments would often have preferred an "anything-but-biomass" approach, as they look for ways to reduce – and eventually replace – this form of energy, in line with their National Energy Policies (Owen et al. 2013). The **necessary awareness for this important energy carrier is still not existent** among most of the key decision makers. It is therefore not surprising that while 35 governments in SSA have set strategic targets to increase access to electricity, only 13 have done so for other "modern" fuels (mainly kerosene, liquefied petroleum gas and natural gas) and just seven for improved wood or charcoal stoves (UNDP and WHO 2009).

An important supranational effort is the recently created **Africa Bioenergy Policy Framework and Guidelines (BPF)**. The BPF was developed to provide an African reference framework to bioenergy issues at the continental level in order to help African countries design bioenergy policies contributing to a more sustainable energy mix. The BPF highlights that "bioenergy resources are poorly used (for instance inefficient energy conversion process and poor cooking devices) and there is urgent need to formulate policies that can mobilise resources and stakeholders to make a proper use of the resources to the benefit of humans and the ecosystems". The development of the **African Sustainable Charcoal Policy Framework** (ASCPF) is an important step in the implementation of the overall BPF. It will provide guidance towards the modernisation of an important segment of biomass energy and improved sustainability of charcoal along the value chain from wood production to end-use. The African Union Commission (AUC) provides a coordination function at the continental level on the Sustainable Charcoal Policy Framework.

A recent document published by the SNV (Dutch) supported **REDD+ Energy and Agriculture Programme** (REAP) highlights facts that help policy makers and practitioners to better understand the woodfuel value chain by linking it with the REDD+ objectives (Schure et al. 2014). In this context it is also noticeable that in some countries (e.g. Ivory Coast, Congo, Burkina Faso) the REDD process has taken up the issue of wood energy as one of its priority engagements (MINESUDD 2013; Schure et al. 2014).

The above examples show the difficulties to create ownership and political commitment at country level when donor driven initiatives support policy and strategy development for wood energy. The first lesson is that creating ownership requires enough time for a real participatory process. Decision makers and the public must be informed on the potentials of wood energy. It might be necessary to adapt the key messages to the specific interests of different sectors. There is a potential of mainstreaming wood energy into forest, energy and other sector related processes but this requires considerable efforts in terms of intra and, cross-sectoral coordination.

Furthermore, policy and strategy development should be based on existing woodfuel-related strategies as an entry point. This might entail moving away from isolated wood energy interventions, towards a more holistic and integrative approach. Assessing global and regional dynamics and opportunities, identifying the needs and societal concerns, putting in place the necessary legal and institutional frameworks for co-ordinating and integrating economic, social and environmental objectives, mobilising and building capacities (human and institutional), consulting and engaging stakeholders, and setting up monitoring mechanisms are all critical to the success of a sustainable bioenergy policy. Support to policy formulation should be followed by support to an efficient implementation.

4.2.2 Land use and wood energy supply planning

Land use planning is an indispensable precondition for sustainable forest management (and, by extension, sustainable provision of biomass energy). It ensures quantitative protection of forest resources against haphazard conversion for short-sighted gains, and helps to prevent/mitigate disputes over access to land resources. Land use plans analyse, valuate and prioritise multiple interests in land. From a forest governance point of view, land use plans serve a double purpose: first, to determine the permanent forest estate, and, second, to identify "surplus" areas available for reforestation. In Madagascar (➔ case study Madagascar), the potential reforestation sites have been identified through a spatial planning exercise incorporated into a regional land use plan.

At local level, the development of **Woodfuel supply master plans** (WSMP – originally initiated by World Bank) is now common practice for cities such as Niamey, Maradi, Zinder (Niger) N'Djamena (Chad) (AEDE/ECO 2002), Kaolack, Ziguinchor (Senegal) to support the sustainable supply with woodfuel. As in Rwanda (Drigo, Rudi et al. 2013), this is partially also done on the basis of a WISDOM exercise (see 4.2.3.). The WSMP are based on forest resource inventories in the woodfuel catchment areas of each city, complemented by socio-economic studies. They assess: (i) available woody resources (estimated areas, standing stocks and yields) (ii) prevailing woodfuel flows, describing the main woodfuel supply chains and the current woodfuel harvesting and charcoal-making areas at local level (iii) human dynamics (history, demography and migrations, main land-based activities, etc.). The WSMP highlights the geographic priority areas and gives strategic guidelines for implementation. Experience shows, however, that the operational relevance of those master plans is rather limited due to the fact that the process does frequently not succeed in creating adequate institutional ownership through participation in the process, no concrete and realistic action planning is involved and the issue of financing is generally not addressed.

Recently, a more future/development-oriented way of developing the wood energy sector has emerged; these combine woodfuel supply master plans with actions plans to modernise the woodfuel value chain. These plans are developed on sub-national level under the auspices of a **"strategic support unit (SSU)"** (see next chapter). Examples are the Wood Energy Modernisation Strategy for the Extreme North of Cameroon (MINFOF 2013) and the wood energy strategy for the Diana Region of Madagascar (Richter et al. 2009).

4.2.3 Wood energy data collection and analysis

Reliable data on wood energy are important to promote wood energy on the decision-making level and in the field. They are also a prerequisite for intervention planning. The process of collecting and verifying facts and figures is a laborious, costly and time-consuming undertaking, requiring properly trained and qualified personnel. To alleviate these constraints, FAO has published a guide outlining simple, rapid methods to verify existing data, to fill gaps in the information chain, and to conduct more reliable surveys (EC-FAO 2002).

Box 6: WISDOM Analysis

A WISDOM analysis involves five main steps: (1) selection of the spatial base, (2) development of the demand module, (3) development of the supply module, (4) development of the integration module, and (5) identification of woodfuel hotspots. On the national level, the WISDOM approach has been implemented in Mexico, Senegal and Slovenia. On the subregional level, WISDOM has been implemented over the Eastern and Central African countries covered by the Africover Programme (Burundi, D.R. Congo, Egypt, Eritrea, Kenya, Rwanda, Somalia, the Sudan, United Republic of Tanzania and Uganda) and over the countries of Southeast Asia [(Cambodia, Malaysia, Laos, Thailand, Viet Nam and China (Yunnan Province)].

FAO also developed and introduced the **Wood-fuel Integrated Supply/ Demand Overview Mapping** (WISDOM) methodology 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 woodfuel as a renewable and prolific energy carrier. The methodology has been expanded to investigate the scope of urban woodfuel supply[9], which identifies the extent to which supply zones encroach into rural areas and forests (Trossero et al. 2008).

WISDOM is a powerful analysis tool. It seems imperative, however, to couple any analysis reports with strategic planning to modernise the value chain as a whole. It seems that the WISDOM tool has often not been properly introduced to the respective administrations of the partner countries for further application. Once trained personnel has moved, the tool has not been institutionalised sufficiently, so that, as in the case of Mozambique, the measure remained a well-intentioned but unsustainable intervention.

A tool has been developed recently (FAO 2014) that supports countries in the design of bioenergy policies and strategies The BEFS approach does not refer exclusively to wood energy but to biofuels in general and includes a Rapid Appraisal Tool which can help to guide policy makers to assess the sustainable wood energy potential in their countries – the basis of policy formulation. It covers feedstock availability, definition of biofuel options with their socioeconomic implications and trade-offs.

4.3 Setting up adequate institutional frameworks

In order to overcome institutional settings experienced as inadequate (see chapter 3.1) an array of reform processes have been undertaken: An early initiative was the World Bank supported Household Energy Project, HEP, in Chad, 2001 (➔ case study Chad). **An independent, cross-sectoral agency for household energy and environment** (Agence pour l'Energie Domestique et l'Environnement – AEDE) was created on national level to spearhead the formalisation of the woodfuel sector and to place it in on a sustainable basis.

AEDE operated as an autonomous, private, non-profit agency of a public status. It was governed by a board that consisted of representatives of the associated ministries (the Treasury, Environment, and Energy) as well as the private sector. Its success has been confirmed by the World Bank implementation completion report (World Bank 2004).

The recent initiatives by some African Governments to establish **Renewable Energy Agencies** seem to be steps in the right direction. However, the focus of these agencies is on promoting the renewable power potentials of solar, wind, hydro geothermal as well as biofuels but not necessarily that of wood energy. The strategic orientation of the 2013 created Africa Clean Energy Corridor initiative by IRENA bears witness of that.

Another example on sub-national level can be cited from Madagascar where a regional environ-mental concertation platform (OSC-E/DIANA) was established and took stewardship to implement the woodfuel modernisation strategy (➔ case study Madagascar).

9 The term "urban woodsheds" is analogous with the familiar geographic concept of watersheds.

This platform reunites relevant civil society representatives of the respective region. These gather regularly to discuss the progress of the modernisation process and to negotiate how to overcome upcoming barriers. Likewise, the creation and empowerment of regional governance structures in Senegal, piloted by the regional government in close cooperation with the forest service, provides an encouraging example. Support for institutional development (e.g. recruitment of forestry technicians by the Regional Council) and capacity building at local level (e.g. for Forest User Groups, Forest Management Committees, Inter-village Committees) proved to be a key to successful implementation (➔ case study Senegal).

Another aspect is that woodfuel producers are usually reluctant to formalise their businesses. Firstly, because they are unsure if investments can be recovered, given the high cost of formalisation. Secondly, their relation with local and central government officials (many of whom are suspected of corruption) is often fraught with mutual distrust. Thirdly, procedures are usually time-consuming and complicated. Rwanda can be cited as an example, where formalisation is in good progress. This is partly a result of fair prices paid to the producers (World Bank 2011).

4.4 Devolution of power

As already outlined in chapter 3.1 secure tenure rights are crucial for sustainable management of forest resources. Since state ownership of forest lands had fallen short in many respects, during the predecessing decades, and in the international political climate and shift of powers of the 1990ies many countries embarked on processes of **devolution and decentralisation**. Forest property and management responsibilities were increasingly transferred to stakeholders, both local communities and private entities.

In this context, devolving control over forest land and forests from a centralised forest authority to the village, user group, or individual household has gained particular significance. The goal is to try to better expand forest access to local people to address problems stemming from both the failures of state management as well as the prevalence of open access.

South Korea and Nepal illustrate long-standing devolution to the village level. Subsequent to a land reform, the Republic of South Korea for example, initiated in the 1970ies the "Saemaul Undong" movement amongst others to increase the number of forest management efforts through local communities to satisfy their woodfuel demand (Ferguson and Chandrasekharan 2004). Some 73 per cent of the forest area of the Republic of South Korea is under private ownership, the average size of holdings being 2.6 ha.

The system is often cited as an example of a successful system of cooperative, multitiered and federated structure with a comprehensive program, involving social mobilisation and covering all aspects of forestry for the improvement of community life. The selected case studies of experiences in the Asia-Pacific Region reviewed by Ferguson und Chandrasekharan (2004) show that devolution to village levels is more likely to be effective when adapted to traditional systems of governance and aimed principally at poverty alleviation and fuelwood supply.

In Africa the first experiences of **devolution of power to local people** for wood energy production started in the late 80ies, when community-based forest management (CBFM) was introduced. Under CBFM, responsibilities formerly held by government forest services are delegated to local civil society institutions and harvesting becomes the responsibility of local user groups. Members of these groups are entitled to extract and sell forest products according to regulations that specify harvesting areas, standards, and quotas. Fees paid by the user groups from their commercial sales are typically invested in social infrastructure and sustainable forestry operations, with a portion also remitted to the government. CBFM alters the balance of power towards community-level institutions and away from central government and commercial quasi-monopolies that often dominate forest product trade, especially the urban charcoal trade (Miranda et al. 2010).

An apparently successful example of this type of initiative is the support for village managed **rural fuelwood markets** in the periphery of urban Niger (around Niamey, Zinder, and Maradi), where unsustainable fuelwood harvesting had decimated natural woodlands. It has demonstrated that woodlands can be restored and made productive, relying primarily on local efforts and minimally on forest service outlays (Noppen et al. 2004). Villages in Niger for the first time provided proof that self-management of wood resources creates significant income and employment through rural woodfuel markets (Oumarou 2007). Notwithstanding the project's demonstrated success, the Niger Government was not in a position to replicate the fuelwood-market concept on its own initiative. To date, only 13% of the total national demand can be satisfied by the rural fuelwood markets. The remainder is still supplied from uncontrolled areas. However, a review of the project impact two decades after the project had started, confirmed that there are still signs of sustainable forest management on community level, although no substantial support from the forest services is provided. The various projects in the past focused on community empowerment and capacity building, but failed to pay equal attention to capacity deficits of the forest service. Often they created parallel structures (advisory services, monitoring units), so as to achieve their ambitious objectives in the shortest possible time (Sepp 2009). The approach became known as the "fuelwood market approach". It has been replicated with World Bank support in Mali and Chad (➔case study Chad).

There has been a growing allocation of forests to **private households** in selected countries such as Vietnam and China, significant growth of plantation forestry in the Philippines, and large increases in forests in Uruguay due to successful private afforestation efforts (FAO 2006a). In Africa growing of trees by private farmers to supply markets for wood products is not a new or unfamiliar phenomenon, and examples from Madagascar and Rwanda illustrate the conditions under which it can thrive. Farmers in Rwanda have become aware that with security in land tenure and rising woodfuel prices it has become profitable to invest in tree planting and to produce poles, firewood and wood for charcoal making. Rwanda is one of the few examples of African countries with increasing forest cover since 2000.

The village-based **individual reforestation** (➔case Study Madagascar) as it was coined and tested in Madagascar is a strikingly successful model approach, referring to the principle of allocating land titles to an individual person, combined with collective administration and capacity building, usually by a specially for this purpose created village afforestation body as the organisational entity. The envisaged reforestation was made subject to a consultation process between community council, community members and foresters in order to exclude disputed land upfront, and enable a consensus-based decision on the allocation and size of the future reforestation sites. Endorsed by a community council decision through a communal decree, the individual reforestation sites are allocated to interested households, along with defined use-rights and obligations. The project enjoys great popularity due to its tremendous success in regard to poverty alleviation and enhancement of the regional economy.

Within decentralisation policies, devolution often goes hand in hand with **deconcentration** processes meaning the transfer of administrative responsibility for specified functions to lower levels within the central government bureaucracy, generally on some spatial basis. Experience shows that it is often easier to start policy shaping on decentralised level than on national level. Sub-national decision makers are closer to the needs of the local population.

The main lesson learned from these examples is that allocating land tenure and/or long-term user rights to communities and individuals requires not only legal reforms but also accompanying development measures. Capacity/ organisational development for forest resource users and the administration in charge, as well as law enforcement are needed in order to display full effectiveness for sustainable forest management or reforestations. Fighting corruption is decisive for success. To this end it will be necessary to foster public awareness. This can be achieved, for example, by including the forestry sector into the process of fighting against corruption. In Cameroon, the forest sector has been deliberately investigated for suspicion of inherent corruption. Proposed strategies to address it have been included in the National Anticorruption Strategy (CONAC 2010). A similar process has been launched in Madagascar through a public anti-corruption initiative by the civil society led through the NGO “Alliance Voahary Gasy” (Raonintsoa et al. 2012).

4.5 Incentives and financing mechanisms

Although domestic public financing should be the major source of financing for forestry activities particularly African countries find themselves unable to raise adequate domestic public funds for the forest sector and even less for the modernisation of their wood energy value chains. With the hundreds of millions of foregone taxes out of the woodfuel markets, many African governments could spur an adequate financing of their forest services including their related development programs. But only little attention is paid by development projects to support these countries to improve this important field of wood-energy-related forest governance. Likewise, the Regional Forest Law Enforcement and Governance initiatives FLEG(T), tend to neglect the domestic wood energy sector. FLEG(T) initiatives focus on internationally traded commodities and so far have had little – if any – bearing on the dynamics of largely non-regulated domestic wood energy markets.

4.5.1 Fiscal stimulus

Wood energy producers generally encounter **no real incentive to invest in sustainable forest management** as the producer prices remain low and face direct competition with uncontrolled/ illegal exploitation. To counteract these two problems, a differential taxation system has been introduced since the 1990ies in several Sahelian countries in the framework of rural woodfuel markets (Niger, Mali, Chad).

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

It turned out that for maximising incentives to the various stakeholders, a triple rate was conducive: (i) a low rate in communities with managed forestry resources and private plantations, but the proceeds accrue mostly to the community; a low rate invites transporters to go buy products here, yet, most of the revenues are allowed to be kept by the community; (ii) an intermediate rate elsewhere in non-protected, non-conservation areas, with the proceeds mainly for the Ministry of Finance; and (iii) a high rate in protected areas (parks, reserves, etc.) and conservation areas to avoid all exploitation. The main beneficiaries are communities with an approved management plan, which are allowed to keep 80% of the proceeds of the tax, while transferring 20% to the Ministry of Finance.

The differential taxation as introduced in the woodfuel catchment of N'Djamena displayed the following impacts: (a) return 90% of tax revenues to communities and local management structures (LMS), and (b) discourage of unregulated exploitation of open-access areas by means of a surcharge. Illegal logging and tax evasion carried a fourfold surcharge plus additional fines, and strict controls/law enforcement (at city-limit checkpoints) ensured the system would operate (see Table 5).

This arrangement created a strong incentive for sustainable forest management, as illustrated by the participation of more than 100 villages (with a total area 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. However, the project's success alarmed certain interest groups, whose influence subsequently eroded policy commitment and national ownership. The government reversed its policy, enacted a blanket charcoal ban, and used force to nullify community tenure rights. In 2005, the revenue generated through the Household Energy and Environment Agency (AEDE) were about 600 million FCFA; in 2006, they dropped to 19 million FCFA. The basis for operating differential taxation was thus lost, causing the newly introduced system to collapse.

The major lesson learned is that the introduction of a differential taxation system turned out to be the **strategic leverage instrument** to initiate a switch from an exploitative to a sustainable wood energy supply system. Combined with efficient supervision and law enforcement they were the major driving forces that influence and interact with all other components of a sustainable woodfuel supply strategy. This combination led to a series of reactions: (i) increased revenue collection and (ii) decline of unregulated open access use, which then led to (iii) a price increase for woodfuel, as merchants are forced to add forest replacement taxes to the consumer price. The price increase provided incentives for counter-action: (a) further investments in sustainable forest management as well as forest plantations; (b) adoption of improved kilns; (c) proliferation of improved stoves; and (d) increased competitiveness of substitute fuels.

The model serves as an example of what can be accomplished with appropriate policies (➔ Case study Chad) and also underlines the importance of government commitment to promoting a sustainable value chain.

Table 5: Differential Taxation in Chad incentivised sustainable Community based Forest Management (CFA/stère)

Beneficiaries	Sustainably Managed	Open Access	Illegal Exploitation
AEDE	15	300	600
Ministry of Finance	15	300	600
Local Management Structures	150		
Community	120		
Total	**300**	**600**	**1,200**

Source: (Miranda et al. 2010)

4.5.2 Tree planting subsidies

In most developed or emerging countries governments provide incentives (subsidies) for private investment in forestry. Justifications for plantation subsidies include provision of raw material, environmental concerns and social issues such as employment generation and reduction of rural poverty. Subsidies usually involve free or cheap planting stock, cash payments to offset establishment and maintenance costs, or cheap credits.

In Latin America (Brazil and Nicaragua) the Government obliges small industries and other business consumers of wood energy by law to replace their wood consumption by payment of a replacement fee (tree-value) to a local Forest Replacement Association (FRA) (➔case study Brazil) (Ceccon and Miranda 2012). Noticeable is also the forest development law (nr. 701) of Chile decreed in 1974 providing a **subsidy** of 75 per cent of the plantation cost for afforestation projects, aimed at low productivity lands that have been deemed unsuitable for agricultural use. Since then Chile has seen a significant growth in its plantation forestry sector – from 375,000 hectares in 1974 to 2.05 million hectares in December 2003 (Tomaselli 2004). This was also coupled with a privatisation strategy securing private property rights (Low 2010). While in 1974, the forest service was responsible for 91% of the plantations, its participation decreased to only 0.1% in 1981, ending entirely by 1986. Uruguay successfully pursued a similar approach. The country's Forestry Promotion Law from 1987 provided subsidies and tax exemptions for plantations established on low productivity soils (Martino and del Castillo 2006). To date Chile and Uruguay are the only countries in Latin America to experience net growth in their forest covers, thanks to high plantation rates (FAO 2010c).

Sometimes it is argued that tree planting subsidies are self-financing investments in the sense that the income generated over time may greatly exceed the subsidy and, if that income is taxed, the government may at least partly recover its contribution.

4.5.3 Financing instruments

There are a number of international and national financing mechanisms which include (or could include) the support of woodfuel related projects. Apart from bi- and multilateral ODA, numerous foundations, NGOs, the private sector and decentralised cooperation provide grants or loans of different scope and magnitude.

Relatively new international instruments are emerging from the Carbon market such as the Clean Development Mechanism (CDM), the voluntary mechanism for forest carbon offsets, REDD+, and the recently upcoming Nationally Appropriate Mitigation Action (NAMAs).

There are only a few wood-energy supply related projects financed under the CDM regime for LDCs, as the pipeline of CDM methodologies is still dominated by approaches which have been tailor-made for large emitters. Introducing improved charcoal projects is much more difficult than getting improved cookstoves projects granted where certain standards have already been developed. Although CDM has traditionally been the world's largest compliance offset program the CDM market plummeted both in terms of volume and value in 2012.

According to a review of forest financing in Africa, three problems have made CDM financing cumbersome in forestry (Gondo 2012): (i) There is a delay of two or more years in getting CDM projects approved, (ii) Transaction costs are so high that smaller projects are not viable, and (iii) particular characteristics of forestry projects related to additionality, leakage, and nonpermanence[10] hinder forest CDM project approval. The lack of evidence based data is another barrier. The voluntary carbon market drove 95% of all market activity and 93% of value (198 million USD) of the grand total forest carbon market of 216 million USD in 2012 (Peters-Stanley et al. 2013).

The majority of carbon-managed land area is associated with REDD+ projects that continue to have the largest impact on forested land, with 17 million ha and a share of 39% in Latin America under management.

The Global Alliance for Clean Cookstoves (2012) reports that approximately 8.2 million stoves have been distributed in 2012. During this year, an amount of about 167 million USD were funneled through carbon markets for their dissemination (Zwick 2014). Korthuis und Meijer (2012) argue that many buyers on the voluntary market use the credits for promotional purposes. Projects with a 'story to tell' or projects with a clear 'pro poor' image, such as cookstoves projects generally fetch higher prices than projects that are less appealing from a promotional perspective, such as improved kilns.

