Deforestation Trends in the Congo Basin

Reconciling Economic Growth and Forest Protection

WORKING PAPER 5 | Wood-based Biomass Energy

Hannah Behrendt
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Africa Region
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Introduction

Congo Basin countries rely more on wood-based biomass to meet their energy needs than most other countries in the world. However, the energy profiles vary from one country to another, based on access to electricity, and availability and cost of wood and fossil fuel energy. In the Democratic Republic of Congo, combustible renewables and waste (overwhelmingly fuelwood and charcoal) made up 93 percent of total energy use in 2008—in a context in which less than 12 percent of the population had access to electricity in 2009. In contrast, in Gabon the reliance on biomass energy is significantly lower due to an extensive electricity network and subsidized gas for cooking. In Gabon and the Republic of Congo, combustible renewable and waste constitute just more than 50 percent of energy use. These two countries also have similar rates of access to electricity—both around 37 percent.

A growing demand...

Woodfuel production is increasing in Congo Basin countries. In contrast to China, India, and much of the developing world, where the extent of wood-based biomass energy has peaked or is expected to peak in the very near future, consumption of wood-based biomass energy is likely to remain at very high levels in the Congo Basin and even continue to increase for the next few decades. In 2007, Congo Basin countries' total production of fuelwood exceeded 100 million cubic meters. The biggest producers were the Democratic Republic of Congo, with 71 percent of total regional fuelwood production, and Cameroon (21 percent), reflecting their shares of the region's population.

Urbanization often produces a shift from fuelwood to charcoal consumption, because charcoal is cheaper and easier to transport and store. Urban lifestyles tend also to be more energy intensive because households in urban areas tend to be smaller, leading to less efficient fuel use for cooking per capita. In addition, charcoal is often the primary cooking fuel for many small-scale roadside restaurants and in kitchens of larger public institutions, such as schools and universities, hospitals, prisons, as well as small-scale industries.

...supplied by an inefficient sector

Charcoal is produced mostly using traditional techniques, with low transformation efficiencies (earth pit or earth mound kilns). The organization of the charcoal supply chain is also notoriously inefficient, relying on poorly designed regulatory frameworks that eventually lead to massive informality in the sector. The pricing structure of woodfuel sends perverse signals: pricing relies on incomplete accounting of different costs along the value chain and, in most cases, the primary resource (wood) is taken as a "free" resource. Under-priced woodfuel generates inefficient and unsustainable practices. Economic signals in the woodfuel supply chain do not allow the producer to apply sustainable forest management techniques. Areas that supply a growing urban demand extend over time and can radiate as far as 200 km from city centers, gradually degrading natural forests.

A major threat to forests

Under a "business as usual" scenario, charcoal supply could represent the single biggest threat to Congo Basin forests in the coming decades. Wood extraction for domestic fuelwood or charcoal production constitutes one of the major threats on forests in the Congo Basin, with a steady increase in

wood removals in recent years. It is estimated that more than 90 percent of the total volume of wood harvested in the Congo Basin is for woodfuel and that on average 1 cubic meter (m^3) of woodfuel is required per person per year.

In rural areas, generally sparsely populated, woodfuel consumption is no longer considered a major direct cause of forest degradation or loss. Woodfuel collection can, however, become a severe cause of forest degradation and eventual deforestation when demanded by concentrated markets, such as urban household markets, industries, and other businesses. For instance, Kinshasa's woodfuel needs (approximately 5,000,000 m^3/year) are met mostly through informal harvesting from degraded forests within a radius of 200 km. As a result, forests within the 200 km radius are experiencing severe degradation, while the peri-urban area within a radius of 50 km of Kinshasa has been largely deforested. It is estimated that fuelwood collection leads to clearing 60,000 hectares (ha) of forests each year in the Democratic Republic of Congo.

This report aims at providing some thinking on how Congo Basin could meet their energy needs in a forest-friendly manner. It is one of a series of outputs prepared during a two-year exercise to analyze and better understand the deforestation dynamics in the Basin. It presents the main findings related to the woodfuel sector in the Congo Basin and its potential impact on forest cover. It is based on an in-depth analysis of the sector (past trends and future prospects). It also builds on results derived from a modelling exercise conducted by the International Institute for Applied Systems Analysis (IIASA) that examined the national and regional trends in in wood-based biomass energy use and the impacts on Congo Basin forests.