This also shows that there is a gross imbalance between 216 million USD of total forest carbon investment of which only a small portion is allocated to improve the woodfuel supply situation, in contrast to 167 million USD spend to end-users for the dissemination of cooking devices. In the end-users' subjective perception woodfuel becomes cheaper, which cements wood as the number-one fuel. A shift to alternative fuels will get more and more difficult.

10 Definitions according to the CDM Rulebook (http://www.cdmrulebook.org):
- **Additionality** is the requirement that the greenhouse gas emissions after implementation of a CDM project activity are lower than those that would have occurred in the most plausible alternative scenario to the implementation of the CDM project activity.
- **Leakage** refers to the increase in emissions outside the project boundary that occurs as a consequence of the project activity's implementation.
- **Non-permanence** involves the risk that emission removals by sinks are reversed, because forests are cut down or destroyed by natural disaster.

Table 6: All forest carbon markets by 2012

		L-Amer.	Oceania	Africa	Europe	N-Amer.	Total
Total forest area	million ha	956	191	674	196	614	2631
Carbon project area	million ha	11,3	1,4	2,5	0,1	7	22,3
Projects represented	Nr.	62	11	36	10	42	161

Source: Figures adapted from Peters-Stanley et al. 2013

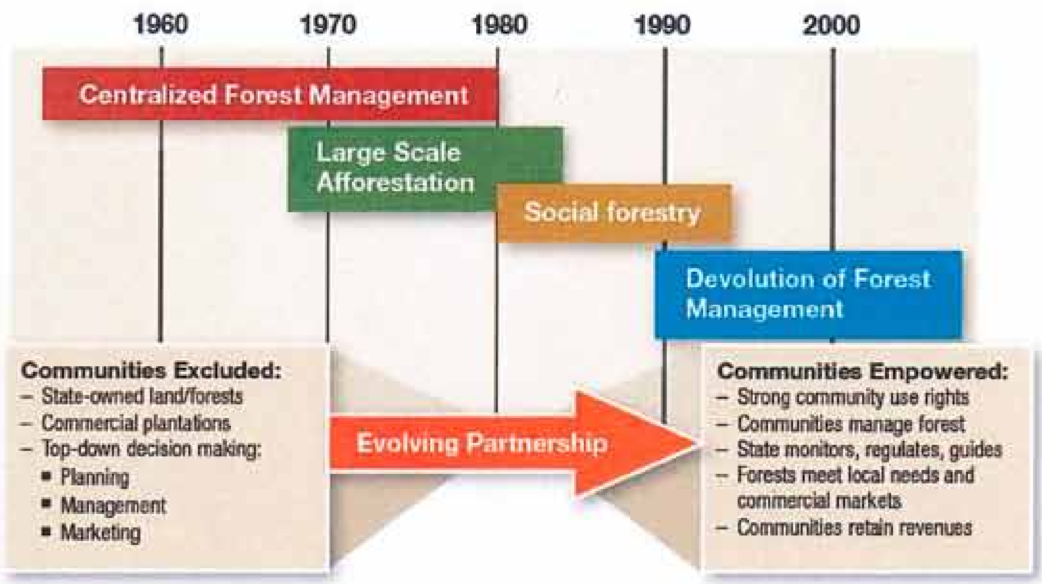
As for incentives in general (generated through financing mechanisms or otherwise), it can be concluded that besides allocating direct incentives, Governments would need to (1) ensure macro-economic, political and institutional stability, (2) access to land and (3) clear resource tenure arrangements to create a favourable investment climate. Evidence from Asia and Latin America, among others, shows that these factors are more important for obtaining significant levels of forest investment in sustainable forest management and reforestation than direct incentives alone.

Also, in view of formalising the wood energy value chain it is noteworthy that the financing mechanisms mentioned in this chapter so open up important opportunities. But they are limited to supporting isolated links of the wood value chain, either on the side of supply or demand side. In their present form, these instruments are not suitable to induce fundamental structural changes of the institutional and regulatory framework to lift this important segment of national economy to a more self-sustaining level.

4.6 Feedstock management

In an attempt to increase production, forest management policies have undergone considerable change since the 1960ies. From the mid-1960ies to the late 1970ies, priority was given to state-run industrial plantation programs, often with donor support. Due to a predicted paper shortage, these large-scale plantations were mainly intended to produce pulpwood at the beginning. However, several of these were not competetive on the paper market and were transferred to woodfuel plantations. This approach was later transferred to social forestry approaches (Miranda et al. 2010). While industrial forestry could indirectly benefit local villagers, social forestry is designed explicitly to make use of local resources such as village labour and to provide local benefits – especially woodfuel (Barnes et al. 1982). In Africa, the devolution of state forest management to local forest users took place in the early 1990ies, providing additional opportunities (Figure 17).

Figure 17: Timeline for the evolving partnership in forest management



Source: (Miranda et al. 2010)

4.6.1 Forest energy plantations

Traditional plantation development projects, launched in many countries since the 1960ies and 1970ies initially mostly for pulp, paper and timber production and later to a minor extent also for wood energy production, have often proved only partially successful, or have indeed failed, leading for a long time to a negative view of the very principle of forest plantations. These large-scale plantation projects were implemented under the auspices of the forestry services of the various countries, using international co-finance in the form of grants or loans. Although the diagnosis was usually sound (soil rehabilitation, demand for wood and wood products, peri-urban afforestation etc.), actual initiatives were rather unrealistic. Plantations were often ill-designed and suffered from insufficient health, vitality, productivity and lacked return on investment. In addition they were often subject to land use and social conflicts. Many of the plantations failed due to poor management, lack of know-how, and the low commitment of staff in the public forestry services.

Brazil is one of the few countries where the large-scale production of energy from wood has been explored for decades. Significant investments have been made in plantation forests with fast growth rates and large scale clonal forestry. Brazil has over 4 million hectares of eucalyptus plantations. Much of this is dedicated to short fiber pulp production. However, Brazil has also some of the largest dedicated bioenergy plantations of the world. Several companies in Brazil grow eucalyptus to produce charcoal that can be used by the pig iron and steel industry.

Woody biomass is also heavily used by tile, brick and gypsum production companies. Most of those companies currently rely on wood from natural forests to supply their energy. However, increasing legal restrictions on the use of these raw materials seem to turn them to short rotation eucalyptus plantations (Couto et al. 2011). Brazil has also developed forest plantations to produce biomass for combustion and generation of heat and electricity, for the food, beverage and other industries (FAO 2008).

Over the last 33 years, the annual plantation rate in Chile has exceeded 100 thousand ha/year. These plantations are also considered a vital part of the countries' conservation strategy as 29% of Chiles native forests are under protection. However, the debate on ecosystem services and tree plantations is also controversial (e.g. water provision, climate regulation, biodiversity conservation) (Paruelo 2012). The forestry sector became Chile's second largest exporting industry, only behind large-scale mining. It generates direct and indirect employment for approximately 400 thousand people and represents approximately 7.3% of GDP (Raga 2009). Wood energy accounts for approximately 20% of the country's energy supply. Further, a national system for the certification of woodfuel is experimented on, which can provide interesting conclusions for employment in other countries.

Mozambique has an estimated 7 million ha of land suitable for large-scale plantations. Of this area, 3 million ha have been identified as a national plantation target, most of which aim at producing industrial roundwood for pulp and paper and construction timber. Mozambique focusses on large-scale plantations by attracting investments of mostly foreign companies. Some large-scale plantations are destined for producing wood energy (e.g. pellets) for the export market as it is the case for the Green Resources company in the Nampula region. A critical appraisal is given in chapter 4.1.

The case of Madagascar may be cited as a promising example where smallholder plantations have been promoted decidedly for the purpose of wood energy productions. Since its beginning the GIZ supported project (➔case study Madagascar) has reforested around 8000 ha of individual plantations.

Box 7: Voluntary guidelines for responsible management of planted forests: 10 principles

Principle 1.	**Good Governance**
Principle 2.	**Integrated** decision makingand **multi-stakeholder approaches**
Principle 3.	Effective **organisational and personal capacity**
Principle 4.	Recognition of **the value of goods and services**
Principle 5.	Enabling environment for **investment**
Principle 6.	Recognition of the **role of the market**
Principle 7.	Recognition and maintenance of **social and cultural values**
Principle 8.	Maintenance of environmental **sustainability and forest health**
Principle 9.	Biodiversity **conservation**
Principle 10.	Management of landscapes for social, **economic and environ mental benefits**

Source: (FAO 2006b)

Another comparatively new development in the African plantation forestry sector that is often targeted at energy provision, are the so-called **'outgrower schemes'** (cf. chapter 4.1).

Rwanda is a striking example where raising woodfuel prices led to a self-sustained turnaround of tea farmers investing in private plantations especially on marginal lands based on secure land and user rights. Studies confirm that the profitability of small-scale Eucalyptus plantations when compared to tea plantations is 47% higher. In particular, Eucalyptus has the lowest production cost and thus the high demand for its wood results in a profitable price (World Bank 2011).

Especially in countries with significant areas of marginal and/or degraded public land, privatisation of land for the purpose of tree farming may be an option. Such schemes have the potential to preserve/ameliorate land and to augment wood-fuel supplies at the same time.

The case of Madagascar may be cited as a particularly promising example. Clear and consistent policies, laws and best practice guidelines can help balance the cultural, economic and environmental trade-offs caused by increased investment in forest plantations (FAO 2008, see also Box 6).

High-productivity plantations, efficient harvesting and good logistics are fundamental in producing wood energy at cost that allow for competitively priced energy generation (FAO 2008). Every plantation activity should be preceded by an economic analysis. Sustainability can only be assured when the returns on investment are significant for the plantation owner, and if there is a certain social and ecological potential. In case a fuel switch is in full swing and the demand for woodfuel decreases, the risk of investment in wood energy plantations is buffered by the fact that wood pulp and reconstituted wood panels industries use the same kind of raw material.

As in many LDCs the producer price for woodfuel is very low, the local population is not able to carry the investment costs. Hence, public or private transfer payments are necessary to support the extension of plantation forestry.

It can be concluded that the increasing pressure on natural forests calls for alternatives to assure a sustainable supply of an increasing demand for woodfuel. Planted forests, established through afforestation or reforestation, have a particularly important role to play in providing a renewable and environmentally friendly energy resource if managed responsibly. They can play a very positive role in: (i) providing ecosystem services, such as preventing erosion, protecting soil and water, and storing carbon etc., (ii) reducing pressure on natural forests; (iii) restoring marginal or degraded land and (iv) providing rural employment and development. Consequently, forest plantations should increasingly become subject of careful development of policies where the past public sector dominance gives room for more private sector participation assuring an integration with other sectors and methods of providing woodfuel. Hereto, plantation establishment should be integrated more fully into the debate on land grabbing.

4.6.2 Participatory Forest Management

There are many types of participatory forest management models. However the concept of participatory forest management can be divided in three different broad types: (i) the **"community-based forest management** (CBFM)" where property or the management rights of forest for woodfuel production are transferred from the state to either local authorities, communities or user groups; ii) **"smallholder forestry"** where property or management rights are transferred to individual families, usually farmers, and iii) **"joint forest management"** (JFM) where state forests are managed by communities on the bases of an agreement. The first form of PFM normally takes place on village customary land, where the status changes from state forest land, often considered as "open-access" resource, to "common property" resource. Trees are managed by a village group or council. Smallholder forestry takes place on state land, and individual families obtain long term rights to manage a plot of forest. The third form of PFM, Joint Forest Management, takes place on "reserved land" – land that is owned and managed by either central or local government. In all cases the communities or individuals involved conclude a contract with the forest service that clearly defines rights and obligations and effectively restricts free access by outside loggers and traders. Village communities are bound to organise a management committee as their representative body, and to apply sustainable management techniques. In return, interested villagers create user groups and are entitled to harvest and sell the forest products for their own benefit. Among the existing management options one example may serve to illustrate the operational organisation of a PFM: A service contract between the user groups and the forest management committee will specify harvesting area, standards and quota. From the turnover of the woodfuel sale the forest user groups are bound to pay taxes to the community. One part of the taxes is used to promote investments in infrastructure (schools, water points, basic health centres etc.). The other will be transferred to the forest service. PFM has received donor funding all over Africa, Asia and Latin America.

In Asia, countries like India, Indonesia, Nepal and the Philippines have focused on delegating or transferring rights and responsibilities over state forest land to communities or indigenous peoples, and other types of entities. In some cases these rights transfers are partial, and require the community to share revenues generated from sales of forest products with the state. In the Indian state Madhya Pradesh for example the sharing of usufructuary benefits in case of JFM is in the proportion of 70% to the Government, 15% to the committee formed, 10% to the individual members, and the remaining 5% is ploughed back for the development area (Pandey 2002). Although there are state specific variations in the shares, the policy has remained more or less a management tool in the hands of government and never transformed into a genuine people's movement for forest conservation (Vemuri 2008). However, Nepal, with its Community Forests program is now ahead of other countries such as Bangladesh and Pakistan in terms of community forestry. The International Food Policy Research Institute (IFPRI) confirmed that Nepal has successfully devolved nearly one-fourth of Nepal's forest to more than 14,000 Community Forest User Groups (Ojha et al. 2009).

Another good example of conducive CBFM activities for energy production is the introduction of rural woodfuel markets (RWM) in West Africa (Niger, Mali, Chad) or Madagascar. These kinds of projects were the first attempt to apply a more holistic approach by including substantial regulatory measures such as introducing a differential taxation system, drafting of woodfuel supply plans for the major cities etc. After phasing out of the international donor support, the forest departments were not able to maintain the high level of support and supervision. However, 20 years after creation most of the RWM are still operational (Sepp 2008a).

A RWM is a place where woodfuel dealers can buy firewood and charcoal drawn from an area of natural woodland formally delimited and agreed between the villages and the local authorities. This woodland area is managed using a simple plan agreed between the village associations and the local forestry service. It includes: (i) an annual woodfuel quota that stays below the annual production rate (safety margin); and (ii) a set of very simple silvicultural and woodfuel cutting rules. Rural woodfuel markets are run by a local management structure. The CILSS-based EU-supported project PREDAS has published a guide on how to create woodfuel markets (Elhadji Mahamane et al. 2005). In the framework of climate change response policies, the French Development Cooperation re-launched this kind of projects focusing on the supply of major cities in Mali, Burkina Faso and Niger[11].

The assumption that households will only invest in forestry operations **if they can make a living out of sustainable forest management**, which is common to all PFM projects, is also the driving force to the so-called WAJIB approach in Ethiopia. In the project, supported by GIZ, a binding agreement is made between the local forest user groups and the district forest office (Tsegaye 2005). The rights, duties and obligations for both partners are clearly defined. This approach differs from many other PFM approaches in Africa in that the number of participating households is limited ex-ante, by assessing the forest carrying capacity and the economic potential.

An example from Senegal shows that the economic viability and contribution to woodfuel supply of PFM highly depends on the initial condition of the forest resource, namely species composition and density (Richter 2009). Where ecological conditions are limited, woodfuel production alone will not cover respective forest investments– at least not under the current market prices. In order to get the population engaged in PFM, all forest resources (fruits, resins, gum, honey, pharmaceuticals, forage etc.) need to be valorised, so as to increase management revenues (Table 7). On the other hand, there are forests which contribute only little to the wood-fuel supply because they have a large ecological potential to produce timber which is of much more economic interest. In such cases woodfuel production is a side product.

Table 7: Profitability of natural forest management of three pilot forest managed by local communities

Forests	Average current costs €/ha	Av. current revenues €/ha			Profit €/ha	IRR
		Wood-fuel	NWFP	Pasture		
Kalounaye	7,50	4,90	3,48	0,00	0,88	12%
Dankou	5,27	0,94	3,02	0,54	-0,77	-8%
Sambandé	20,75	12,26	3,03	0,00	-5,46	-10%

In the context of PFM activities the following features were found to be particularly important when designing and implementing PFM projects for energy supply:

- PFM activities should take place after stakeholder consultation to enhance awareness of the causes and consequences of uncontrolled exploitation and the benefits of available techniques for forest rehabilitation.
- Baseline studies are fundamental tools for assessing success or failure of intended PFM activities. They should also include economic aspects under sustainability criteria as much of the land assigned to local communities is often heavily degraded.
- The extent to which administrative authority and responsibility should be transferred from government agencies to rural communities requires critical analysis and informed public debate. In this respect, the existence of clear and secure (forest) land ownership is a crucial determinant. Equitable sharing of costs and benefits within the communities, and between the communities and the government, needs to be clearly defined. The results should be recorded as an agreement, providing the basis for PFM activities.
- Functional institutional frameworks at village level must be developed to oversee planning, implementation and monitoring. Such a local management structure should be governed by the Community or Village Assembly. Clear guidelines have to be developed to specify the responsibilities of each and every member within the local management structure. Institutional development requires long-term support and substantial capacity building efforts.
- Forest management plans must be simple and short and should be developed through participatory action in a way that is accessible for communities with low literacy levels. To foster local 'ownership' of such a management plan, the contents of the plan must include the knowledge, experience and expectations of the local community about their forest.
- By harvesting woodfuel, people exert complex impacts on their forest resources. These impacts are hard to predict, particularly in regard to their long-term ecological aspects. Ecological monitoring is more and more recognised as a helpful method in natural resource management (Fröde and Masara 2007).

11 "Sahel towns natural forest management and sustainable wood energy supply project" (Fonabes) financed by AFD and FFEM

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

Many of the lands that have been devolved to local community ownership are degraded. Agree-ments tend to be short-term rather than long-term. Resource managers and users are often not well informed about tenure status and the accompanying changes in rights and responsibilities, and the pace of change seems to be slow (FAO 2006a).

To sum up the success of community ownership schemes depends on the effectiveness of institutional arrangements for managing the resource, the distribution of benefits among the community as well as its absolute size. Studies confirm that a lack of income and power of communities lead to: greater discrimination, low levels of participation, conflicts over resources, and, ultimately, exclusion from the benefits of CBFM (Tole 2010).

4.6.3 Trees outside forests and agroforestry

Growing trees and shrubs in agricultural fields in association with crops either as single trees, linear formations or woodlots offers great potential for meeting the growing scarcity of woodfuels in rural areas. In fact, homesteads and farmlands are already important sources of fuelwood supply in some countries. In China, the practice of tree planting around homes, villages, fields, roads and waterways known as “four-side trees” appears to have significantly contributed to fuelwood supply in rural areas.

Another noteworthy example comes from western Kenya. Here woodfuel tree-crops are raised as part of an improved fallow system, whereby nitrogen-fixing trees that can be harvested for fuelwood or charcoal after 3-4 years are planted (or sown) on fallow fields. Each hectare of improved fallow can provide enough wood to supply the fuelwood needs of a typical rural household with 6–7 members for 6–8 months (Jama et al. 2008).

Agroforestry approaches to provide fuelwood supplies as charcoal are still limited especially in and around urban areas. The Mampu plantation, about 140 km east of Kinshasa on the Batéké plateau is one of the rare examples where the taungya system[12] has been applied (➔ case study Congo) and it involved the establishment of plantations on degraded grassland in partnership with farmers.

12 Essentially, the taungya system consists of growing annual agricultural crops along with the forestry species during the early years of establishment of a forestry plantation.

The project provided technical assistance by demarcating degraded lands and supplying pegs and seedlings, while the farmers provided all the labour involved in site-clearing, pegging, planting, maintenance and fire protection. Farmers were permitted to cultivate their food crops, which were inter-planted with trees. The agroforestry activities were complemented with other income generating activities in order to increase farmers’ benefits. Mampu farmers, have been trained in beekeeping and honey processing, and market more than 7,500 kg of acacia honey each year. This additional source of income for Mampu farmers has been, furthermore, complemented by a valorisation of honey by-products such as beeswax and hydromel. In addition, farmers use their forest for rearing caterpillars, a delicacy in the DRC. To sum up: diversification of income generating activities and production processes can support not only urban energy needs but also meaningful local development.

The “Sustainable Energy Production through Woodlots and Agroforestry in the Albertine Rift Project (SEW)”, which operated between 2009 and 2013 in Burundi, Rwanda and Congo and supported woodlot establishment by farmers, is also notable. In this case, farmers provided land and about 20% of initial woodlot establishment and tending cost in the form of labour. The project provided 80% of the establishment cost. This is one of the few projects that applied a value chain approach by increasing the number of trees grown for fuel while decreasing wood consumption. In fact, besides the plantation of an equivalent of 20,000 ha, the project engaged in the professionalisation of the energy production sector (dissemination of improved kilns and stoves) thus reducing fuelwood requirements. Although the SEW project is a very encouraging approach, the project design lacks support to a change in the woodfuel policy and regulatory framework of the participating countries.

The socio-economic and ecological advantages of agroforestry can outweigh the results of many expensive, ill-conceived tree plantation programs. Agroforestry can be developed at a fraction of the cost of large-scale plantations, and this approach can encourage greater local participation as well as providing a wider range of goods and services for the local economy. It can be concluded that it is important to promote the role agroforestry systems and ToF at policy level so that they are recognised as an important source of fuelwood supply, besides natural forests and plantations.

4.6.4 Wood harvesting and conversion residues

Analyses of energy supply from wood residues in developing countries suggest that there is considerable potential for energy generation. The wood residues generated from sawmills include sawdust, shavings, trimmings, slabs, veneer core, defective veneer, edgings, offcuts and barks. Furthermore logging waste has a considerable volume (branches, fallen trees, broken stems, small clearings in the forests). For each m^3 of wood transported to the sawmill at least 2 m^3 are left in the forest.

To this adds the volume of wood residues left from harvesting operations in tropical forests which can be three to six times that generated at mills (Tomaselli 2007).

A sawmill energy efficiency study conducted in Ghana estimates that around 45-55% of the wood volume of felled tree is left in the forest as residues. Lumber recovery in sawmills is approximately 30-45% of the log input. Thus, on average, about 80% (between 75% and just above 85%) of the standing tree in the forest ends up as residues (Nketiah et al. 2001).

Some medium and large companies use the residues to fire burners, in order to raise process steam, particularly for kiln drying. Others went into downstream processing and producing profile boards, furniture parts, flooring parquets and finger-jointed materials. However, large quantities are simply burnt onsite.

Tomaselli (2007) illustrated the dimension of the energy potential from wood residues: He estimated that in countries such as Cameroon, energy from wood residues generated at saw mills were sufficient to supply the total national electricity demand. The GIZ project ProPSFE in Cameroun is supporting saw mill operators to convert the residues to charcoal by introducing improved kilns.