The report is structured as follows:

- **Chapter 1** gives an overview of the woodfuel sector in the six Congo Basin countries, including an analysis of its impact so far on forest cover.
- **Chapter 2** presents the prospects of energy needs and production in the near future, and the potential impacts on forest under a "business as usual" scenario.
- **Chapter 3** identifies potential key levers in the woodfuel sector that could limit adverse impacts on forest cover. The chapter builds on the analysis of the previous chapters and recommends priority activities for Basin countries to address the current and future drivers of deforestation.

CHAPTER 1

Wood-based Biomass Energy in the Congo Basin

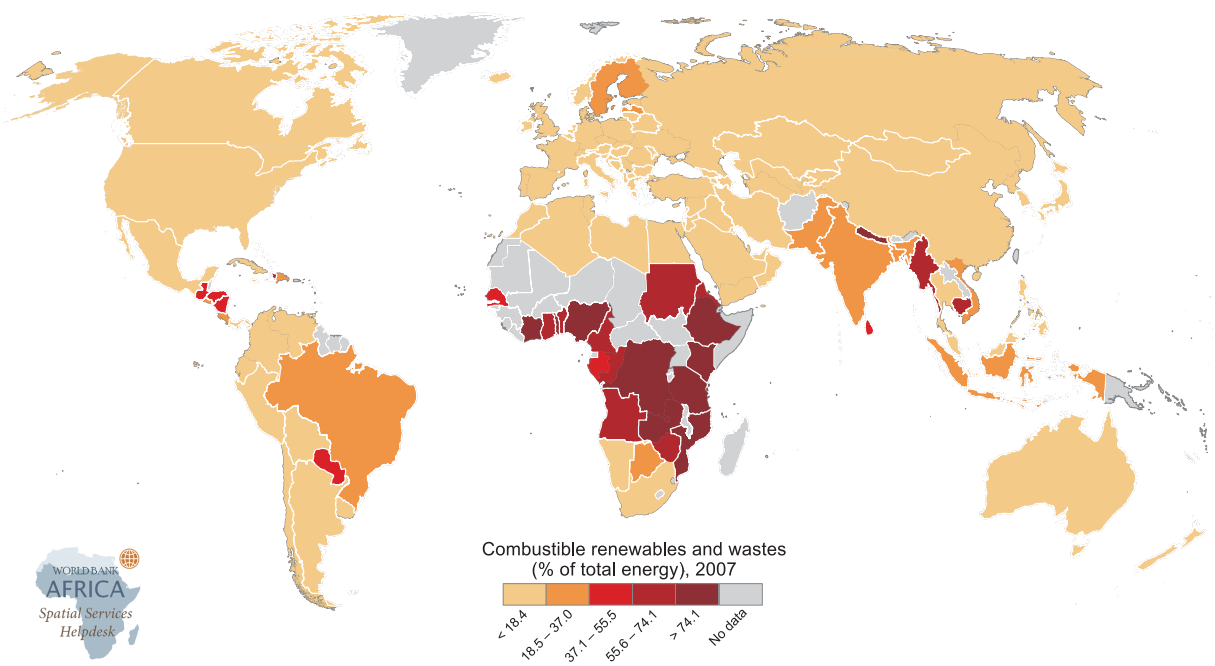
CONSUMPTION PROFILES

Reliance on wood-based biomass energy from fuelwood and charcoal is far greater in Sub-Saharan Africa (SSA) than in any other region in the world. In 34 countries worldwide, wood-based biomass energy satisfies more than 70 percent of energy needs, and in 13 countries it satisfies more than 90 percent—the majority of these countries are located in SSA (Trefon et al. 2010). Most of the consumption of biomass energy is in the residential sector for cooking (and to a lesser extent heating).

In the 47 countries comprising SSA, the majority of the rural and urban population relies on wood-based biomass to satisfy their energy needs, especially for cooking.[1] About 80 percent of SSA households rely on biomass for their daily energy needs and for cooking—far more than in any other region in the world (IEA 2010a). In 2006, it was estimated that in rural areas, 93 percent of the population in SSA depended on biomass resources for their primary cooking fuel, and

1 This includes island states, such as Madagascar, Comoros, and São Tomé & Príncipe.

Figure 1.1: Combustible Renewables and Waste (percent of total energy) in 2007



Source: World Bank, 2011

even in urban areas almost 60 percent of people use biomass for cooking (IEA 2006).

In most countries in Africa, energy from biomass makes up the majority of the energy portfolio. Figure 1.2 plots use of energy from combustible renewables and waste (almost exclusively woody biomass for these countries) against their total energy use, with the size of the country markers indicating total population. The closer a country is to the 100 percent line, the higher the percentage of biomass energy in the country's total energy use. The figure shows that all Congo Basin countries for which data were available use more than 50 percent biomass energy. While Gabon and the Republic of Congo only marginally exceed the 50 percent line, the figure shows that the Democratic Republic of Congo is one of the greatest users of biomass energy, in absolute terms and also as a percentage of total energy use.

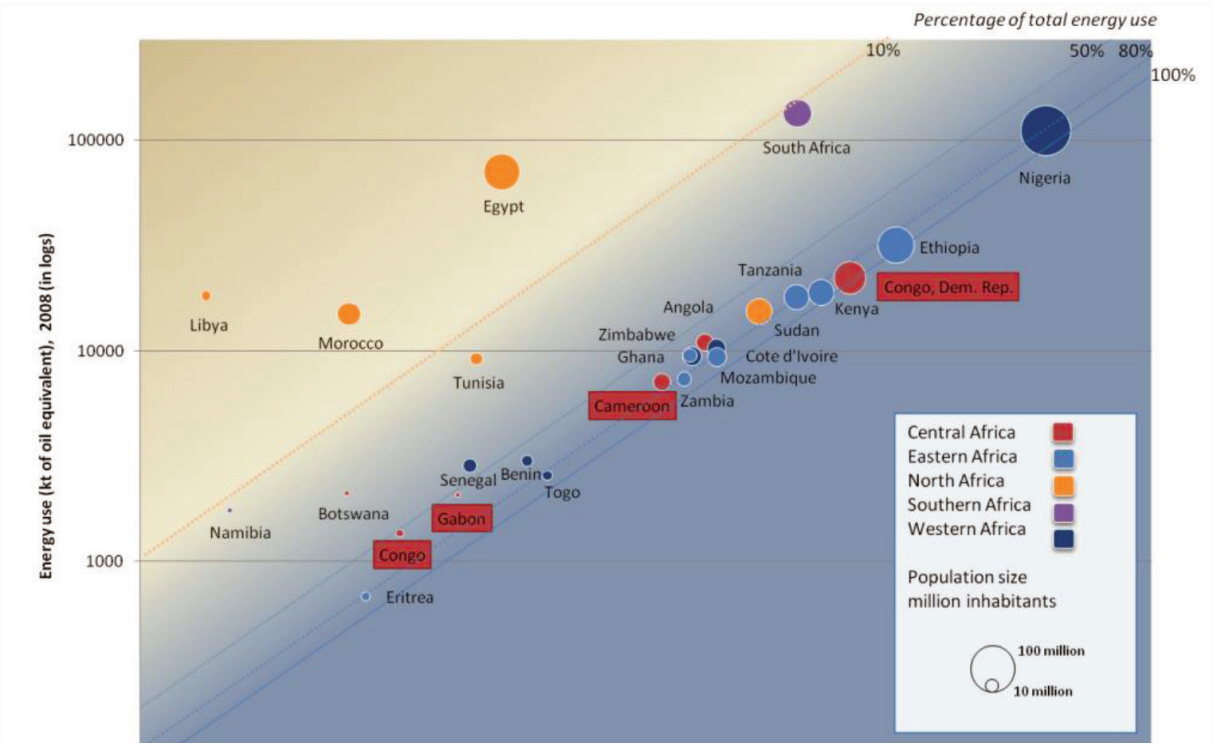
Energy profiles vary from one country to another in the Congo Basin, based on country wealth, access to electricity, and availability and cost of wood and fossil fuel energy. Table 1.2 gives some key insights into the role of wood-based biomass energy in different countries in the region. In the Democratic Republic of Congo, combustible renewables and waste (overwhelmingly fuelwood and charcoal) made up 93 percent of total energy use in 2008—in a context in which less than 12 percent of the population had access to electricity in 2009 and fossil fuels met only 4 percent of the Democratic Republic of Congo's energy use in 2008. Kinshasa alone, with 8–10 million inhabitants, uses 5 million m^3 of fuelwood or the equivalent per year. In contrast, in Gabon the reliance on biomass energy is significantly lower due to an extensive electricity network and subsidized gas for cooking. In Gabon and the Republic of Congo, combustible renewable and waste constitute just above 50 percent of energy use. These countries also have similar rates of access to electricity—both about 37 percent. However, access to electricity is not necessarily a precise indicator of the extent to which biomass is used. While access to electricity is higher in Cameroon at close to 49 percent, combustible renewables and waste still constituted more than 70 percent of total energy—a slight increase from 2007, which may be explained by consumers switching to the relatively cheaper biomass when confronted with price shocks in fossil fuels. Gabon and the Republic of Congo, on the other hand, both witnessed a biomass energy use decreasing about 5 percentage points from 2007 to 2008.