However, the demand for charcoal in the vicinity of the saw mills is too low and the charcoal deficit region in the north of Cameroun too far away from production zones for the produce to be transported in a profitable manner.

A simple calculation (see table 8) from the D.R. Congo provides an example that the residues of just one saw mill enterprise can satisfy the annual demand of around 29,000 people (Khennas et al. 2009). Again, the price of charcoal is too low to cover long transportation distances and thus charcoaling of residues remains only suitable for timber enterprises in and around consumer markets. Otherwise the residues are simply burnt or disposed of elsewhere. To sum up, residues from timber industry especially in Africa is a largely untapped resource. However, as long as wood energy prices remain low it remains difficult to have them contribute to the energy supply.

Table 8: Estimate of charcoal supply from waste wood (sawmill)

Daily roundwood conversion	240	m3/day
Working days	200	
Annual roundwood conversion	48,000	m3
Waste wood	40%	
	19,200	m3
Auto-consumption saw mill	20%	
	3840	m3
Amount of waste-wood for charcoal making	15,360	m3
Conversionrate m3-T	0.7	
Amount of waste-wood for charcoal making	10,752	T
Kiln efficiency	20%	
Amount of charcoal produced from waste wood	2,150	T
Coverage of demand by charcoal from waste wood		
Annual charcoal consumption per capita	0.074	T
Supplied population	29,030	Persons

4.7 Technology development and transfer

In the last 30 years of wood energy projects, the development of improved conversion and combustion technologies only showed moderate advancement. Especially in the field of carbonisation the research and development stagnated. Traditional production techniques in open pits or earth mound kilns is still predominant. The efficiency or recovery rate of charcoal kilns depends upon many factors such as kiln type, moisture content, wood species, wood arrangement, and most importantly, the producer's skill. For traditional kilns the efficiency rate varies between 8 to 14%[13] (mass basis). The often illegal and thus clandestine nature of production leads to efficiency losses as producers use humid wood and smaller kiln sizes, both crucial factors impacting the recovery rate. Furthermore, most of the charcoal producers are poor and have few or no formal skills. Thus, they learn the trade by observing others, which limits innovation and development of the sector.

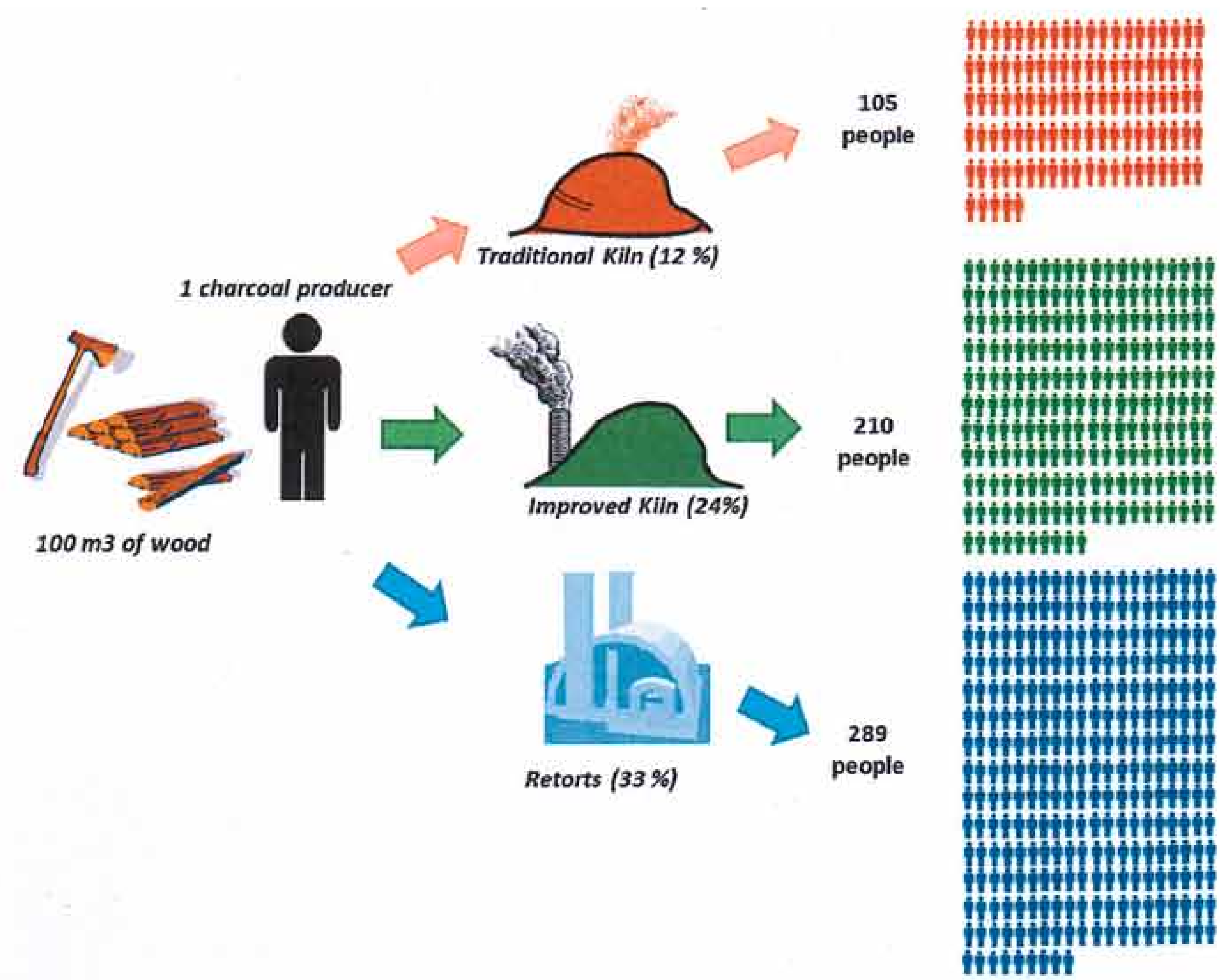
The introduction of **improved kilns** has an extreme leverage factor as the wood savings depart at the source, which has a direct tangible effect on the amount of people supplied and on the area exploited. Assuming an allowable cut of 100 m^3 per hectare and an average consumption per person of 80 kg of charcoal per year, the switch from a traditional kiln to an improved kiln increases the supply by 100% and decreases the area exploited by 50 %.

Improved conversion technologies can be broadly classified into four categories, namely (i) earth kilns, (ii) metal kilns, (iii) masonry kilns and (v) retort kilns. Earth and metal kilns are moveable; the other kiln types are stationary. One of the most widely disseminated improved kiln, over 30 years, has been the Casamance kiln, which can be made at fairly low costs. The only significant cost involved is the purchase of a chimney necessary for the kiln to work efficiently. This kind of improved kiln has an efficiency rate of about 25%. In Senegal, the application of this technology has been made obligatory whenever communities enter a forest management agreement with the forest service. However, the charcoal producers, once trained, tend to revert to their traditional technique as they are reluctant to reinvest in a new chimney and are not fully convinced of the new technology. Economic analyses underpin that in areas where wood is freely accessible, additional investments do not pay off, although the output has substantially been increased (ECO Consult 2006).

Metal kilns like the Uganda Mark V kiln date back to the 1960ies and have a reasonable high efficiency of 20-30% due to their controlled air supply and gas flows during the carbonisation. However, they did not gain acceptance as the costs exceed 1200 Dollars for more advanced kilns, while their lifespan of about 1-2 years is relatively short.

13 Ratio of charcoal produced to dry wood input

Figure 18: Supply of one charcoal producer with the same amount of raw material using traditional or improved kilns



Stationary kilns are mostly used in areas with a substantial amount of wood resources per area, as the raw material has to be collected and transported to the kiln. Furthermore, it requires a fairly high organisational level of the charcoal producer to manage a continuous supply and run the kiln.

Stationary kilns are therefore particularly suitable in case of wood energy plantations. Most of the charcoal used commercially in Brazil is produced by brick kilns with a weight-based conversion efficiency of 25 to 30%.

Unlike the kilns described above the **retorts** are externally heated and thus the charring temperature can be controlled within a very narrow range. This means that a fraction of the biomass is used as a fuel to heat the retort. As the wood gases are channelled back to the carbonisation chamber, a higher proportion of the tar components and gazes are burnt and the heat is used for the carbonisation process. Efficiency can be as high as 40 % and noxious emissions are reduced by 70 %. In addition the production cycle is completed within 24 to 30 hours.

Another advantage of the retort is that it avoids CH^4 emissions by recycling flue gases that would otherwise be emitted into the atmosphere. Because of the high global-warming potential of CH^4 (21 times that of CO^2), this technology yields significant CO^2-equivalent reductions. However, Bailis (2009) notes that besides the carbonisation technology the magnitude of carbon emissions reductions also depends on the coppicing cycle as well as on the choice of tree species.

A retort labelled "Adam-retort" has been introduced in several countries (Senegal, Tanzania, Mali, Angola, Madagascar, Peru, Costa Rica, Mexico, India, Cambodia, etc.) on a pilot basis. Investment cost exceed 2,000 € and special skills are required for construction and operation. Another recent innovation is a dome-like retort that was developed by the GIZ wood energy project in Madagascar. The retort is better suited to resisting the high temperatures, and it has a higher volumetric capacity than the Adam retort. The internal rate of return of such an investment (4500 €/unit) exceeds 40% (Etter et al. 2014).

Currently, this retort is being further refined for up-scaling in the framework of the RVI plantation management (➔ case study Madagascar). It is noteworthy that for operating the retort, the project supported the local producers to create an association and to formalise their business.

The greatest bottleneck for introducing improved kiln technologies is the fact that in almost all countries taxes and dues are raised on the basis of the number of sacs of produced charcoal, irrespective of the amount of raw material used. This is paired with insufficient controls at harvesting and production sites. Hence, the charcoal producers have no incentive to invest in improved technologies. It is therefore of utmost importance to assign user rights to a certain amount of raw material to be converted. This of course presupposes management plans for all forested areas. In Senegal first attempts are being made to change the tax regime in this sense.

It can be concluded that increasing the efficiency of charcoal production requires regulatory measures, systematic training, and further engagements by the international donor community through demonstration programs.

Improved combustion technology – cook-stoves in particular – display two major advantages: First, in terms of reduced indoor air-pollution. Second, improved cook-stoves help to reduce fuel consumption, and thus reduce pressure on natural resources. Despite these – widely recognised – factors, dissemination of improved cookstoves in practice remains fraught with numerous difficulties, including high up-front investments, lack of technical standards and quality assurance, insufficient production capacity and market outreach, and low consumer awareness (Guta 2012).

In Ethiopia e.g., a wide variety of alternative / improved cook-stove types (Mirt, Gonzye, Tikikil, Laketch, Merchayle, Rocket) has already been introduced with support by a wide range of stakeholders, including numerous international as well as national NGOs, and donor agencies (specifically GIZ). However, the generally low penetration rates (around 15 to 20%) bear witness to the difficulties encountered by demand-side interventions – even more so since the stovetypes listed have apparently been developed in reference to Ethiopian cooking habits (e.g. preparation of Injera), availability of raw materials (clay, mud, sheet-metal, concrete), suitability for decentralised, small-scale production, and comparatively inexpensive designs. Similar cases can be recorded from other countries where dissemination rates stagnate between 15 to 25%.

A positive exception to the rule is the improved Kenya Ceramic Jiko (KCJ) charcoal stove which is used in almost all urban households in Kenya and can reduce charcoal consumption by some 30%. KCJ production is now a fully self-sustaining business using locally produced materials and skills, generating jobs and new enterprises. KCJ-type improved stoves are widely used in Sub-Saharan Africa and can now be found in Uganda, Tanzania, Rwanda, Burundi, Sudan, Ethiopia, Senegal, Mali, Burkina Faso and Ghana (GTZ 2007).

One reason for low adoption rates is that the price of an improved stove is about 2-10 times the price of a traditional one. Since charcoal is usually rather cheap, the payback rate due to charcoal savings is at least 1-3 months (for a stove with a lifetime of approx. 1 year) (NL Agency 2010).

To sum up, improved stove programs have been most successful when targeted to specific areas where woodfuel prices or collection time are high. Rwanda is a vivid example as it is one of the few countries in Africa where improved stoves have deeply penetrated due to the high wood energy prices which is an incentive for the use of woodfuel saving stoves (World Bank 2011).

To this end the dissemination of improved stoves is of strategic importance when initiating the switch from exploitative to sustainable forest management. They can buffer the wood-fuel price increase caused by the formalisation of fuel-wood production as it is the case in Rwanda. An isolated dissemination of improved stoves potentially impedes forest preservation, due to the fact that it creates the consumers' widespread perception that wood-fuel is a low-value commodity.

4.8 Marketing of wood energy

It has to be stressed that the current woodfuel trade is a reliable supply chain in a largely informal sector often dominated by a small number of powerful and well-connected entrepreneurs, especially in the case of charcoal. Depending on the circuit followed by woodfuel from producer to consumer, various actors are involved, including charcoal producers, collectors, transporters, wholesalers and retailers.

Charcoal is generally packaged in a distinctive way, using old rice, sugar or maize sacs. A standard bag contains 30 to 35 kg, a large bag up to 60 kg of charcoal, depending on the tree species used. The charcoal producer generally takes responsibility for transporting the charcoal from the production site to the roadside closest to the kiln and to sell it to transporters or wholesalers. Prices at roadside differ along certain criteria: (i) type of species used, (ii) quality, (iii) season, and (iv) distance to main road. Road transport can be by various means from handcart/wheelbarrow, bicycle, motor cycle, car/pickup, tractor, to light and heavy lorry. Direct marketing of small quantities of woodfuel by producers is in many areas the main source of cash income for the poor and landless. Normally, wood cutters and charcoal producers in Africa earn 15 to 30% of the final selling price, whereas in Asia, this varies between 30-50%. A publication of the FAO Regional Wood Energy Development Programme in Asia reveals that the woodfuel trade and transport channels do not much differ from those in Africa (RWEDP 1996).

In most countries such as Senegal, Sudan, Mozambique etc. a tax is charged per bag. Often very large bags are used, only to be repacked into smaller bags once the tax has been paid. In addition, in many countries, vehicles carrying charcoal may have to pay bribes to pass roadblocks or may even have their loads confiscated.

There are only a few projects intervening to improve the woodfuel trade sector. The most common approach is to create rural fuelwood markets by facilitating wood and charcoal producer to join their efforts and create associations or cooperatives (➔ case studies Chad and Madagascar). This is being done to increase bargaining power vis-à-vis traders and thus increase the revenues. Bayard-Gamatié and Madon (2003) state in their 10 years review of rural woodfuel markets in Niger that, formerly, fuelwood suppliers were regarded as an inferior caste and blamed for the destruction of the country's forests. With the introduction of sustainable management and increasing income, their social status has been markedly raised.

In Madagascar (➔ case study Madagascar), rural small-scale energy enterprises have been established, based on a shareholder principle, to commercialise their produce through creation of centralised rural charcoal depots. They are officially recognised and pay duties to the commune as well as taxes to the region. They serve as reloading and wholesaling points, hence formalising the interactions between transporters, traders and retailers. Besides a better bargaining position, the charcoal depots also serve to take advantage of seasonal price changes and to thus increase the profit of the shareholders. Another avenue being tested is to increase the profits by selling premium charcoal through sorting and packaging in specially labelled bags. Target group are better positioned households willing to pay premium prices for premium charcoal.

Furthermore, on a pilot basis several of rural small-scale energy enterprises were connected to one urban fuelwood market thus creating "a green value chain" as the traceability from plantation site to selling point can be granted. They organise the transport themselves and thus tap on the profits normally made by the wholesalers or transporters.

An important lesson learned is to leave time to these small-scale energy enterprises to get in practice and settled before burdening them with taxes and additional standards (certification, packaging, labelling etc.).

Overall one can say intervening in the field of woodfuel trade is an extremely sensitive issue, as the powerful and well-connected entrepreneurs often dominating this field are reluctant to accept changes as they are afraid to lose their sinecures. The ➔ Chad case study bears witness of that.

If production was legalised, governments could collect fees and money could be diverted from the private pocket to the public purse. Some of this money could help train the producers and improve the transport system.

In the context of a modern and legalised charcoal sector, facilitating charcoal producer associations or cooperatives, as practiced in the agricultural sector, can result in several benefits. Not only would it provide an enabling framework for investments in improved charcoal production techniques, but also could it strengthen the position of rural stakeholders in the charcoal value chain.

It can be noted, that the creation of a network of rural and urban charcoal markets offers excellent opportunities for organising the woodfuel sector and assisting wood and charcoal producer to obtain better prices. These charcoal depots have to be managed like micro, small or medium enterprises (MSME) and subject to standard financial rules.

4.9 Key messages

- Most wood energy projects intervene either on the supply or on demand side without applying a value chain approach and are designed on a too short timeline.

- The few existing national woodfuel (biomass) strategies lack real buy-in from respective Governments and thus receive little support from the international donor community.

- There are promising instruments (e.g. WISDOM) to improve the generally bad data situation but they are neither institutionalised nor used upfront to shape framework policies.

- The creation of an autonomous agency interacting in the field of household energy and environment proved to be more efficient to resist the pressure of structural changes as if it were part of a ministry.

- Devolution of responsibility, land tenure and/or user right security, paired with economic incentives turned out to be the prerequisite for community and/or private investments in boosting sustainable woodfuel supply.

- Open-access exploitation shifts up the supply curve of woodfuel, increasing future costs. The introduction of a differential taxation system and an efficient law enforcement shows two pragmatic results: (i) it ensures equity between managed and unmanaged producers, (ii) it finances forest programs and compensates for additional law enforcement costs.

- Secure tenure/user rights and good producer prices boost reforestation activities and motivates for investments in sustainable forest management.

- Price distortions through prevailing open access exploitation make financial transfers for sustainable forest management and/or reforestation necessary for a long time to come.

- Carbon financing mechanisms support isolated links of the woodfuel value chain especially improved cookstoves, and to a lesser extent woodfuel supply, but are not able to engender structural changes of the regulatory framework.

- Tree planting subsidies can be a self-financing investment, as at a later point in time the Government can at least partly recover its contribution by generating taxes on the income.

- From a technical point of view proven experiences for up-scaling successful participatory forest management schemes are available.

- The potentials of agroforestry schemes and the use of wood residues to contribute to the sustainable woodfuel supply are not really exploited and warrant further development.

- More attention should be allocated to charcoal production as it has a high leverage effect to improve the woodfuel supply but requires regulatory measures, systematic training and additional research.

- Improved stove programs have been most successful when targeted to specific areas where woodfuel prices or collection time are high.

- The creation of a network of rural and urban charcoal markets offers excellent opportunities for formalising the woodfuel sector and channelling additional income to the producer and the government. Care has to be taken to take the entrenched interests of many of the powerful and influential players in the woodfuel sector into account.

5 Recommendations for greening the wood energy value chain

5.1 Holistic approach for a structural change

Discussing experience and lessons learned, the foregoing chapter outlined a wide range of measures geared towards promoting sustainable wood-energy production and use. Combined, they reflect a consolidated approach to modernising the wood-energy value chain, while differing – individually – in regard to their respective results and impacts. Still, a **self-sustaining modernisation** of the ways in which wood energy is produced, processed, distributed and consumed has not yet been achieved, despite the wood-energy sector's importance for the overall energy supply and its high economic potential. The vision - which serves also as an orientation for the recommendations – is that a **modernised system** (i) leads to positive environmental and climate impact; (ii) guarantees security of energy supply; (iii) achieves economic efficiency; and complies with advanced health and safety standards.

The lessons learned provide a telling confirmation of the fact that unsustainable wood energy use roots in more **systemic deficits** related to land tenure, fiscal and incentive policies, corruption, urban energy markets, and misallocation of forests and crop-land— problems associated with the policy and regulatory framework. These underlying problems usually make themselves felt all along the wood energy value chain.

Addressing these issues independently will not achieve needed value chain improvements. Instead, the shift to a modernised wood energy supply and use system requires a **structural change. This means to formalise the current informal and unregulated system.** Incentives for sustainable production and efficient use of wood energy need to be provided. For self-sustenance and long-term economic viability it is necessary that the market price of woodfuel cover all expenditures that are required for sustainable wood energy production according to the above-mentioned objectives.

From a development point of view, there is a need for an approach that, while making the sustainable production of woodfuel economically attractive (e.g. by secure tenure and/or user rights, adequate market prices), does not place additional and unacceptable burdens on poor end-consumers (e.g. access to improved cookstoves)

For the large number of countries (especially LDCs in SSA) which do not have the possibilities to provide **incentives** through subsidies (see 4.5.1) it is recommended to initiate the structural change through introduction of a **differential taxation system** (see 4.5.1). It´s effect is based on effective law enforcement and supervision. The induced structural change evolves in the following prototypical stages, each supported by flanking key interventions:

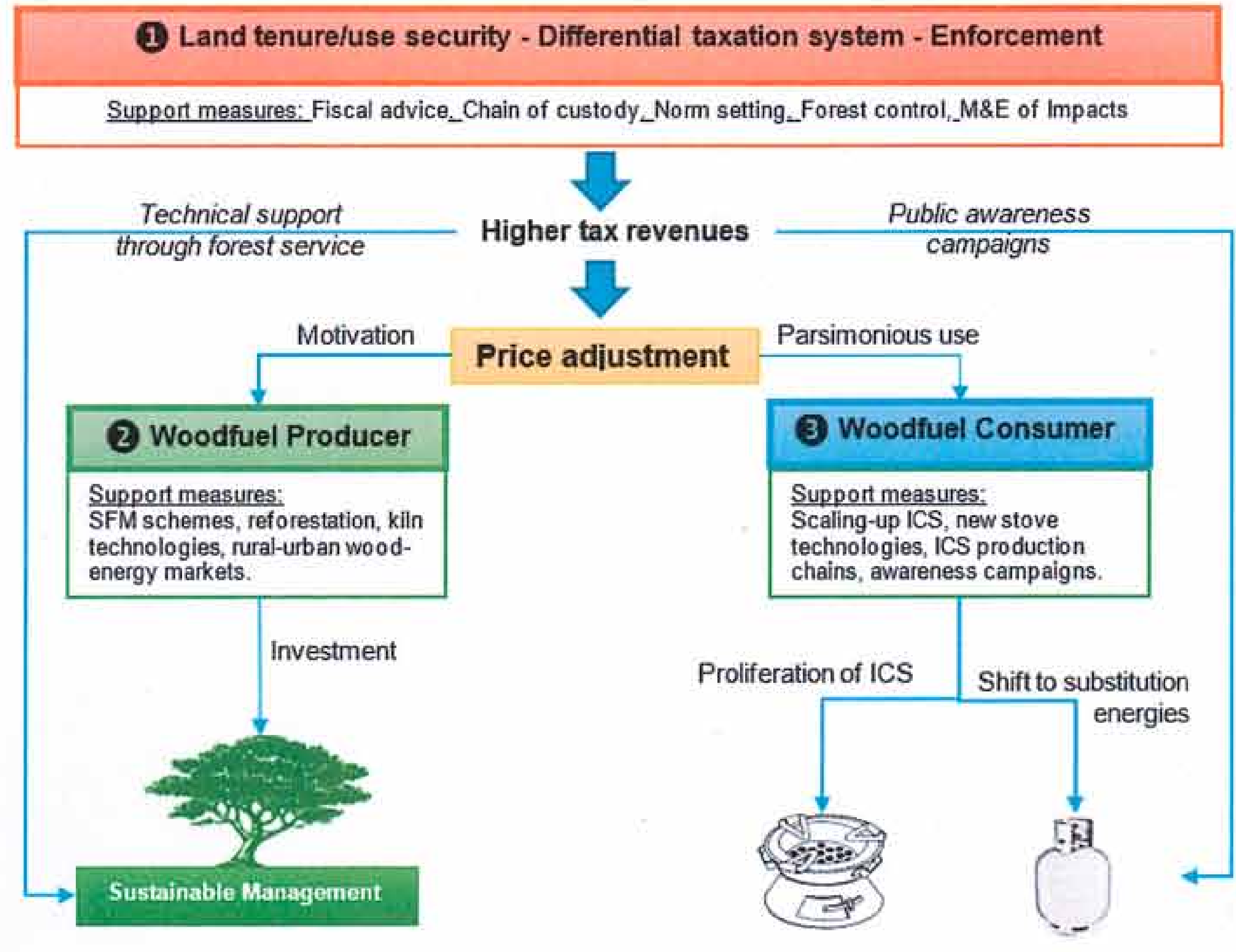
1. Backed by a conducive policy framework (e.g. in respect to forest tenure and use) and good governance of the forest sector (e.g. fighting corruption, law enforcement) a differential taxation system is introduced. It internalises sustainable production costs and will be reflected by increasing woodfuel prices. Law enforcement, by contrast increases the tax recovery rate from those not respecting norms and standards of sustainable wood production. The increased tax revenues will allow government services to improve their technical support for SFM and to conduct public awareness campaigns for applying woodfuel saving technologies. Supporting measures include introduction of a system of proof of origin for woodfuel, installation of an effective control system and respective capacity measures.

2. Producers (rural population) will be motivated to engage in SFM. Organisational and technical support and capacity building for forest management and conversion and marketing ensures sustainability and efficiency of wood energy production.

3. The increase of the price for wood energy gives an incentive to the consumer to modify their behaviour and use woodfuel more efficiently. At the same time, alternative energy sources are becoming more competitive. To avoid social hardships to consumers, flanking interventions proliferate energy-saving stoves.

The following chart presents the required measures and their impact structure from a development cooperation perspective:

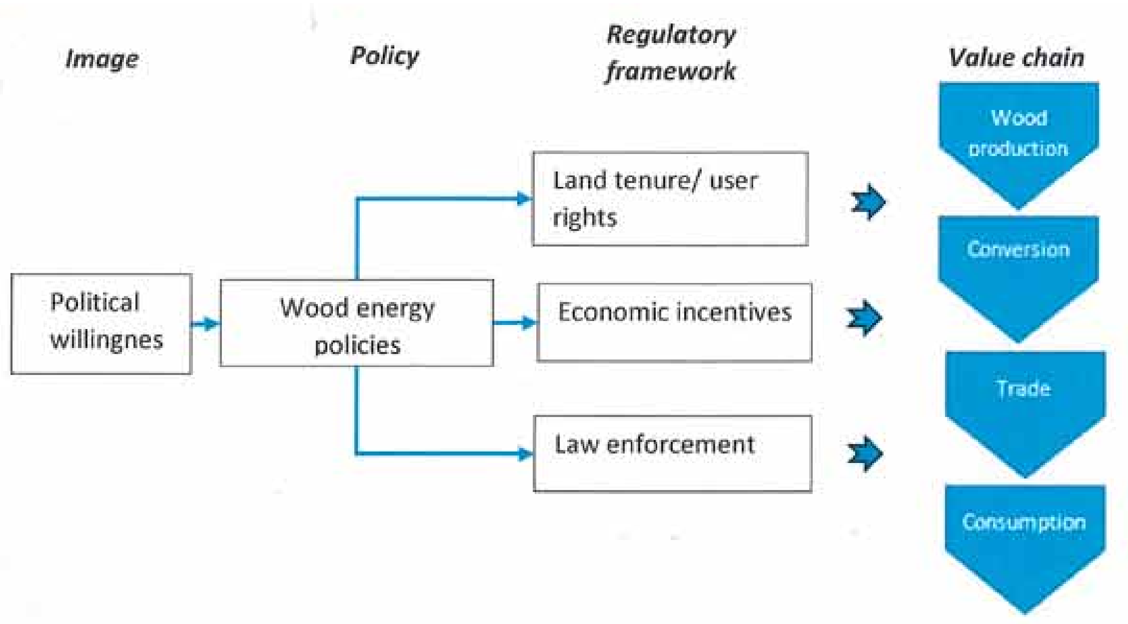
Figure 19: Measures and their impact structure of wood energy value chain development



When putting this structural change in practice, it is strongly recommended to apply a holistic approach. This does not mean that single measures should not be supported - as long as they are complementary for a greater design. Aspects of perception and behaviour change, promotion of conducive policies, the regulatory framework, and improvements all along the value chain must be combined in a synergistic fashion. Support is needed in the form of policy advice, capacity building, organisational development and technical improvements.

In the following, all cited types of interventions addressed, to illustrate the most promising steps, according to hitherto experience, how structural change can be initiated and supported throughout the interlocking stages of the holistic approach.

Figure 20: Aspects of a structural change to be combined in a synergistic fashion



5.2 Image change

Modifying the negative image of wood energy is a precondition for stakeholders' involvement in the structural change process and conducive policy reform. Wood energy should be promoted as a renewable, climate friendly, environmentally sound and technically adapted option in the energy mix of the country. It should also be stressed that if wood energy is used in a modern way it could substantially contribute to future economic development and poverty alleviation for generations to come.

Changing the negative image of wood energy demands concerted international efforts. Several points of action should be considered simultaneously:

1. **Linking modern wood energy promotion to high-level internationally recognised processes**. A shift of perception seems most likely to materialise if it can be linked to the emergence of green economies, climate change and poverty alleviation. International development agents should aim to (i) align wood energy support with green economy development, climate change mitigation and adaptation and (ii) to mainstream biomass issues more broadly in rural development policies, forest policies, pollution control strategies (e.g. emissions standards) and the like.

2. **Fostering scientific practical experience and further dissemination of lessons learned**. Work along these lines may draw on the experience of developed countries (e.g. to formulate national biomass action plans and to promote successfully modern forms of wood energy).

3. **Promoting science and research**. Evidence-based analyses of the woodfuel value chain provide the opportunity to demonstrate the regional added value of woodfuel production and thus help inform policy makers about a sustainable source of energy previously largely ignored by them.

4. **Supporting collection, processing and publication of reliable data**. With a rapidly changing context for wood-based biomass energy, policy makers need reliable baseline data to design appropriate measures. Such data include wood availability and potential production; population growth, urbanisation dynamics and consumers' fuel switching behaviour. To improve wood energy data within the country, wood energy databases should be established at regional and national levels. This can be achieved through establishing regular field surveys for wood energy, supply, demand and data analyses to monitor the changes over time. Regular surveys should be undertaken preferably at five-year intervals, to enable updating the data for future wood energy plans and policy formulations.

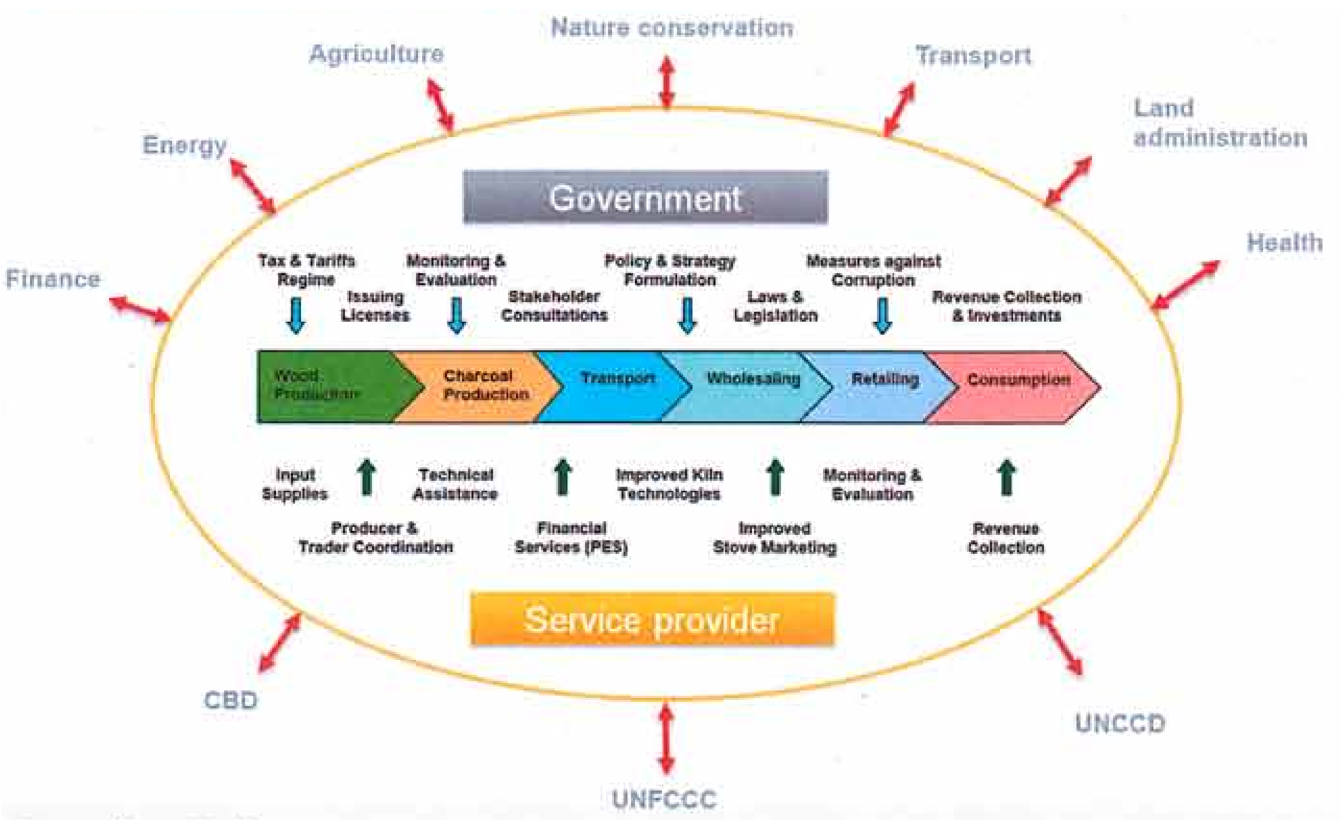
5.3 Promoting enabling policy frame work conditions in partner countries

Wood energy production and use are interlinked with many sectors, especially energy and forestry but also agriculture, land administration, health, transport etc. Currently, the coordination and linkages among the sectors concerned are weak and need to be strengthened. Inter-agency communication and cross-sector coordination should be strengthened. Closer links to international processes should be established. This will not occur spontaneously but requires an adequate institutional setting as well as effective procedures.

It is important that such policy reforms are spearheaded by a strong national entity to ensure that the aforementioned improvements be made, that the taxation and verification mechanisms be operational, and all monitoring and capacity building activities be realised. Some countries have had positive experience with intersectoral working or steering groups, others, with the creation of a dedicated independent organisation (e.g. Biomass Energy Agency, BEA).

Policies need translation into national (and sub-national) **strategies**. Existing strategy development approaches supported by the international community (e.g. National Biomass Energy Strategies -BEST- or National Domestic Energy Strategies) should take up the holistic modernisation approach. They should be developed in a more systematic participatory way comprising stakeholder consultation, participation, and capacity-building at all levels. The process should be adapted to the partner country's circumstances to create ownership.

Figure 21: Wood energy value chain – highly interlinked



Source: (Sepp 2013)

There are also many helpful tools for **operationalisation**. WISDOM, for example, is a powerful analysis tool (see chapter 4.2.2). It should be coupled with strategic planning exercises to modernise the whole value chain. Software modelling tools such as LEAP can be useful when evaluating different scenarios in terms of impact and cost/benefit. At local level, the development of **Woodfuel supply master plans (WSMP)** for cities in SSA have proven useful to support the sustainable supply of woodfuel. Rooting in partner countries' structures and respective capacity building is necessary to deploy full impact.

Efforts to improve the **informational basis** of policy making and subsequent implementation should focus on:

- Identifying information gaps as well as the specific needs and potential contributions of relevant stakeholders (stakeholder analysis, needs assessment)

- Measures to improve information and knowledge management (IKM), including harmonisation of statistics and management information systems (MIS), documentation and upscaling of experience and lessons learned, 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.).

5.4 Regulatory framework

Incentive measures and systems of control ("Carrots and sticks ") will be needed to put a wood energy modernisation policy in practice. According to the lessons learned the most important incentives for a strategic shift from open-access to sustainable forest management are **secure tenure or use rights and economic benefits.**

Decentralisation and devolution of power for forest management (e.g. from state owned forests to community forests) appear to be effective in many partner countries and might be used to create incentives and could be supported by the international community. This process should strongly be linked to respective **capacity building and organisational development** at subnational levels. Governance bodies which are newly mandated with forest matters need structured support. This may (also) pertain to regional or community councils, forest user groups, local forest management structures and/or NGOs as long-term supporters for communities or households.

As outlined above, a promising tool to foster **economic benefits** for sustainable producers in those countries that depend on wood energy supply from open-access areas (i.e. most African countries) is a **differentiated taxation scheme**. If backed by conducive policies, law enforcement and good sector governance it serves to protect wood energy producers who enter a formal, sustainable production system against informal/unsustainable producers. Support may include: (i) conducting economic studies, improving data bases and understanding for the design of tax systems, (ii) elaborating and lobbying for such a taxation system; (iii) training. It is strongly recommended to the international community to enhance their support in the field of law enforcement because land tenure reforms and theoretically provided economic incentives cannot display any impact without effective control, including monitoring. This may concern: (i) introduction of a proof of origin (coupon system on the basis of sustainable exploitation quota), (ii) installation of road checks, (iii) putting in place a traceability system (bar code system), (iv) efficient tax collection.

5.5 Value chain approach

Based on the lessons learnt, it is strongly recommended to consider the entire value chain. On the basis of a careful analysis support should be focused on specific weaknesses identified. For feedstock management proven approaches are available, but it is recommended to arrange for intensive capacity building and long-term support especially for the local population. Conversion technologies deserve special attention because respective efficiencies are a strong leverage factor for the overall efficiency of the entire value chain. Improvement of transport and marketing should enforce the negotiation power of fuelwood and charcoal producers vis-à-vis the traders and thus contribute to a more even distribution of benefits among all stakeholders involved in wood energy production, trade, and marketing

A twofold support of the value chain is recommended:

1. **Institutional development**: Formalisation of the value chain requires the organisation of stakeholders in the form of professional associations, cooperatives or private enterprises (e.g. tree planter associations, forest user groups, charcoal maker and stove producer cooperatives). The balance between stakeholders' rights, responsibilities and benefits has to be negotiated at each stage of the value chain. Support may concern the definition of mandates and rights of the different stakeholders, promotion of stakeholder dialogue and agreement[14], the establishment of internal structures and an intensive, long term capacity building to fulfil their specific tasks. Cooperation with other relevant organisations, respective contracts and information management are some of the context-related tasks for capacity building. An end-to-end formalisation of commercial circuits should be promoted creating a network of rural and urban wood energy markets. Wood energy depots (where suitable) should be managed like micro, small or medium enterprises (MSME) and be subject to standard financial rules.

2. **Technology improvement**: Modernisation of the wood energy value chain needs to capitalise on technological advances. To be effective, technical interventions need to take full advantage of recent research and development and associated technological advances. However, research has been somewhat neglected in the past and there is still room for improvement.

It is recommended to further develop, test and promote new improved kiln designs (e.g. low-cost retorts that utilise gases to pre-dry wood or assist in the carbonisation process, instead of venting them into the atmosphere) the "next generation" of improved cookstoves (e.g. micro-gasifiers which operate on volatile gases, leaving charcoal instead of ash) (Roth 2011). New types of wood-based fuels and corresponding stoves should also be developed, including pellets and wood chips, as well as more efficient approaches to use industrial timber residues.

14 A useful tool to clarify roles and relationships of stakeholders is "The Four Rs" (Mayers 2005)

6 References

AEDE/ECO, 2002. Plan Directeur d'Approvisionnement en énergie domestique de N'Djamena.

AGF, 2012. 2012 Study on forest financing: Advisory Group on Finance -Collaborative Partnership on Forests.

Angelsen, A., Jagger, P., Babigumira, R., Belcher, B., Hogarth, N. J., Bauch, S., Börner, J., Smith-Hall, C., Wunder, S., 2014. Environmental Income and Rural Livelihoods: A Global-Comparative Analysis. World Development. 10.1016/j.worlddev.2014.03.006.

Ardenti, M. A., 2013. Mit öffentlichen Geldern finanziert: Wenn Entwicklungsbanken Vorhaben unterstützen, die Land Grabbing zur Folge haben. Dossier von Brot für alle und Fastenopfer 11-2013.

Bailis, R., 2009. Modeling climate change mitigation from alternative methods of charcoal production in Kenya. Biomass and Bioenergy 33 (11): 1491–1502. 10.1016/j.biombioe.2009.07.001.

Bailis, R., 2011. Narok's charcoal commodity chain: land use change and cahrcoal production in southwestern Kenya. Arusha.

Bailis, R. E., 2005. Fuel from the Savanna: the Social and Environmental Implications of the Charcoal Trade in Sub-Saharan Africa. Dissertation. Berkeley.

Barnes, D. F., Allan, J. C., Ramsay, W., 1982. Social Forestry in Developing Nations. Discussion Paper D-73F. Washington D.C.: Center for Energy Policy Research.

Barnes, D. F., Krutilla, K., Hyde, W. F., 2005. The urban household energy transition: social and environmental impacts in the developing world. Washington, DC: Resources for the Future Energy Sector Management Assistance Program.

Barr, C., Dermawan, A., Purnomo, H., Komarudin, H., 2010. Financial governance and Indonesia's Reforestation Fund during the Soeharto and post-Soeharto periods, 1989–2009: a political economic analysis of lessons for REDD+. Occasional paper 52. CIFOR, Bogor Indonesia.

Bart Minten, Klas Sander, David Stifel, 2010. Forest Management and Economic Rents: Evidence from the Charcoal Trade in Madagascar.

Bayard-Gamatié, M., Madon, G., 2003. Le bilan dix ans après la création des marchés ruraux au Niger: Une responsabilisation réelle des populations rurales pour la gestion et le contrôle des ressources ligneuses de leurs terroirs.

Bennett-Curry, A., Malhi, Y., Menton, M., 2013. Leakage effects in natural resource supply chains: a case study from the Peruvian commercial charcoal market. International Journal of Sustainable Development & World Ecology 20 (4): 336–348. 10.1080/13504509.2013.804892.

Blackden, C. M., Wodon, Q., 2006. Gender, time use, and poverty in sub-Saharan Africa. Washington, DC: World Bank.

Broadhead, J. S., Bahdon, J., Whiteman, A. Past trends and future prospects for the utilisation of wood for energy.: Global Forest Products Outlook Study. Working Paper No. 5. Rome: FAO.

Bruce, N., 2008. Indoor air pollution from unprocessed solid fuel use and pneumonia risk in children aged under five years: a systematic review and meta-analysis. Bulletin of the World Health Organization 86 (5): 390–398. 10.2471/BLT.07.044529.

Ceccon, E., Miranda, R. C., 2012. Sustainable Woodfuel Production in Latin America: The role of Government and Society. Mexico: Copit-arXives.

Chokkalingam, U., de Jong, W. I., 2001. Secondary forest: a working definition and typology. The International Forestry Review, 19-26.

CIFOR, World Agroforestry Centre & USAID, 2009. Integrating climate change into forestry: adaptation [PowerPoint presentation]: In:Forest and climate change toolbox: Topic 2 section C.

CIWMB, 1999. Feasibility Study on the Expanded Use of Agricultural and Forest Waste in Commercial Products: Publication No. 431-98-019. Sacramento, CA.

Cocchi, M., 2011. Global wood pellet industry, market and trade Study. IEA Bioenergy Task 40 "Sustainable Bioenergy Trade".

CONAC, 2010. Stratégie Nationale de Lutte contre la Corruption 2010-2015. Yoaundé: Commission Nationale Anti-Corruption.

Cotula, L., Finnegan, L., Macqueen, D., 2012. Holzhunger in Europa. E+Z 2012/01.

CRC-PREDAS, 2006. Wood energy, poverty alleviation and environment in the Sahel: Regional Programme for the Promotion of Household and Alternative Energies in the Sahel.

de Gouvello, C., Dayo, F. B., Thioye, M., 2008. Low-carbon Energy Projects for Development in Sub-Saharan Africa: Unveiling the Potential, Addressing the Barriers. Washington: World Bank.

Diop, F., 2011. Les consommations en combustibles domestiques dans la région de Fatick. Programme d'Electrification Rurale et d'Approvisionnement Durable en Combustibles Domestiques (PERACOD). Dakar, Sénégal.

Drigo, Rudi et al., 2013. Woodfuels value chain analysis: As a basis for the Rwanda Supply Master Plan for fuelwood and charcoal.

Dutta, K., Shields, K. N., Edwards, R., Smith, K. R., 2007. Impact of improved biomass cookstoves on indoor air quality near Pune, India. Energy for Sustainable Development 11 (2): 19–32. 10.1016/S0973-0826(08)60397-X.

EC-FAO, 2002. A guide for woodfuel surveys: EC-FAO Partnership Programme. Rome: FAO.

ECO-Consult, 2006. Le reboisement villageois individuel. Antananarivo, Madagascar: GTZ.

Ekouevi, K., Tuntivate, V., 2011. Household Energy Access for Cooking and Heating: Lessons Learned and the Way Forward: World Bank ESMAP.

Elhadji Mahamane, Lawali, M., Khennas, S., al., e., 2005. Guide de création de marchés ruraux de bois. Ouagadougou-Burkina Faso: CRC / PREDAS / CILSS.

Erakhrumen, A. A., 2011. Global Increase in the Consumption of Lignocellulosic Biomass as Energy Source: Necessity for Sustained Optimisation of Agroforestry Technologies. ISRN Renewable Energy 2011 (6): 1–8. 10.5402/2011/704573.

Ernsting, A., 2014. A new look at land-grabs in the global South linked to EU biomass policies: biofuelwatch.

Etter, H., Sepp, S., Ackermann, K., Plugge, D., Schauer, M., 2014. Securing productive landscapes: Modernisation of wood energy supplies in Northern Madagascar. ETFRN News 56 (Forthcoming).

EUEI/GIZ, 2012. Biomass Energy Strategy (BEST)-Mozambique. Maputo.

EUEI-PDF/GIZ, 2014. Biomass Energy Sector Planning Guide. Eschborn: HERA/GIZ.

EUEI-PDF/GTZ, 2009. Malawi Biomass Energy Strategy. Lilongwe.

Eurostat, 2012. Data Explorer - EU27 Trade Since 1995 By CN8. http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database.

FAO, 2000. The Energy and Agriculture Nexus.

FAO, 2001. Trees Outside the Forest: Towards Rural and Urban Integrated Resources Management. In: Working Paper. Rome: Forestry Department.

FAO, 2006a. Global Forest Resources Assessment 2005 - Progress towards sustainable forest management. Rome: FAO.

FAO, 2006b. Responsible management of planted forests - Voluntary guidelines. Rome: FAO.

FAO, 2008. Forests and Energy: Key issues. Rome.

FAO, 2010a. Forests and Climate Change in the Near East Region. Forests and Climate Change Working Paper 9. Rome.

FAO, 2010b. What wood-fuels can do to mitigate climate change? Rome.

FAO, 2012a. State of the world's forests, 2012. Rome: Food and Agriculture Organization of the United Nations.

FAO, 2012b. Urban and peri-urban forestry in Africa: the outlook for woodfuel: Urban and peri-urban forestry working paper n°4. Rome.

Ferguson, I., Chandrasekharan, C., 2004. Paths and pitfalls of decentralisation for sustainable forest management: Experiences of the Asia-Pacific region. [Bogor]: Center for international forestry research (CIFOR).

Fowler, M., Abbot, P., Akroyd, S., Channon, J., Dodd, S., 2011. Forest sector public expenditure reviews: Review and guidance note. Washington D.C.: Program on Forests (PROFOR).

Fröde, A., Masara, C., 2007. Community-based ecological monitoring: Manual for practitioners. Harare: SAFIRE - Southern Alliance for Indigenous Resources.

GEF, 2013. Africa will import—not export—wood.

GIZ, 2014. Multiple-Household Fuel Use – a balanced choice between firewood, charcoal and LPG. Eschborn.

Global Alliance for Clean Cookstoves, 2012. 2012 Results Report: Sharing Progress on the Path to Adoption of Clean Cooking Solutions. Washington D.C.

Gondo, P. C., 2012. A review of forest financing in Africa: Study prepared for the United Nations Forum on Forests (UNFF). Harare.

Green Resources, 2012. Company report. Oslo.

GTZ, 2007. Successful energy policy interventions in Africa. Eschborn.

Guta, D. D., 2012. Assessment of Biomass Fuel Resource Potential And Utilisation in Ethiopia: Sourcing Strategies for Renewable Energies. INTERNATIONAL JOURNAL of RENEWABLE ENERGY RESEARCH (Vol.2, No.1,).

Hanna, R., Duflo, E., Greenstone, M., 2012. Up in Smoke: The Influence of Household Behavior on the Long-Run Impact of Improved Cooking Stoves: Working Paper Series. Cambridge: Massachusetts Institute of Technology - Department of Economics.

Hoff, H., 2011. Understanding the Nexus. Background Paper for the Bonn 2011 Conference: The Water, Energy and Food Security Nexus. Stockholm: Stockholm Environment Institute.

IEA, 2006. World Energy Outlook - Chapter 15, Energy For Cooking in Developing Countries. Paris: International Energy Agency / Organisation for Economic Co-operation and Development.

Iiyama, M., Neufeldt, H., Dobie, P., Njenga, M., Ndegwa, G., Jamnadass, R., 2014. The potential of agroforestry in the provision of sustainable woodfuel in sub-Saharan Africa. Current Opinion in Environmental Sustainability 6: 138–147. 10.1016/j.cosust.2013.12.003.

Indufor Oy, 2013. Forest Financing in African Countries: Second Macro-Level Paper. Helsinki.

IOB, 2013. Impact Evaluation of Improved Cooking Stoves in Burkina Faso. IOB Evaluation No. 388. The Hague: Policy and Operations Evaluation Department (IOB). Ministry of Foreign Affairs of the Netherlands.

IRENA, 2014. REmap 2030: A Renewable Energy Roadmap. Abu Dhabi.

IUCN, 2013. Avis de l'UICN sur le programme et les Objectifs de développement durable pour l'après 2015. https://cmsdata.iucn.org/downloads/fre_iucn_contribution_to_sdg.pdf.

Jagger, P., Luckert, Martin K., Duchelle, A. E., Lund, J. F., Sunderlin, W. D., 2014. Tenure and Forest Income: Observations from a Global Study on Forests and Poverty. World Development. 10.1016/j.worlddev.2014.03.004.

Jama, B. A., Mutegi, J. K., Njui, A. N., 2008. Potential of improved fallows to increase household and regional fuelwood supply: evidence from western Kenya. Agroforestry Systems 73 (2): 155–166. 10.1007/s10457-008-9132-7.

Jeuland, M. A., Pattanayak, S. K., Scalas, E., 2012. Benefits and Costs of Improved Cookstoves: Assessing the Implications of Variability in Health, Forest and Climate Impacts. PLoS ONE 7 (2): e30338. 10.1371/journal.pone.0030338.

Kartha, S., 2006. Environmental Effects of Bioenergy. In: Bioenergy and Agriculture: Promises and Challenges: International Food Policy Research Institute.

Khennas, S., Sepp, C., Hunt, S., 2009. Review and Appraisal of Potential Transformative Rural Energy Interventions in the Congo Basin: Scoping Phase: Practical Action, ECO Consult.

Korthuis, A., Meijer, E., 2012. Climate Finance for Biomass: An inventory of climate finance options and a review of overlaps with biomass sustainability certification. Utrecht: NL Agency.

Lamers,, P., Marchal,, D., Schouwenberg, P.-P., Cocchi, M., Junginger, M., 2012. Global wood chip trade for energy.

Larson, A. M., Ribot, J. C., 2007. The poverty of forestry policy: double standards on an uneven playing field. Sustainability Science 2: 27. 10.1007/s11625-007-0030-0.

Lauri, P., Havlík, P., Kindermann, G., Forsell, N., Böttcher, H., Obersteiner, M., 2014. Woody biomass energy potential in 2050. Energy Policy 66: 19–31. 10.1016/j.enpol.2013.11.033.

Louppe, D., 1991. Guiera senegalensis espèce agroforestière ? Revue Bois et Forêts des Tropiques. N° 228, 2e trim.

Louppe, D., N'Klo, O., 2013. Etude sur l'exploitation forestière et les contraintes d'une gestion durable des forêts dans le domaine rural en Côte d'Ivoire. GIZ-CIRAD.

Low, K., 2010. Models for a sustainable forest plantation industry: A review of policy alternatives. Canberra, A.C.T.: ABARE.

Lyons, K., Westoby, P., 2014. Carbon colonialism and the new land grab: Plantation for
estry in Uganda and its livelihood impacts. Journal of Rural Studies 36: 13–21. 10.1016/j.jrurstud.2014.06.002.

Macqueen, D., Korhaliller, S., 2011. Bundles of energy: The case for renewable biomass energy. London, U.K: International Institute for Environment and Development.

Martino, D., del Castillo, A. P., 2006. Uruguay as an Attractive Host Country for A/R-CDM Investments: Carbosur and Pike&Co.

MEWNR, 2013. Analysis of the Charcoal Value Chain in Kenya: Final Report 2013. Nairobi.

MINESUDD, 2013. Readiness Preparation Proposal (R-PP): Forest Carbon Partnership Facility (FCPF). Abidjan.

MINFOF, 2013. Stratégie de modernisation de la chaine de valeur bois-énérgie dans la région de l'Extrème Nord - Cameroun: PROPSFE -Ministère des Forêts et de la Faune.

Miranda, R. C. de, Sepp, S., Ceccon, E., Mann, S., Singh, B., 2010. Sustainable production of commercial woodfuel: Lessons and guidance from two strategies. Washington: ESMAP - The International Bank for Reconstruction and Development/THE WORLD BANK GROUP.

Mugo, F., 2014. Rapid desk-based study: donor and partner programmes in sustainable forest management and fuelwood value chains in Eastern and Southern Africa: Evidence on Demand.

Müller, N., Spalding-Fecher, R., Bryan, S., Battye, W., 2011. Piloting greater use of standardised approaches in the Clean Development Mechanism: Phase II: Development of standardised approaches. Zürich: GERES, Pöyry, South Pole and CEEEZ.

Mustalahti, I., Lund, J. F., 2009. Where and How Can Participatory Forest Management Succeed? Learning From Tanzania, Mozambique, and Laos. Society & Natural Resources 23 (1): 31–44. 10.1080/08941920802213433.

Mutimba, S., Barasa, M., 2005. National Charcoal Survey: Exploring the potential for a sustainable charcoal industry in Kenya. Nairobi.

Mwampamba, T. H., Ghilardi, A., Sander, K., Chaix, K. J., 2013. Dispelling common misconceptions to improve attitudes and policy outlook on charcoal in developing countries. Energy for Sustainable Development 17 (2): 75–85. 10.1016/j.esd.2013.01.001.

Ndegwa, G. M., 2010. Woodfuel Value Chains in Kenya and Rwanda - Economic analysis of the market oriented woodfuel sector. Cologne.

Nketiah, K., 2008. The prospects of charcoal production contributing to poverty reduction in Ghana. In: INBAR. Proceedings of the "Conference on Charcoal and Communities in Africa". Maputo.

Nketiah, K., Atakora, S., Brew-Hammond, A., 2001. Ghana Sawmill Energy Efficiency Study. Kumasi: Institute of Technology and Environment.

NL Agency, 2010. Making charcoal production in Sub Sahara Africa sustainable. Utrecht.

Noppen, D., Kerkhof, P., Hesse, C., 2004. Rural fuelwood markets in Niger: an assessment of Danish support to the Niger household energy strategy 1989 - 2003. London: International Inst. for Environment and Development.

Ohler, F. J., 1985. The fuelwood production of wooded savanna fallows in the Sudan zone of Mali. Agroforestry Systems 3: 15–23.

Ojha, H., Persha, L., Chhatre, A., 2009. Community Forestry in Nepal: A Policy Innovation for Local Livelihoods. IFPRI Discussion Paper 00913. Washington D.C.: International Food Policy Research Institute (IFPRI).

ONU-REDD, 2013. Proposition de mesures pour l'état de préparation (R-PP) - Pays République de CÔTE D'IVOIRE.

Openshaw, K., 2010. Biomass energy: Employment generation and its contribution to poverty alleviation. Biomass and Bioenergy 34 (3): 365–378. 10.1016/j.biombioe.2009.11.008.

Ouedraogo, B., 2013. Assessing Wood-Energy Pricing Policies in Urban Ouagadougou (Burkina Faso). International Journal of Energy Science 3 (5): 362. 10.14355/ijes.2013.0305.08.

Oumarou, I., 2007. Commune rurale de Torodi - Diagnostic de l'exploitation forestière. Niamey: GESFORCOM-Niger.

Owen, M., der Plas, Robert van, Sepp, S., 2013. Can there be energy policy in Sub-Saharan Africa without biomass? Energy for Sustainable Development 17 (2): 146–152. 10.1016/j.esd.2012.10.005.

Pandey, D., 2002. Fuelwood Studies in India - Myth and Reality. Bogor, Indonesia: Center for International Forestry Research.

Paruelo, J. M., 2012. Ecosystem services and tree plantations in Uruguay: A reply to Vihervaara et al. (2012). Forest Policy and Economics 22: 85–88. 10.1016/j.forpol.2012.04.005.

Pennise, D., Brant, S., Agbeve, S. M., Quaye, W., Mengesha, F., Tadele, W., Wofchuck, T., 2009. Indoor air quality impacts of an improved wood stove in Ghana and an ethanol stove in Ethiopia. Energy for Sustainable Development 13 (2): 71–76. 10.1016/j.esd.2009.04.003.

Peters-Stanley, M., Gonzalez, G., Yin, D., 2013. Covering New Ground - State of the Forest Carbon Markets 2013. Washington D.C.: Forest Trends' Ecosystem Marketplace.

Prathoumvanh, B., 2000. Gender and Wood Energy in Lao PDR. In: Energia News Vol. 3 Nr. 1, 12–13.

Rafanoharana, S. C., Locatelli, B., Russell, A. J., 2012. An analysis of climate change scenarios and their impacts on ecosystem services in Ziro-Sissili,: Draft Technical Report. CIFOR: Bogor, Indonesia.

Raga, F., 2009. The Chilean Forestry Sector and associated risks. trébol 51/2009.

Raonintsoa, P., Rakotoarisoa, J. N., Gräbener, J., 2012. Etat des lieux de la gouvernance forestière à Madagascar. Antananarivo: Alliance Voahary Gasy.

Ribot, J., 2005. Waiting for Democracy: The Politics of Choice in Natural Resource Decentralization. Washington: World Resources Institute.

Richter, F., 2009. Note sur l'analyse financière d'un aménagement durable de trois forêts naturelles dans la zone d'intervention du PERACOD.

Richter, F., Mundhenk, M., Charpin, M., Bodian, L., 2014. Adaptation de la filière bois-énergie burkina-bé au changement climatique: PROFOR/World Bank.

Richter, F., Sepp, S., Jorez, J.-P., 2009. Vision 2020. Vers une stratégie bois énergie de la région de Diana.: L'art de résoudre la querelle des anciens et des modernes. ECO-Consult Oberaula, Germany.

Roden, C. A., Bond, T. C., Conway, S., Osorto Pinel, A. B., MacCarty, N., Still, D., 2009. Laboratory and field investigations of particulate and carbon monoxide emissions from traditional and improved cookstoves. Atmospheric Environment 43 (6): 1170–1181. 10.1016/j.atmosenv.2008.05.041.

Rose, S., Remedio, E., Trossero, M., 2009. Criteria and indicators for sustainable woodfuels: Case studies from Brazil, Guyana, Nepal, Philippines and Tanzania. Rome.

Roth, C., 2011. Micro Gasification: Cooking with gas from biomass. Eschborn.

Roy, B., Rahman, M. H., Fardusi, M. J., 2013. Status, Diversity, and Traditional Uses of Homestead Gardens in Northern Bangladesh: A Means of Sustainable Biodiversity Conservation. ISRN Biodiversity 2013 (3): 1–11. 10.1155/2013/124103.

Ruiz-Mercado, I., Masera, O., Zamora, H., Smith, K. R., 2011. Adoption and sustained use of improved cookstoves. Energy Policy 39 (12): 7557–7566. 10.1016/j.enpol.2011.03.028.

RWEDP, 1996. Report on the regional course on trade in woodfuel related products. Bangkok: FAO Regional Wood Energy Development Programme in Asia.

RWEDP, 1999. Gender Aspects of Woodfuel Flows in Sri Lanka: A Case Study in Kandy District: Kandy, Sri Lanka: Food and Agriculture Organization of the United Nations.

RWEDP-FAO, 1997. Regional Study on Wood Energy Today and Tomorrow in Asia. Field Document - Regional Wood Energy Development Programme in Asia, No.50.

Sander, K., Hyseni, B., Haider, W., 2011. Wood-Based Biomass Energy Development for Sub-Saharan Africa: Issues and Approaches. Washington, DC: The World Bank.

Schlag, N., Zuzarte, F., 2008. Market Barriers to Clean Cooking Fuels in Sub-Saharan Africa: Working Paper. Stockholm: Stockholm Environment Institute.

Schure, J., Dkamela, G. P., van der Goes, A., McNally, R., 2014. An Approach to Promote REDD+Compatible Wood-fuel Value Chains: SNV.

Schure, J., Ingram, V., Akalakou-Mayimba, C., 2011. Bois énergie en RDC Analyse de la filière des villes de Kinshasa et de Kisangani: Projet Makala/CIFOR.

Schure, J., Ingram, V., Sakho-Jimbira, M. S., Levang, P., Wiersum, K. F., 2013. Formalisation of charcoal value chains and livelihood outcomes in Central- and West Africa. Energy for Sustainable Development 17 (2): 95–105. 10.1016/j.esd.2012.07.002.

Sepp, S., 2008a. Review of Community based Strategies for Sustainable Production of Commercial Fuelwood in Africa. Washington D.C.: ESMAP.
Sepp, S., 2008b. The way ahead – Creating a formal and sustainable charcoal sector: Contribution to the World Bank Workshop in Dar Es Salaam Tanzania - 27th October 2008 “Promotion of sustainable charcoal production through community level approaches”. Dar es Salaam.

Sepp, S., 2009. Review of Community based Strategies for Sustainable Production of Commercial Fuelwood in Africa. Washington: ESMAP.

Sepp, S., 2013. From root to soot -The wood energy value chain, elements, impacts, challenges, supporting instruments. Yoaundé.

Sepp, S., 2014a. Reboisement Villageois Individuel: Exploration de la possibilité d’intégrer l’approche RVI de Madagascar au Projet Promotion des Filières Agricoles et de la Biodiversité (PROFIAB) en Côte d’Ivoire. GIZ-CCD-Project Bonn.

Sepp, S., 2014b. RVI-Upscaling - Project design study. Bonn: GIZ-Sector Project to Combat Desertification.

Smeets, E., Faaij, A., 2006. Bioenergy Potentials from Forestry in 2050. An assessment of the drivers that determine the potentials. Climatic Change Volume 81, Numbers 3-4.

Sylla, S., 2010. Wood – A source of supply for sustainable energy - Examples of best practice from project experience. Eschborn: HERA/GTZ.

Tole, L., 2010. Reforms from the ground up: a review of community-based forest management in tropical developing countries. Environmental management 45 (6): 1312–1331. 10.1007/s00267-010-9489-z.

Tomaselli, I., 2004. Lessons from Latin America and their relevance to SFM in Africa. Curitiba, Brazil.

Tomaselli, I., 2007. Forests and energy in developing countries. In: Forests and Energy Working Paper 2. Rome: FAO.

Trossero, M., 2002. Wood energy: the way ahead. Unasylva 211, Vol. 53.

Trossero, M., Gauthier, M., Drigo, R., Salbitano, F., 2008. WISDOM for cities. Analysis of wood energy and urbanization using WISDOM methodology. Rome: FAO.

Tsegaye, T., 2005. Guidelines for Implementation of the WAJIB Approach in Ethiopia. Addis Abbeba.

UNDP, WHO, 2009. The Energy Access Situation in Developing Countries: A Review Focusing on the Least Developed Countries and Sub-Saharan Africa. New York, USA.

UNEP, o.J. Facts and Figures. http://www.unep.fr/energy/activities/reed/pdf/energy-facts.pdf. Accessed 2012.

UNEP, 2009. Towards sustainable production and use of resources: Assessing biofuels. Paris: United Nations Environment Programme.

UNEP, 2014. Illegal trade in wildlife: the environmental, social and economic consequences for sustainable development: Information note by the secretariat. Nairobi.

USAID, 2007. Land Tenure and Property Rights Regional Report; Vol. 2.1 East and Central Africa.

Vattenfall, 2010. Vattenfall acquires share of Buchanan Renewables Fuel Ltd in Liberia. http://feed.ne.cision.com/wpyfs/00/00/00/00/00/11/96/D8/wkr0011.pdf. Accessed 6/17/2011.

Vemuri, A., 2008. Joint Forest Management in India: An Unavoidable and Conflicting Common Property Regime in Natural Resource Management. Journal of Development and Social Transformation (Volume 5).

WHO, 2011. Health in the Green Economy – Household Energy. Geneva, Switzerland.

Wiskerke, W., 2008. Towards a sustainable biomass energy supply for rural households in semi-arid Shinyanga, Tanzania: A Cost/benefit analysis. Master of Science program. Utrecht.

World Bank, 2004. Implementation completion report: Chad: Household Energy Project. Washington, D.C.: World Bank.

World Bank, 2009a. Environmental Crisis or Sustainable Development Opportunity ?: Transforming the charcoal sector in Tanzania - A Policy Note. Washington.

World Bank, 2009b. Environmental Crisis or Sustainable Development Opportunity ?: Transforming the charcoal sector in Tanzania - A Policy Note. Washington.

World Bank, 2011. Establishing a green charcoal chain in Rwanda: A feasibility study. Washington D.C.

World Bank, 2012. Forests, Trees, Forests, Trees and Woodlands in Africa: An Action Plan for World Bank Engagement.

Zwick, S., 2014. How Carbon Markets Save Lives And Slash Poverty. http://www.huffingtonpost.com/forest-trends/how-carbon-markets-save-lives_b_4043178.html.

7. Annex: Project case studies
Participatory forest management

1 INTRODUCTION

Senegal is a flat low-lying sahelian country situated in the westernmost part of Africa with a national territory of 196,722 km^2. Distinct rainfall patterns determine the vegetation, with bushy steppes in the north to closed forests in the south and southeast. In 2013, the population of Senegal was estimated at around 12,9 million growing at an annual rate of 2.5%. Around 45% of the population lives in urban areas (ANSD, 2014). Deforestation, overgrazing, soil erosion, and desertification constitute Senegal's major environmental challenges. Woodfuel harvesting is said to be a major contributor to deforestation in Senegal with an estimated loss of 40,000 ha of forest land per year mainly due to agricultural extension, excessive consumption of charcoal in urban areas and forest fires (FRA, 2010). Around 84% of households still depend on wood-based fuel (26% charcoal; 58% firewood) (Direction de l'Energie, 2007).

2 CONTEXT

Senegal's forests are mostly public domain. The promulgation of a new forest code in 1993[1] and the decentralisation process in 1996[2] heralded a considerable step forward and added momentum to the transfer of authority to newly established regional and local government bodies. The amended forest code of 1998 (i) invested local communities with management rights outside designated state forest lands, (ii) created the possibility for the State to entrust management of part of its forest lands to local communities under letters of agreement, and (iii) gave local communities the right to enter contracts with physical persons and legal entities concerning the forest lands under their administration. In the past, the Forest Service had the exclusive prerogative to assign commercial exploitation rights over forest resources nationwide. In the case of charcoal, these rights were principally assigned to urban based traders, based on an annually determined & centralised "charcoal quota system". Over the years, this practice gave rise to an oligopolistic industry with widespread corruption, economic and social inefficiency problems, and negative environmental impacts. In turn, this led to a distinctly distorted distribution of income where villagers retained only a very small portion of the (Ribot, 1995). In 2008, the forest service decreed that charcoal production is only allowed in forest areas under sustainable management. The strongly criticised "charcoal quota system" favoring merchants/wholesalers was abolished in 2010 giving more autonomy of decision to local authorities. Seeking to harness the momentum of decentralisation the Government of Senegal implements a series of projects supported by different donors, geared towards generating experience and lessons learnt from the management transfer of natural forests to local communities.

1 Law Nº 93.06 of February 1993

2 Law Nº 96-07 of March 1996

3 DESCRIPTION OF ACTIVITIES – APPROACH

3.1 Promotion of community-based forest management

3.1.1 Institutional development

The GIZ supported Program to support renewable energies, energy efficiency and access to energy services (PERACOD) took up with its forest component the work and experience by two precursor projects (PSACD and PSPI) which started already in 1994 and 1996 respectively. The program operates in the Peanut Basin and Casamance Region since 2004. In the area, population pressure and the need for farmland has resulted in large-scale forest conversion and fragmentation. Remaining forests are heavily degraded. PERACOD addresses fuel wood issues within a wider context of community based multipurpose forest management integrating itself into the ongoing process of transferring land use rights to rural communities.

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In case of community forests, rural communities enter into contracts with Inter-Village Committees (CIV) which are set up for planning and coordination purposes on the entire forest area. Those protocols govern (i) the granting of access and use rights to participating villages, (ii) supervision and (iii) sharing of the proceeds. In case of state forests, a protocol of agreement is signed between the forest service and the respective communities before the latter can transfer the management to an inter-village structure. Furthermore, each village interested in participating in the management of their local forest establishes a Village Committee (CV) to coordinate management activities (enrichment planting, planting, bushfire control, supervision of forest exploitation) (Bodian, 2007).

Forest dwellers interested in harvesting certain forest products form Economic Interest Groups. The revenues collected by the CIV's "accountant" is shared according to a benefit-sharing arrangement, agreed among the principal stakeholders: 70-85% for the producer groups (charcoal-makers, beekeepers etc.), 10-20% for the local forest management fund to cover forest management activities (e.g. fire protection), 5-10% for the communal development fund out of which general communal investments are covered and in some cases 5-10% for a village development fund.

3.1.2 Management planning

Rules and regulations oblige communes to present full-fledged management plans prior to any formal utilisation of the forests. A detailed, inventory-based management plan, which also reflects and harmonises locally perceived needs and expectations, is drafted and aims at balancing local expectations and the forest resources' productive potential and defusing land-use conflicts.
According to the management plans, logging is limited to 50% of the standing wood energy volume, so as to avoid overexploitation and assure natural regeneration. The rotation period has been fixed at eight to twelve years. Harvesting operations are subject to continuous recording and, in the case of wood energy, the requirement to carry a badge when working in the forest. Charcoal makers are obliged to use the improved Casamance-Kiln, a provision that is in reality only reluctantly met in some production zones.

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3.1.3 Promoting local participation in the charcoal value chain

The active participation of the local population in forest management goes along with significant changes in the structure of the charcoal value chain. While in the traditional system the production and marketing of charcoal was dominated by urban wholesalers, the number of local producers and user groups entering the value chain is now steadily increasing. PERACOD provides organisational and capacity building support (e.g. training for improved kiln utilisation) to local charcoal producers. A particularity of the PERACOD approach is the integration of women associations in the marketing segment. Initially supported by the project (subsidy contract) local women buy the produce at the production sites, organise transport to regional consumption centers and take charge of marketing to retailers.

In order to foster traceability of the sustainably produced household fuel and to support marketing, the concerned organizations currently test a labeling approach (tailored bags and coupons) for charcoal from managed forests.

3.2 Upscaling of participatory forest management to the regional level

Between 2004 and 2008, PERACOD supported 14 rural communities on the way to sustainably managing their forests. By the end of 2008, replication was underway on 50,500 ha of state forests in 10 rural communities (ECO-Consult, 2009). In light of the good results at the end of this test phase, and the numerous calls for support from other rural communities, it has been decided to replicate the interventions on the regional level, in line with the regionalisation policy promoted by the Forestry administration of Senegal. In 2009, the regional councils of Fatick, Kaolack, Ziguinchor and Kolda committed to defining a regional strategy for participatory forest management, with the support of PERACOD, aiming at:

- establishing sustainable production systems through participative development and implementation of forestry management plans, and improvement of charcoal production systems (improved technologies).
- adopting of concerted regulatory measures in order to limit uncontrolled and illegal forest exploitation (forestry controls, taxation etc.).
- distributing improved cookstoves to households in order to reduce demand in wood energy, generate household savings and limit negative health impacts.

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The regional strategies are based on five key points:

- The region, with the support of the Forest Service and other partners, establishes a regional action plan to promote participatory forest management and sustainable supply of domestic fuels as part of the Regional Environmental Action Plan (EIA)

- The region installs a steering committee comprising all technical services, local institutions and development partners. A technical assistant is recruited by the region to ensure regular monitoring and evaluation of activities in rural communities under the supervision of the committee.

- Rural communities recruit a community volunteer who is, in close cooperation with the concerned forestry officer, in charge of supporting local people involved in forest management. The volunteers receive respective training and have at their command a set of simple tools guiding their work step-by-step.

- A regional forest fund, managed by the steering committee, provides funding grants to rural communities. It is supplied by a share of the revenues generated by the different forests under management as well as by contributions from development partners.

- The region, supported by the forestry service, actively promotes its regional action plan in order to mobilise financial and technical support. The diversity of proposed forestry activities and the structure of the regional system provides opportunities for co-financing from a wide range of partners (national programs, decentralised cooperation , innovative financing, etc.)

The figure below shows the basic structure of the regional approach.

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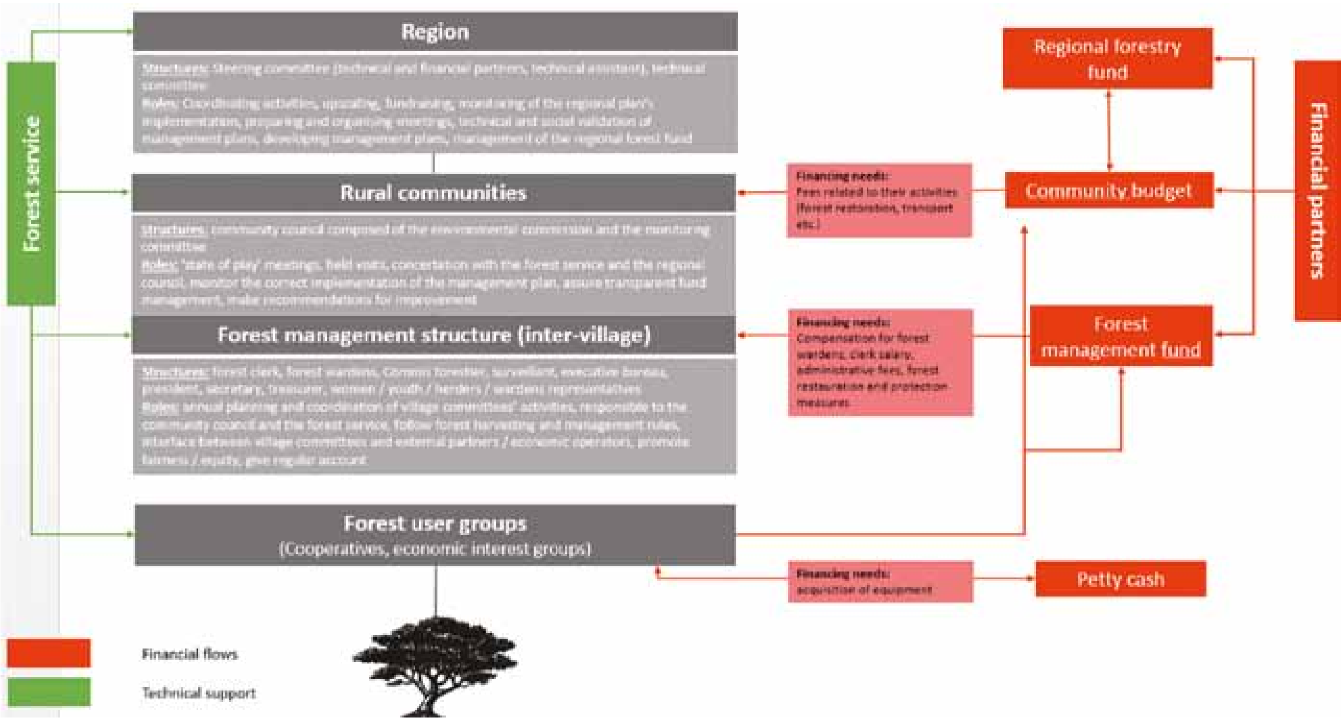
All three regions are currently implementing their regional action plan for participatory forest management and sustainable supply with household fuels, integrating interventions along the wood fuel value chain. The region of Kolda in southern Senegal joined in in 2011. For the 2013-2015 period, the regions forecast to put 138 500 ha of forest under management. They also plan to reforest 5250 ha of degraded land and 76 800 ha of mangrove. The distribution of improved stoves and cookers will also continue on a large scale.

Figure: Basic Structure of the regional approach



4 RESULTS

In general, it can be concluded that significant success has been achieved in reinforcing the capacities of local communities (at regional and rural community level). They now have increased technical competences and means required to implement their action plan for forest management. The local population is the primary beneficiary of this new management system, and they make substantial efforts to ensure that "their" forests are well managed. Villagers are represented in the decision-making and implementation body. The interlocking framework of CIV (co-ordinating body), CV (sustainable management responsibilities) and GIE (sustainable business responsibilities) provides certain checks and balances and safeguards sustainable forest management. Furthermore, community members are increasingly taking measures to participate in the surveillance necessary to assure sustainable access to forest resources and to the benefits derived from them.

The decentralised forestry administration (regional inspection, engineers and agents) is also actively engaged in the regional forestry management processes and facilitates its dissemination. The national Forest Service also provides support in applying the participatory forest management methodology adopted by the four regions. Technical solutions brought forth in terms of local forest management (firebreaks, precautionary burning, and use of the "Casamance" kiln) have proven efficient and are quickly adopted by economic interest groups.

However, the communes have neither the technical competence nor the financial means to draft management plans. Management plans often presuppose investments beyond the forest resources' economic potential. They depend entirely on external support. Furthermore, it appears that many of the tools and procedures introduced are too sophisticated or burdensome to be sustainably applied by rural communities after external support ends. Fortunately, the national forest service is harmonizing and documenting the different approaches through a ministerial working group tasked to establish national standards and simplified regional guidelines.

Numerous partnerships have been developed with various development actors, particularly in the framework of decentralised cooperation. In order to mobilise their European counterparts, the regions of Fatick, Ziguinchor and Kolda have pegged forestry management as a priority theme for decentralised cooperation (2013-2015 framework agreement). The four regions are also members of the International association of forest communes, COFOR International.

Despite the commitment of local government and the forestry service, and the support provided by various projects and programs, the financial needs for the implementation of regional forest management action plans still remain high and require additional financial partners during the initial set up phase. These external funds are essential for the regional management and implementation system to be put in place (recruitment of technicians, training, equipment purchasing etc.). After an initial transition phase, forest exploitation should generate sufficient revenues to ensure the sustainability of the system on its own, through contributions to the forestry fund.

As far as the development of a modern and locally beneficial charcoal value chain is concerned, the revenue sharing still shows signs of distortion. Charcoal producers still capture only a relatively small percentage of the value of the forest products they sell, while middlemen and retailers higher up the commodity chain capture a much greater share. Nevertheless, the figure below illustrates how the re-organisation of the charcoal value chain has contributed to re-distributing benefits among the involved stakeholders. Local producers' share in the charcoal value chain, formerly practically inexistent, has considerably increased in the community-based exploitation scheme with sale of the produce either at the roadside (or in the forest) or directly to urban wholesalers in consumption centers.

The implementation of the regional replication strategy in the four concerned regions yields already several promising results:

- 59 000 ha of forest are being managed or on the verge of being managed in 255 villages of 30 rural communities.
- 750 ha of degraded land have been reforested.
- Savings of 927 tons of wood were made between 2010 and 2012 thanks to the systematic use of the « Casamance » kiln.
- 10 forest user groups have been created by charcoal producers or retailers.
- 249 women have engaged in charcoal and forest fruit retailing and now dominate the trade.
- 50 000 improved cookstoves have been sold.

5 LESSONS LEARNT FOR REPLICATION

The **creation or empowerment of local governance structures** integrating representatives of all relevant stakeholders (forest service, local authorities, partners) proved to be key for a successful implementation of participatory management schemes and the elaboration of the regional forest management strategy. **Local ownership**, build up through systematic implication and capacity building, is of particular importance if substantial leadership is required, e.g. for leveraging additional funding, and for local structures to earmark their own funds for forest management.

Even though charcoal is the leading commodity targeted by the developed forest management plans, the **development of additional forest product value chains** (honey, baobab fruit) has played an important role in stimulating community interest in forest management and protection. Revenue accruing from the use and marketing of NWFP provides a strong incentive and helps to bridge the forest rehabilitation phase.

With the abolition of the centralised quota system in 2010 a major barrier in the liberalisation of woodfuel trade was removed. However, to date, the existing **taxation system** still does not provide enough incentives to direct merchants to the sustainably produced woodfuel from managed zones. Production costs in unmanaged zones are still much lower and compromise the competitiveness of the managed production zones. Furthermore, a **clear and fair pricing system** which maximises producer prices needs to be put in place in order to stimulate further investments in sustainable forest management. **Facilitating the direct markets access of producers** in order to avoid the deviation of rents from producers to intermediaries can be a solution to this end.

In summary, a **coherent and holistic reform** of the entire wood energy sector and the nationwide application of sustainable forest and NRM practices is crucial for a successful "greening" of the sector.

The **integration of women** into the marketing segment has proven very effective in developing a local/regional value chain with direct market access. Furthermore, this new income generating activity gives women a certain economic independence and reinforces their role within the local communities.

6 REFERENCES

ECO Consult (2012) L'aménagement participatif des forêts et l'approvisionnement durable en combustibles domestiques dans les régions de Fatick, Kaolack, Kolda et Ziguinchor. PERACOD-GIZ

Sepp, S. (2008): Review of Community based Strategies for Sustainable Production of Commercial Fuelwood in Africa. ESMAP. The World Bank: Washington D.C., USA.

Richter, F., Mundhenk, M. & Gueye S. (2014) Analyse de la filière bois-énergie pour le Sénégal. Rapport provisoire.

Homepage : http://www.peracod.sn/?lang=fr

Village-based individual reforestation

1 INTRODUCTION

Due to its geological history, Madagascar is endowed with unique eco-systems and an endemism rate of about 80% for fauna and 90% for flora. Madagascar ranks among the world's mega-diversity countries. Forests harbour most of Madagascar's biodiversity. It is estimated that Madagascar lost some 12 million hectares of forest essentially to increase the availability of land for shifting cultivation (tavy). Since then, the agricultural land increased by only around 100,000 ha leaving huge areas abandoned and devastated (World Bank 2003). These degraded and abandoned lands constitute the target areas to be earmarked for reforestation. Secondary threats to natural forests arise from firewood and charcoal production, livestock grazing, and invasive species. Every year, as much as a third of Madagascar's forest area is jeopardised due to fires. Heavy erosion and frequent floods destroy paddy fields (the basis of food production) and affect food security.

2 CONTEXT

Non-regulated, competitive access (hereafter: "open-access") to natural resources carries the risk of overexploitation ("tragedy of the commons"), a common occurrence in many developing countries such as Madagascar. Sustainable forest management (SFM) requires that extraction rates, including of wood-fuel, remain at (or below, if stock accumulation is intended) the calculated annual increment. Wherever sustainably managed forests and open-access forests exist side by side, the transition towards SFM may even increase, and further accelerate pressure on open-access forests and deforestation (leakage). In response, the **Gesellschaft für Internationale Zusammenarbeit** (GIZ) pioneered a complementary, twofold approach by (i) creating new forest resources through reforestation of degraded landscapes and by (ii) modernising the value chain for higher efficiency. Both fields of action substantially contribute to relieving the pressure on natural forests.

3 DESCRIPTION OF ACTIVITIES – APPROACH

The approach addresses the entire value chain, from individual afforestation schemes at village level, to harvesting, processing, conversion, distribution and marketing, all the way to end-consumers and related technology.

3.1 Activities along the value chain

3.1.1 Reforestation

The approach as such is based on voluntary participation of communities willing to rehabilitate degraded lands by means of village-based individual reforestation (RVI[1]). A village based participatory approval process allocates individual reforestation sites to interested households, along with defined use-rights and obligations. Each plot is demarcated, mapped, and documented with the communities' approval. Technical assistance is provided by specially trained NGOs through a three-stage approach, with a total implementation period of 21 months: (i) awareness raising and social mobilisation (3 mos.), training, planning and implementation (8 mos.) and self-management (10 mos.).

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Figure 1: Contributions of the project along the wood energy value chain

Besides institutional and technical support, the only substantial external input is mechanised soil preparation along contour lines. Tractors must be used to break up compact layers in degraded soils, to increase percolation of rainwater and ensure higher survival rates of seedlings. Nursery operations are collectively organised; plantation and maintenance are the plantation owners' responsibility.

The investment cost for one hectare of eucalyptus plantation amounts to 207 € of which 66% are borne through technical assistance (the remainder comes in the form of labor invested by the plantation owners).

3.1.2 Conversion technologies

Fast-growing plantations managed with short rotation cycles yield large quantities of wood and thus enable the development of technologically advanced (in terms of both, efficiency rates and reduction of harmful emissions) kiln types, e.g. the stationary "GreenMad Dome retort". The retort has a proven efficiency rate of more than 30% in comparison to 12% of traditional kilns. The internal rate of return of such an investment (4500 €/unit) exceeds 40%.

Another advantage (as compared to traditional and improved traditional kilns) of the retort is that it avoids CH_4 emissions by recycling flue gases that would be normally emitted into the atmosphere. Because of the high global-warming potential of CH_4 (21 times that of CO_2), this technology yields significant CO_2-equivalent reductions.

3.1.3 Commercialization

Plantation owners and charcoal burners organise themselves as a group of shareholders, create a registered micro-enterprise to invest and run the retort, and commercialise the produce (including proof of origin) on the basis of a rural energy market. The business plan of the established company is based on the exploitation plan of the plantation area available. Producers have to pay duties to the commune as well as taxes to the region. Several of such rural energy markets join their forces, establishing an urban charcoal market, and thus facilitate the traceability of the product by creating a "green value chain". The economic return for the producer increases on average by 30% compared to the traditional marketing structure.

3.1.4 Consumption

As part of a holistic approach, dissemination of improved cookstoves (ICS) can help reduce wood-fuel consumption and, by extension, deforestation. The challenge lies in designing ICS types that, while being compatible with established cooking habits and nutritional routines, readily lend themselves to manufacturing by local artisans. The project intervened at all levels of the ICS value chain from production to commercialisation, by supporting private entrepreneurship and public relations activities.

Figure 2: Introduction of improved kilns and retorts

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Improved traditional kiln Mati

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Adam retort

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GM-Dome high performance Retort (New development)

A women's association has been created to promote the use of improved stoves in the households of Antsiranana, the capital of the Diana Region. The association is composed of 15 members and focuses on educating households about the environmental and health hazards associated with traditional stoves as well as the benefits of ICS. Most of the ICS production sites and selling points established are run by women. A permanent consumption panel comprising 150 households has been established to monitor annually the consumption pattern as well as the adoption rate of ICS. To date, around 4500 families (about 20% of all households in Diego) use ICS. Instead of 125 kg/pers./yr., the households only consume 89 kg/pers./yr of charcoal.

3.2 Supplementing activities to shape the framework conditions

3.2.1 The modernisation strategy

The strategic orientation is laid down in a **Regional Modernisation Strategy** (Vision 2020 - Jorez, J. P., Richter, F. & Sepp, S. (2009)) for the DIANA region[2]. Due to the political crisis, the Vision 2020 was mainly the outcome of a negotiation process with the main actors of civil society to incorporate their expectations and preferences. Its key elements include improved forest management, reforestation and the introduction of more efficient utilisation and conversion technologies as well as the development of local wood energy markets. In addition, proposals for urgently needed regulatory measures are being made to curb the unregulated and widespread production of wood energy in the remaining natural forests.

In order to connect the actions of the different stakeholders according to the Vision 2020 and to transfer process-related and learning capacities, an **environmental coordination platform** (OSC-E/DIANA) reuniting all relevant actors of the civil society of the DIANA region has been created. The members of the platform gather regularly to discuss the progress of the modernisation process and to negotiate how to overcome upcoming barriers.

3.2.2 Land tenure the power of property rights

Awarding individual long-term land-use rights enhances motivation and ownership and hence provides the primary motivating factor for the vibrant engagement of the local population to the RVI approach.

The RVI approach relies on the availability of barren land non-suitable for other land uses. As a first step, the envisaged reforestation is subject to a consultation process (including foresters) on village (fokontany) level to exclude disputed land upfront and to take an unanimous decision on the allocation of the future reforestation sites. The results are laid down in minutes and a sketch plan.

The authenticity of the decisions taken during the compilation of reforestation records is checked by the communal decision makers and endorsed through a communal decree. The land is then assigned to the village afforestation body based on a specification document drawing up the rights and obligations. Furthermore, the individual wood lots are mapped with project support and the plot owners receive their individual map with the GPS coordinates signed by the mayor of the community. The communal decree is the primary step of securing land tenure. In a next step, the reforestation sites are registered by the topographical services of the respective land office. This procedure involves an official verification of the reforestation site based on the sketch plan, the Communal decree and the enrolment into the local tenure plan (Plan Local d'Occupation Foncière (PLOF)). Once enroled in the plan of the topographic service, the reforestation sites in principle cannot be attributed to a third party. This marks a new and unprecedented level of tenure security.

3.2.3 Necessary institutional landscape

Each link of the value chain made it necessary to use existing or create new institutional structures to enhance participatory decision-making processes, support the formalisation of the value chain, and promote private entrepreneurship.

Besides the Environmental Cooperation Platform (which takes charge of implementing the 2020 Modernisation Strategy) the regional administration is involved to identify and insert potential reforestation sites into their regional land use planning (schéma d'aménagement du territoire -SRAT). The interested communes play a pivotal role by allocating degraded land for reforestation purposes, securing ownership rights to plot owners (communal decree) and supporting individual land titles through their local land registry offices (Guichet foncier)

NGOs certified to apply the standardised RVI procedures provide the technical assistance to implement the RVI approach on community level. The village afforestation bodies[3] represent the community of plot owners towards the community council and coordinate the collaborative reforestation works of individual households.

Small-scale energy enterprises have been established based on a shareholder principle to commercialise the produce, and to pay duties to the commune as well as taxes to the region. Women associations conduct environmental awareness campaigns and promote improved stoves.

2 Organisation de la Société Civile pour l'Environnement dans la Région Diana (OSC-E/DIANA)

3 Groupements d'adhérents au reboisement-GAR

3.2.4 Impact and result oriented monitoring

All services are currently accompanied by a comprehensive GIS-based monitoring. The monitoring of selected indicators is carried out along the value chain of forest products, i.e. from wood production, conversion, transportation, selling to the consumer. In addition, livelihood indicators on the level of the target groups are periodically assessed. All data are **compiled to an "atlas"** and provide at all times the opportunity of a professional presentation of the information required.

4 RESULTS/IMPACT

4.1 Impacts on local population

On average, smallholder households involved in the afforestation scheme own 3 hectares of energy forest. This will enable them to produce about 2.6 tons of charcoal annually for at least 27 years without further investment. It will increase their income by about 40% compared to the average income in rural areas; for many people the increase will be significantly higher, since about 30 % of farming households belong to the poorest landless segment of the population. The approach also gives women greater opportunities to own forest plots and thus strengthens their economic position in society.

4.2 Impacts on the natural forest landscape and energy supply

Overall, 2,900 households afforested 8,000 hectares of wasteland around 68 villages, using mainly eucalyptus. The following table illustrates efficiency gains realised through comprehensive value chain interventions by means of a comparison between traditional and modernised value chains. The relative improvement achieved at three principal stages (production, conversion, combustion) is shown as an improvement coefficient, resulting in a summary leverage factor of 9.1. With an average energy requirement of 625 MJ/pers./a the traditional system can supply 1.5 persons sustainably, whereas the modernised value chain 13.9 persons. In other words, sustainable woodfuel production at a scale of 8.000 hectares offsets the hitherto unregulated exploitation of more than 72,000 ha of natural forests, both within and adjacent to protected areas (see figure), which would otherwise have been cleared for charcoal production. Biodiversity conservation is thus an intended side benefit. Another positive spin-off is a reduction in the number of bush fires in the afforestation zones, since the owners of the forest plots have a strong interest in protecting their property.

Barren land being a finite resource, application of the RVI approach can only supplement, but not replace targeted measures to promote the transition towards SFM of all types of forests.

Table: Efficiency gains through plantations and an improved value chain

Interventions	Traditional value chain (Nat. forests)	Modernised value chain (Plantations)	Improvement coefficient
	[1]	[2]	[3]
Production	Annual increment (m^3/ha)	2	3.25
Conversion	Efficiency	12%	2.50
Combustion	Efficiency	19%	1.12
Useful energy	**MJ**	**958**	**Leverage factor**
Consumer sustainably supplied	**Nbr. of pers.**	**1.5**	
Assumptions: wood density: 700 kg/m^3; energy content: wood 16 MJ, charcoal 30 MJ, * weighted average as only 25% of the urban population use ICS having a 28% efficiency			
As an alternative to calculating useful energy values for columns 1 and 2, respectively, one may, for the sake of convenience simply multiply the improvement coefficients in column 3 – the resulting leverage factor being the same either way. The leverage factor thus provides a convenient gauge for the total efficiency gain realised by a landscape based system.			

4.3 Impact on non-state actorsw

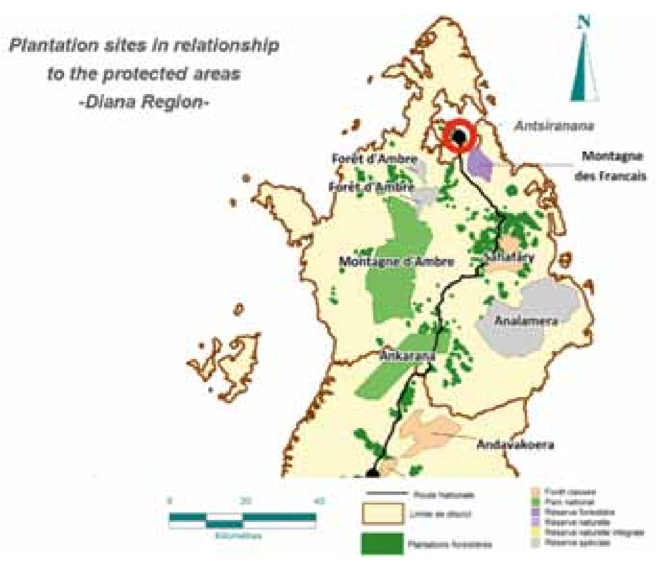
Local service providers (e.g. non-governmental organisations and small private businesses) are able to give professional advice and ongoing support to the relevant target groups. To a great degree, the pioneers in the afforestation scheme now have the skills to carry out the afforestation work independently.

4.4 Impact on local authorities

Joining forces at village level has given the people involved in the afforestation scheme the right to have a say at local level, particularly in important areas such as land use planning. In some municipalities, the legal production of charcoal became an additional source of tax revenue.

5 LESSONS LEARNT FOR REPLICATION

Rehabilitating formerly degraded land and consecutive sustainable management, promotes stewardship responsibility by local communities or user groups and thus creates incentives for more resource-saving and sustainable approaches in forestry. Reforestation of degraded sites not only alleviates manifest pressure on extant forest resources, but also counters erosion and similarly adverse environmental impacts due to overexploitation. This option creates significant synergies especially in close vicinity to protected areas.



Long-term right to forestland is a strong motivation for reforestation. Tenure security is pivotal to motivating communities for forest protection and sustainable management with a view to meeting own needs and preventing uncontrolled access by outsiders.

Policy formulation and coherence: Formulation of a regional woodfuel strategy has to be based on a consensual vision, high-level commitment and ownership, and sound baseline information. The strategy must combine the modernisation of "upstream" and "downstream" aspects of the value chain.

Land use planning analyse, valuate and prioritise multiple interests in land. They provide important information to feed a consultation process between community council, community members and foresters in order to exclude disputed land upfront, and enable a consensus-based decision on the allocation and size of the future reforestation sites.

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The introduction of improved kiln technologies gave the local producer associations the financial leeway to get further involved in woodfuel marketing, reap benefits and include sustainability standards. Furthermore, they are able to comply with financial rules and obligations as they got formalized.

Capacity development on local level should, besides forest related technical advice, include the strengthening of skills required for product and enterprise development, drafting of business plans, linking producers to financial markets and to market information.

6 REFERENCES

Email PGME/GIZ, Madagascar: giz-madagaskar@giz.de

<table>
<tr><th>Technical description of the approach</th><th>Thematic sheets: e.g. standards and principles</th><th>Atlas</th></tr>
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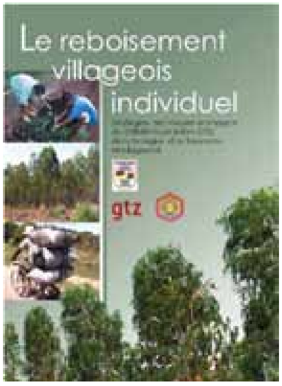

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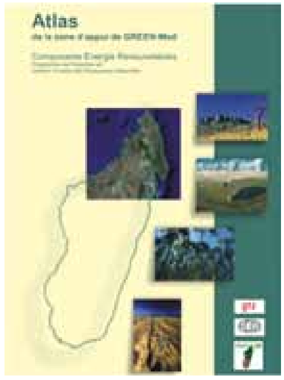

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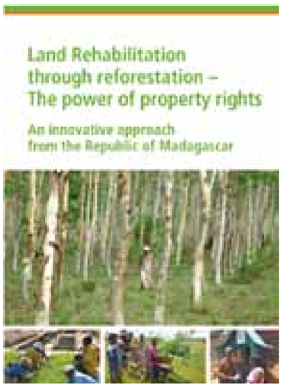

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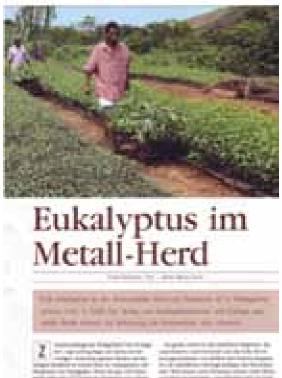

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Recent publications:

Ackermann, K., Andriamanantseheno, C., Kirtz, L., & Sepp, S. (2014). Sustainable Charcoal Production in African Drylands – combining Poverty Alleviation, Biodiversity Protection and Land Rehabilitation. Rural 21 - The International Journal for Rural Development;, pp. 36–38

Etter, H., Sepp, S., Ackermann, K., Plugge, D., & Schauer, M. (2014). Securing productive landscapes: Modernisation of wood energy supplies in Northern Madagascar. ETFRN News 56 (Forthcoming),.

Household Energy Projekt

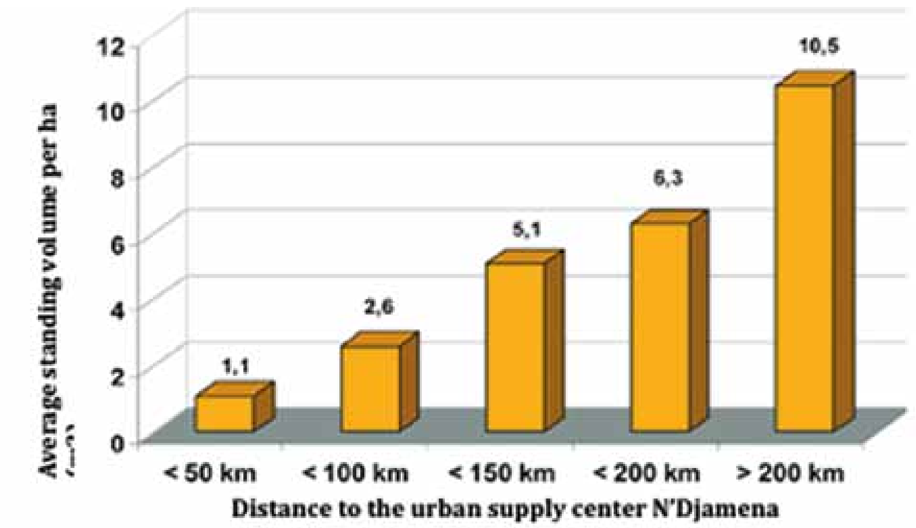
1 INTRODUCTION

Chad is relatively well endowed with energy resources such as oil, biomass and solar energy. Modern energy consumption, however, is extremely low and is mainly limited to petroleum fuels for transportation and some electricity supply in urban areas. Chad's main source of energy is wood which accounted for nearly 90% of final energy consumption, as well as more than 95 of household consumption. Substitute fuels are out of reach for the majority of the population, and will be for the foreseeable future.

2 CONTEXT

Over-cutting of wood has been a growing problem. There was no effective control over the production and exploitation of wood. A tax on wood production existed but served no regulatory purpose; its level and collection rate were marginal, reflecting lack of capacity and dedication. The rural population had no incentives to properly manage wood resources, given the minimal rural revenues from wood trade. The concentrated demand particularly around N'Djamena led to an increasing desertification and a decline in soil fertility. This has been exacerbated by the switching of households from fuelwood to charcoal.

Figure: Efficiency gains through plantations and an improved value chain



Source: (Forster & Matar, 2002)

3 DESCRIPTION OF ACTIVITIES – APPROACH

Upfront regulatory changes

A new law (No. 36/PR/94) and its accompanying Decree (107/MTE/DG/97) were introduced to deal with rural land ownership in relation to woodfuel production and management of woody biomass resources, as well as transport and taxation of woodfuels. Villages were given under certain conditions the usufruct rights to the resources on the land that traditionally belongs to them, and a supportive regulatory framework was created to sustainably manage the resource. The law 36 also encompassed a differential taxation system to counteract the external costs of open-access harvest and thus compensate society at large for the external costs to rehabilitate the degraded areas for future generations. Furthermore, the Government established an independent, cross-sectoral agency for household energy and environment (Agence pour l'Energie Domestique et l'Environnement – AEDE) to spearhead the formalisation of the woodfuel sector. AEDE operated as an autonomous, private, not for profit agency of a public nature. It was governed by a Board that consisted of representatives of the associated ministries (the Treasury, Environment, and Energy) as well as the private sector.

The adoption of the law by the Government and the establishment of the agency was a precondition for entering a project agreement with the World Bank.

Value chain approach

The project design followed a value chain approach by introducing a village-based natural resources management system, improved conversion technologies, rural woodfuel markets, efficient law enforcement and tax collections system as well as improved combustion technologies.

Creation of capacities to develop a village-based natural resource management system

With the adoption of Law 36 the responsibility of managing forests was devolved to the villages. Conditions which the villages need to comply so as to become a "green village" (Village VERT) are: (i) they need to be organised in a management structure that is officially recognised and that has a bank account (SLG, Structure Locale de Gestion); (ii) they need to have a long-term management plan for the resources on their land that maintains or even improves the resource conditions; and (iii) they need to sign a long-term contract with the Ministry of Environment. Appropriate NGOs were selected to support the village communities to create a Village Vert along the following steps.

- Create the SLG (Structure Locale de Gestion); this is based on numerous discussions with the village, and regroups the whole village for the purpose of managing the wood resources on its territory; the SLG needs to be officially registered and own a bank account; a manager, an accountant, and a technical specialist are the minimum number of officials elected to the SLG;

- Together with representatives of neighbouring villages, the territory is delineated and surveyed;

- A simplified wood inventory is made, based on which an annual quota is established; the quota is below the mean annual increment of the standing stock so that a restitution and increase of the standing stock can be expected.

- Rules for exploitation are established (cutting techniques, types of trees and diameters, rotation of exploitation plots, etc). This results in a simplified management plan.

- The SLG signs a contract with the Ministry of Environment and Water.

- The SLG receives tax coupons inline with its annual quota; it now has the right to levy a tax on the transport of woodfuel on behalf of the Government; most of the proceeds remain in the village, and a small portion goes back to Treasury.

  The village can now forbid exploitation by outsiders.

Furthermore, the local charcoal producer were trained in applying improved kiln technologies (casamance kiln) to increase their output and thus their revenues. They were eager to apply this technology as their raw material was capped by the quota stipulated in the management plan.

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Creation of capacities to monitor and control wood products flows

Forestry police agents from the Ministry of Environment have been detached to the AEDE; they operate under strict rules set out by AEDE, these rules include wearing correct uniforms at all times, no fixed work place but rotating venues and teams, and proper remuneration including a bonus for the level of tax compliance. Any deviation from the rules automatically implies departure from the AEDE. The verification system thus operates in an autonomous fashion and is subject to control and audits. Statistics are collected to double check payment compliance as well as to follow the supply of charcoal and firewood by source of origin (and monitoring of quotas).

The tax control system and monitoring certainly deserves greater attention and analysis for replication.

Improving the efficiency of household fuel use;

The two options pursued are (i) promote the use of more efficient stoves, and (ii) promote the use of modern fuels to substitute for wood fuels. Several models of metal and ceramic stoves were tested by households; the two models that were preferred showed high performance (20-30% fuel savings) compared to the baseline level. The most popular model was a duel-fuel metal stove and allowed the use of both firewood and charcoal.

4 RESULTS

AEDE evolved into a specialist agency in the overlapping fields of household energy and environment appreciated by the ministries as it was able to realise more in just a short time than the public administration over many years. When the project phased out 100 villages were operational as villages VERT, covering more than 450,000 ha of natural resources. At the regional level, an efficient and lasting collaboration has been set up between AEDE and Forestry Inspection offices to enforce both the quota and tax control systems. Since the project initiated profound changes in the way people conduct woodfuel business, some powerful and influential individuals tried to influence the outcome of the project and to destabilise AEDE, however, it has been generally able to resist this pressure, which may not have been possible if it were part of a Ministry.

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In 2005, AEDE collected taxes amounting to around 600 million FCFA (in comparison to 30 million in 2001) and was able to pay for its current high standard of control and verification as well as the support to communities. Furthermore, the preferential tax system gave strong incentives for transporters to buy from villages VERT rather than to obtain their woodfuel elsewhere. Secondly, approximately 90% of the proceeds of the tax remained in the production zones and only about 10% flows back to the Ministry of Finance. Villages VERT perceive the right to levy this tax as a very strong incentive to prepare and implement the management plan.

The villages became the sole users of the wood resources on their land and are able to reap the full benefits of this. It allowed villages to prevent encroachment by outsiders, and to set up small village businesses that either sustainably harvest and transform the resources into a marketable product or contract this out to outsiders. Some Villages VERT created a union to better negotiate prices with transporters.

Consumer households reacted positively to the awareness and promotional campaign: sales increased substantially; a total of 14,500 stoves have been sold. About 20 artisans and two cooperatives have been trained in the production of the "Nafacamu" improved stove. The main problem has been a lack of sufficient raw material of good quality; the preferred material is recycled oil barrels. Households showed no interest in kerosene stoves, mainly because the cost of cooking with kerosene is much higher than with charcoal. Although LPG was highly subsidized it was generally not available.

5 LESSONS LEARNT FOR REPLICATION

The principal lessons learned apply at three different levels (World Bank, 2004):

a) at the **central level**, the fact that the regulatory and environmental frameworks were correct from the beginning, was crucial for the success of the project. The autonomy of the implementing agency also helped enormously to preserve the project, both from the turmoil affecting the rest of the energy sector, and from political pressure resulting from induced redistribution of the rent extracted from the natural resources;

b) at the **local level**, the fact that villagers, legally, were given an opportunity to become owners of their natural resources, and to earn money as well, showed to have far reaching impact: from "subjects" they became "individuals" and moreover, "organised individuals", mostly, that environmental degradation could be halted;

c) the capacity to combine the environmental agency - AEDE - formal autonomy, with active participation on the ground of both villagers, and local Forestry Inspection Offices teams, ensured a high level of ownership by stakeholders.

Furthermore:

d.) A well-designed taxation system provides many incentives to a variety of actors, and allows maintaining the current high standard of control and verification in the absence of external funds.

The model developed in this project demonstrably delivered results, but ultimately failed due to powerful vested interests of political decision makers and economic powerful people who wanted to preserve dominance in the conventional wood energy market. This leads to an additional lesson learned:

e.) Because of the entrenched interests of many of the players in the charcoal sector and the lack of transparency, an open dialogue with key stakeholders is a necessary first step.

6 References

Abdel-Hamid, M. A. (2003). Formes de transfert de la responsabilité de gestion des ressources forestières et de l'organisation de l'espace aux collectivités locales, à l'échelle du terroir villageois: Etude de cas du village de Djongotolli (Tchad). Actes du colloque international, 25-27 février 2003, Montpellier.

Forster, H., & Matar, B. (2002). Résultats d'Inventaire Forestier Général dans le Bassin de N'Djamena. N'Djamena: ECO-Consult/AEDE.

Sepp, S. (2003). Rapport Fin de l'Assistance Technique du Groupement ECO-Consulting Group/Agritchad. Oberaula.

van der Plas, R. J., & Abdel-Hamid, M. A. (2005). Can the woodfuel supply in sub-Saharan Africa be sustainable?: The case of N'Djaména, Chad. Energy Policy (U.K.), 33, No. 3, 297–306. Retrieved from http://www.sciencedirect.com/science/journal/03014215

World Bank. (2004). Implementation completion report: Chad: Household Energy Project. Document of the World Bank. Washington, D.C.: World Bank.

Forest replacement associations at the examlple of São Paulo

1 INTRODUCTION

In Brazil firewood has not been the primary cooking fuel since the introduction of LPG subsidies in the 1970s. But charcoal remains to be hugely important for industry and small business, especially in iron and steel production.

To feed the charcoal demand, wood waste from forest industry and logging would be a prolific source. But though it is often freely available it is usually not close enough to the fuelwood-consuming industries, nor is there enough wood waste to meet the total consumer demand. Natural forests harvested under a technical management plan presuppose considerable political will and financial enforcement, which is not common in many developing countries. Even then, sustainable operations in natural forests remain a very expensive way to produce fuelwood.

Likewise, in Brazil up to the 1980s, the country's fuelwood-consuming industries relied completely on secondary degraded forests. This contrasted with growing federal and state governments' concerns to take action against the country's excessive deforestation rate, one of the highest in the world, and - on the economically developed Eastern coast of the country - protect the last remaining closed forest cover of both the Atlantic Forest and surrounding remnant secondary forests.

2 CONTEXT

In the 1960s, when protection and conservation of natural resources occupied public policies for the first time, the Brazilian Forest Code (BFC) of 1965) was introduced. It required industrial wood consumers to use only sustainably produced wood, i.e. guarantee their own sustainable supplies. Along with it, the National Forest Improvement Program of 1966 introduced tax incentives. Larger investors were granted up to 50% deduction of their tax liabilities for investments in reforestation.

From 1970, even more generous deductions were allowed for companies that established large-scale forest plantations. This effected a total increase in reforested areas from 470,000 ha in 1965 to 6 million ha in 1987, when the tax incentive policy ended (Antonângelo and Bacha 1998, quoted in Ceccon and Miranda)[1] . Of this area 5 million hectares were planted Eucalyptus and Pine forests. The Forest Improvement Program also had unintentional negative effects specifically in the Amazon region but it laid the basis for what has since grown into Brazil's genuine 'reforestation sector[2].

While larger industries were permitted to establish their own tree plantations or enter into agreements with credible third-party wood suppliers, small- and medium sized industries were originally urged to pay a "forest replacement fee" equal to their wood consumption to IBAMA, the Brazilian Institute of Environment and Natural Resources, responsible for forest replacement activities. The fee was used by federal agency for the existing Tree Farming Program (TFP) that promoted local public-private afforestation partnerships for tree planting on small and medium size farms.

In the state of São Paulo, however, as Ceccon and Miranda subsume, SME experienced that the fee got too rarely invested in plantations close to their area and that wood was becoming scarcer and more expensive. So the enterprises started to create a woodfuel consumers association by themselves and "began collecting the taxes from its associates – though they had no legal authority to do so - and used the money to run a TFP. The FRA movement was born". Other industry groups followed and set up similar FRAs throughout the state.

In 1990 the São Paulo State Service for Natural Renewable Resources Protection endorsed the FRA concept, and assumed responsibility for its oversight. From 1985 to 1995, 13 FRAs were created in São Paulo state. They established around 20,000 hectares of firewood plantations, involving more than 3,000 farmers.

3 DESCRIPTION OF ACTIVITIES - APPROACH

The Forest Replacement Association programme is based on a model that shares the costs of labour, land and capital equitably between consumer industries and resource-poor producers. In it, wood-consuming businesses collaborate to create a reforestation programme to provide for their own future requirements.

The rationale can be summarised as follows:

- Industrial consumers of wood are obliged by law to replace the wood they consume.
- The replacement costs are funded through the payment of a fee to a local FRA, the scale of which is based on estimated consumption.
- The FRA invests in production of seedlings of fast-growing trees of high genetic quality and provides them at no charge to local farmers. Additional incentives, such as technical assistance, fertiliser, or fencing materials, may be offered.

1 Total plantation forest area was 6.6 million hectares in 2008 (Brasilian Forests at a Glance)

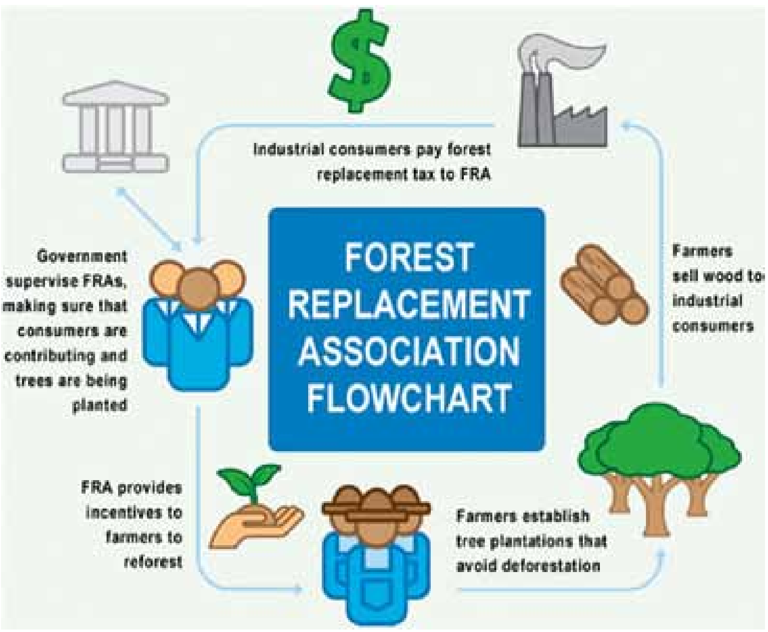
2 Amended several times, up to today's BFC 2012.

- The farmers assume full ownership of the trees and may dispose of them as they wish, although the industrial consumers who have financed the FRA are given the first chance to buy.

- The government supervises the operation of FRAs and the forest replacement fees collected from wood consumers.

Each industry contributes monthly to a fund which is used to reforest the amount of wood (trees) consumed. For instance, if an industry consumes 100 m^3 of fuelwood in a given month, it should reforest 600 trees since, in Brazil, approximately six fast-growing trees harvested at the age of six years will produce 1 m^3 of fuelwood. The cost to reforest each tree is about US$ 0.25, including the seedling, technical assistance, fertiliser, wire, pesticides and administration.

With funds received from all fuelwood-consuming industries of the region, each FRA contracts forest technicians to promote reforestation among farmers from the area surrounding the industries. The trees are usually planted on small plots of land that are unproductive for agriculture but serve well for tree crops. Each farmer participating in the programme receives (free of charge) high-quality seedlings, technical assistance, fertilizers, protective wire and pesticides. The farmers agree to dedicate an agreed area to fuelwood plots; carry out the necessary maintenance to the trees; protect against insects, animals and diseases; plant 10 to 20 percent of the total area in trees with native fruits and wood species for conservation purposes; and grant first refusal rights to the industries associated with the FRA when it is time to sell the fuelwood.



Source: Miranda, R. C. de, Sepp, S., Ceccon, E., Mann, S., & Singh, B. (2010)

At the time of harvest, industries that can prove that they are consuming the fuelwood produced by farmers enrolled in the programme receive the further incentive of a reduction equal to two-thirds of their contribution to the FRA fund. This provides incentives for the industries to consume the fuelwood from the plantations and guarantees a market for the participating farmers. The reduced but continuous contribution is needed to support and maintain the reforestation base for sustainable industry consumption.

4 RESULTS

The State of São Paulo, pioneering in the development, has remained the stronghold of the FRA movement in Brazil. In 2012, 16 FRAs operated in the state, of which 13 are members of the State Federation of Forest Replacement Associations (FARESP). The 13 FARESP FRAs, created between 1985 and 1995, have established more than 20,000 ha of fuelwood plantations, involving around 3,000 farmers. FARESP members planted nearly 126 million trees between 1993 and 2011, of which 89 percent were exotic species, mainly Eucalyptus.

Thousands of small industries are currently consuming wood produced under FRAs.

For the **small consumers**, FRA constitute a reforestation agent that avoids the high capital cost of land and labour for the operation and maintenance of a self-owned fuelwood reforestation project. But the benefits to industry are not only financial. Compliance with environmental and forest regulations, e.g. consuming sustainable fuelwood, carries a significant public relations value. Other benefits include the reduced risk of shortages owing to a guaranteed supply of fuelwood near industrial plants and the strong, positive image that the industries project in the region by supplementing the incomes of local farmers.

While the country's larger industrial consumers put up their own dedicated forest operations to comply with the Forest Act, small industries cannot afford to buy land or invest in a full fuelwood plantation. So, for small and medium bakeries, tobacco producers, lime producers or brick factories, FRA paved a way to secure their sustainable supplies of wood from partnering with neighbouring small farmers.

Farmers, in turn, benefit from the starting capital allocated by the companies. The FRA alleviates the very common barrier of high initial capital investment cost compared with long rotation time, which usually prevents farmers from investing in forestry activities. Also, very commonly in Latin America, farmers lack the land and labour in the first place.

The FRA provides a **win-win-model**, in that the industry provides the initial capital to plant the trees, and the farmers contribute the labour. Farmers receive a guaranteed market with the consuming industries and a higher profit by trading directly through the FRA. By reforesting closer to the consumers and trading through the FRA, the intermediary and transport costs are reduced. This decreases the final price of the fuelwood for the small and medium industrial wood consumer and transfers better profits to the producers. Other benefits include increased production on formerly unused land, the protection of fragile soils and diversification of economic activities.

5 LESSONS LEARNT FOR REPLICATION

In Brazil, other states have started adopting the model. FRA have also spread to other parts of Latin America, such as Nicaragua. Their success was varying due to differences in state-level regulation, enforcement and other local issues.

As Miranda & Ceccon have pointed out, in Brazil a tighter supervision of woodfuel consumption is needed in some cases, to increase the amount of forest replacement taxes to be collected. If administration staff is not sufficiently available as was claimed by São Paulo State, the tax control could be incorporated into the control of the production or product sales by the respective wood consumer. Correlation models between wood consumption at the factory and the production of many of the products which use wood as energy source could be applied. The control of the forest replacement taxes due for FRA could then follow the same methods used to pay local sales and other taxes to the state government.

State forest inventories must be updated regularly. Their data will detail regional differences in the availability of forest resources and corresponding implications on the sustainable supply of forest products.

As a mechanism for promoting reforestation, facilitate decentral energy plantations and promote sustainable woodfuel supply FRA seems to be typically suited for Latin American settings. Yet, contextual similarities suggest they might be transferable on a broader scale.

FRA unfold their impacts in a socio-political environment that is characterised by a fuelwood sector that is traditionally informal, disorganised and inefficient. In Latin America, not different from other regions at stake, governments have usually ceded natural forests to be a free source of fuelwood. Giving farmers resources to plant trees for their own consumption remains largely unsuccessful as long as small amounts of biomass are always available free of charge for family-level consumption in the rural areas.

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As Miranda observes, the cost associated with providing farmers with required materials and information to start their own plantations are "high relative to the size of the plantations established". The forest replacement concept, on the other hand, uses new and successful approaches:

1) It holds commercial consumers responsible for the environmental impacts of their business, reversing the traditional business concept of privatising profits and socialising cost. 2) It reduces dependence on the public sector and foreign aid to finance reforestation; and it guarantees a commercial market and fair price for farmers.

Of course, the system depends on a sufficiently available economic infrastructure, private sector enterprises and market.

The policy concept behind forest replacement can be used for any size of economy and could also be adapted to address commercial urban fuelwood demand, since there is profit behind it. For instance, in the capital of Honduras (Tegucigalpa), urban household consumers are paying more than US$ 20/tonne of fuelwood and, in Managua, the capital of Nicaragua, the prices have reached US$ 60/tonne, making fuelwood for cooking even more expensive than electricity and LPG (Miranda).

Forest replacement policy so far has proved to be a win-win solution, since industry benefits from lower transport cost, law enforcement, better fuelwood quality, greater availability and closer vicinity. Farmers' benefits are free or low-interest capital for reforestation, a guaranteed market at fair prices, diversification of economic activities and the use of low-productivity land. Finally, society benefits from the generation of jobs resulting from the injection of capital into the local forestry economy; reduced pressure on natural forests with conservation benefits; a shift to the private sector of the responsibility for environmental impacts incurred on a public good by industry; and increased national pride as a result of a decreasing dependency on foreign aid for reforestation purposes.

Today, there are calls for the implementation of a new Reforestation Program at federal and state levels to enlarge today's 4.8 millions of hectares of planted forests (5% of the national territory and 2.3% of the agricultural land area) to over about 6 millions of hectares, due to high demands. Specific challenges are to improve the creation of planted forests at small and medium size properties and to improve coordination and support for the already developed forest stands at small and medium-size properties. Also, new ways must be established by the state, to involve small and medium-sized farms in forest production, and institutional policies to re-establish FRA operations or similar TFP.

6 REFERENCES

Carneiro de Miranda, R. (1998). Forest replacement schemes in Latin America: an effective model to achieve sustainability of supply for industrial fuelwood consumers. UNASYLVA -FAO-, (192), 62–65.

Ceccon, E., & Miramontes, O. (2008). Reversing deforestation?: Bioenergy and society in two Brazilian models. ECOLOGICAL ECONOMICS, 67(2), 311–317.

Ceccon, E., & Miranda, R. C. (2012). Sustainable Woodfuel Production in Latin America: The role of Government and Society. Mexico: Copit-arXives.

Miranda, R. C. de, Sepp, S., Ceccon, E., Mann, S., & Singh, B. (2010). Sustainable production of commercial woodfuel: Lessons and guidance from two strategies. Washington: ESMAP - The International Bank for Reconstruction and Development/THE WORLD BANK GROUP.

http://www.irena.org/menu/index.aspx?mnu=Subcat&PriMenuID=36&CatID=141&SubcatID=286it

Sustainable charcoal production at Mampu on the Batéké Plateau

1 INTRODUCTION

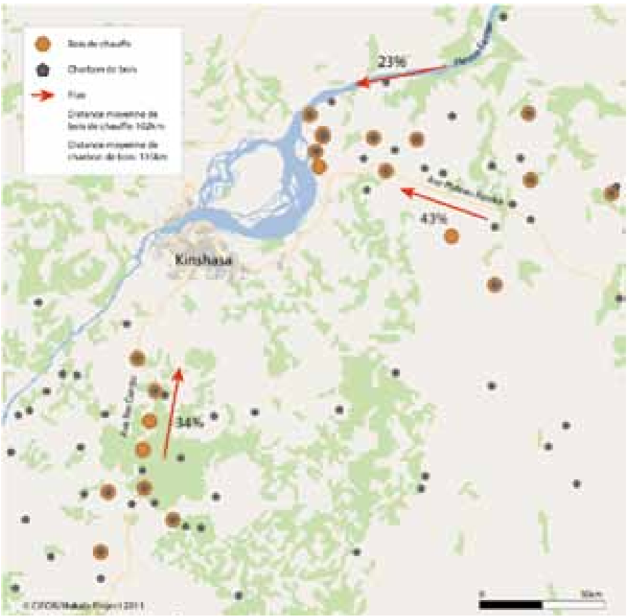
Kinshasa, the capital of the Democratic Republic of Congo, has a population of 8 million inhabitants and consumes an estimated 490,000 tons of charcoal, approximately 4.8 million m^3 of wood in 2010. Not only urban households but also many businesses such as bakeries, breweries, restaurants, and brick and aluminum factories rely heavily on wood energy.

Periurban areas are characterised by overcrowding and a lack of management and development of economic activities. Although forests remain a provider of goods and services indispensable for improving the living conditions of the population, the reliance of urban households on wood energy leads to the overexploitation of the remaining forest areas.

The total value of the wood energy market was estimated at 143 million dollars in 2010, 3.1 times the value of national roundwood exports. Over 300,000 people are involved in this informal sector, representing 20 times the number of persons (i.e. 15,000) working in the formal forest sector.

2 CONTEXT

The city of Kinshasa is surrounded by grasslands and remnants of forest and the area supplying wood energy for the capital spreads from the south-west to the north-east over a distance of about 102 km for fuelwood, and 135 km for charcoal. Charcoal needs, but also most of the staple foods diet (cassava and maize) are provided by slash-and-burn shifting cultivation and by carbonisation of the patches of forest and tree savannahs, which continue to deteriorate. Production obtained from these tree stands is becoming scarce and expensive.



The Mampu plantation, about 140 km east of Kinshasa, was originally designed as the pilot phase of a large-scale reforestation project covering 100 000 hectares of sandy soil on the Batéké plateau and aiming to remedy wood and charcoal scarcities in the capital. Between 1987 and 1993, 8,000 hectares of Acacia auriculiformis were planted by two EU-funded projects implemented by the Dutch company HAI. From 1994 onwards, the activities were taken over by German Hanns Seidel Foundation with support of the non-governmental organisation CADIM.

After 2003 and the resumption of EU cooperation, two new European projects have supported the development Mampu aiming to boost agricultural production by promoting agroforestry and the dissemination of the approach in villages on the Batéké plateau. Between 2009 and 2013, CIRAD implemented the EU-funded "Makala", a research development project about the fuelwood sector that intends to disseminate improved tree fallow techniques and provide sustainable management techniques for the last remaining patches of forest around Kinshasa. The Makala Project was implemented in collaboration with CIFOR, the Hanns Seidel Foundation (in charge of the previously established village fuelwood plantations), Gembloux Agro-Bio Tech and the Faculty of Science at the University of Kisangani.

3 DESCRIPTION OF ACTIVITIES – APPROACH

Around 8000 hectares of Acacia auriculiformis were planted, mainly from 1987 to 1993. Under management of the Hanns Seidel Foundation, from 1994 onwards, the Mampu plantation was divided into plots of 25 hectares allocated to 320 farming families settled in the area. Since 2009, farmers own official land titles and a farmers union manages the plots independently.

Cultivation mainly follows an agroforestry pattern that combines food crops with acacia. This approach allows to maintain soil fertility without having to resort to mechanised plowing and provides a platform from which charcoal, corn and cassava can be produced on a sustainable basis. As with all leguminous plants, the acacia fixes nitrogen from the atmosphere and restores it to the soil which contributes to achieving higher crop yields. In addition, the production of charcoal on site is invariably accompanied by a dispersion of carbonisation residues on the ground. The small pieces of charcoal become a source of potash and organic matter for the soil and improve the soil's water retention potential.

Two or three years after planting the trees, once agricultural products have been harvested, the acacias reach a height of three metres. After around ten years, a veritable acacia forest, mixed with a few local species, becomes established. Farmers can then exploit it, process the wood into charcoal and sell it in town.

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In the unharmed humus, they can replant a new crop cycle. Every 4 metres, a one metre wide strip of soil is left unfarmed, so that acacia seeds can germinate and reconstitute the future forest stand.

As it takes ten years until the rotation can begin, during the initial years farmers mainly generate income from beekeeping. The project also included the promotion of alternative agricultural income sources, such as fish, sheep, poultry, and / or cattle raising, horticulture, and conditioning of agricultural crops (cassava, maize).

The charcoal produced and sold provides farmers with income with which to finance further cultivation work or provide for the immediate needs of their families. In addition, the felling of trees and their transformation into charcoal are relatively labour intensive. Consequently, this activity represents a form of welfare for many young people coming from rural areas or Kinshasa to find work. These workers will then often be asked to participate in the ongoing maintenance work.

Land preparation for a new generation of acacia trees begins with a surface burning which removes dry grass and twigs scattered on the ground and breaks seed dormancy. Corn or cowpeas can indeed be planted directly without any tillage. As for cassava cuttings, they only require limited hoeing on the spot where the cutting is buried.

The agroforestry activities are complemented with other income generating activities in order to increase farmers' benefits. Mampu farmers, under the guidance of CADIM, have been trained in beekeeping and produce, condition and market more than 7,500 kg of acacia honey each year. This additional source of income for Mampu farmers has been, furthermore, complemented by a valorisation of honey by-products such as beeswax and hydromel. In addition, farmers use their forest for rearing caterpillars, a specialty in the DRC, mainly due to their high protein content.

4 RESULTS

Total charcoal production from the plantation varies from 8 000 to 12 000 tonnes per year corresponding to 5 t /ha of wood (6 - 7 m^3/ha/an) and a carbonization yield of 20%. Management rules prescribe that a part of the standing volume is set aside as a precautionary measure. In addition, the production system yields about 10 000 T/year of cassava, 1 200 T/year of maize and 6 T/year of honey. The charcoal production satisfies around 2 per cent of the demand of Kinshasa. It is estimated that the plantation sequesters a permanent carbon stock of 40,000 to 60,000 tons. Gross annual revenue from charcoal alone amounts to 2.6 million US dollars, with owners of the agroforestry plots earning at least a quarter.

The felling 1.5 ha / year yields about 600 bags of 60 kg of charcoal. Around 4.5 dollars per bag go to to the owner, which gives a competent farmer an annual revenue in the order of 2700 dollars per year. To these revenues are added agricultural production of maize (3.75 t per farmer per year) and cassava (30 t per farmer per year). Considering that some farmers also produce honey, condition cassava etc. some households can earn as much as 4 000 U.S. dollars annually, equivalent to the salary of an officer.

The success of the project is an incentive to upscale the model to the savanna lands on the Batéké plateaux, taking traditional land rights into consideration and continuing activities to diversify and process production locally. This is expected to cover a larger share of urban needs for wood energy while also creating rural employment. In order to cater to different ecological and social or economic conditions across the country, other agroforestry systems will have to be tested such as assisted natural regeneration of local multiple-use species. The Makala Project in this context promoted the dissemination of Assisted Natural Regeneration (ANR) techniques, and the reintroduction of trees in the cultural system.

5 LESSONS LEARNT FOR REPLICATION

Diversification of income generating activities and production processes can support not only urban energy needs but also meaningful local development. Complementing wood energy projects with the promotion of other socio-economic activities, such as NTFP harvesting, generates additional benefits and creates incentives. Besides, it allows to bridge the gap between afforestation and wood harvesting (rotation of 10 years). The fact that at the Mampu site, the focus does not merely lie on wood energy production but on combined energy and food production contributed significantly to the success of the project.

The implementation in collaboration with a previously existing local organisation (CADIM) based in Mbankana has proven very successful: the organisation functions independently of project financing and guarantees sustainability at the local level. Since 2009, CADIM and the council of the settlers community („Union des Fermiers Agroforestiers de Mampu“), have been managing project activities with only minor support from HSF (advice, control).

Special attention should be paid to the role of (traditional) land rights to secure village farms and incite producers to cultivate. Interventions should take into account the reliance of a great number of people on wood energy production, its contribution to the energy security of urban populations, and the importance of trade as a profitable activity. Activities should be timely monitored to observe the social appropriation of the suggested techniques.

The management of village lands can contribute but not necessarily account for the entire supply of large urban centers. Village agroforestry approached would need to be implemented jointly with other measures such as reducing wood fuel demand, diversifying energy sources. Any approach should be integrated in the decentralisation process, granting decentralised land entities the necessary autonomy to manage their economic, human, financial and technical resources.

6 REFERENCES

Dubiez, E., Vermeulen, C., Peltier, R., Ingram, V., Schure, J., Marien, J. N., & Temu, A. B. (2012). Managing forest resources to secure wood energy supply for urban centers: the case of Kinshasa, Democratic Republic of Congo. Nature & Faune, 26(2), 52-56.

Peltier, R. & Bisiaux, F. Sustainable charcoal production in the Democratic Republic of Congo. CIRAD

Bisiaux, F., Peltier, R., & Muliele, J. C. (2009). Plantations industrielles et agroforesterie au service des populations des plateaux Batéké, Mampu, en République démocratique du Congo. Bois et forêts des tropiques, (301), 21-32.

Schure J., Ingram V., Marien J. N., Nasi R., Dubiez E. (2011). Woodfuel for urban centres in the Democratic Republic of Congo. The number one energy and forest product returns to the policy agenda. CIFOR Brief. N°7. p.4. http://www.cifor.org/publications/pdf_ files/infobrief/3704-brief.pdf

Hanns Siedel Foundation (2008). Mampu: a village agroforestry program for sustainable agriculture http://www.mampu.org/index_en.html

Heinicke, G. & Teichert, K. (2009) Eine Erfolgsgeschichte der Projektarbeit der Hanns-Seidel-Stiftung in der Demokratischen Republik Kongo – das Agroforstwirtschaftsprojekt „Mampu“ Hanns-Seidel-Stiftung.

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