Table 1.1: Number and Share of People Relying on the Traditional Use of Biomass (million)

Region/Country	Total	Percent	Rural	Urban
Africa	657	67	481	176
Sub-Saharan Africa	653	80	477	176
Developing Asia	1,937	55	1,694	243
China	423	32	377	47
India	855	75	765	90
Other Asia	659	63	553	106
Latin America	85	18	60	24
World	2679	40	2235	444

Source: IEA 2010b.

Figure 1.2: Total Energy Use, Combustible Renewables and Waste Energy Use, and Population in Africa, 2008



Source: World Bank 2011.
Note: Data not available for Central African Republic and Equatorial Guinea. Energy use in kiloton of oil equivalent, combustible renewables and waste in metric tons of oil equivalent, population is total.

Table 1.2: Energy Consumption Portfolio and Access to Electricity in Congo Basin Countries, 2008 (and 2009)

Country	Energy use (kt of oil equivalent)	Energy use (kg of oil equivalent per cap.)	Combustible renewables nd waste (% of total energy)	Fossil fuel energy consumption (% of total)	Electric power consumption (kWh per capita)	Access to electricity (% in 2009)
Cameroon	7,102	372.1	71.0	23.9	262.6	48.7
Central African Rep.	–	–	–	–	–	–
Democratic Republic of Congo	22,250	346.3	93.4	4.0	95.2	11.1
Republic of Congo	1,368	378.4	51.3	43.5	150.2	37.1
Equatorial Guinea	–	–	–	–	–	–
Gabon	2,073	1,431.5	52.5	43.8	1158.0	36.7

Source: World Bank 2011; IEA 2010b: The Electricity Access Database (http://www.iea.org/weo/database_electricity10/electricity_database_web_2010.htm). For 2008 access to electricity and rural/urban breakdown, see http://www.iea.org/weo/database_electricity/electricity_access_database.htm.
Note: Given that detailed data on wood energy consumption are often not available, the numbers presented in this table deviate slightly from other documentation. However, general trends are usually confirmed by different data sources.

DEMAND FOR FUELWOOD AND CHARCOAL

Demand for woodfuel, and for charcoal in particular, continues to increase in Congo Basin countries. This is not surprising, given their continued population growth. In 2007, the Congo Basin countries' total production of woodfuel exceeded 100 million cubic meters, the biggest producers being the Democratic Republic of Congo, with 71 percent of total regional fuelwood production, and Cameroon (21 percent). However, the Democratic Republic of Congo and Cameroon also make up about 70 percent and 20 percent of the region's population.

Charcoal production in the Congo Basin region more than doubled between 1990 and 2007, with an estimated 2.4 million metric tons of charcoal produced in 2007, almost 75 percent of it in the Democratic Republic of Congo. Cameroon follows, with nearly 10 percent of the region's charcoal production; however, because the country constitutes more than 20 percent of the region's population, per capita charcoal consumption is relatively low compared with other countries in the region.

Typically, the move to urban areas is associated with consumption switching from fuelwood to charcoal, the latter being cheaper and easier to transport and store. Because fuelwood is heavy and bulky, and thus difficult and costly to transport over longer distances, it is often converted into charcoal if it is to be used some distance from the forest where it was harvested. This shift does not systematically apply, as shown by the example of Bangui (see box 1.1).

Table 1.3: Fuelwood Production (cubic meters, thousand)

	1990	1995	2000	2005	2007
Cameroon	7,648	8,722	9,111	20,421	21,586
Central African Republic	3,055	3,000	2,000	2,000	2,000
Democratic Republic of Congo	44,183	58,759	64,903	71,066	73,209
Republic of Congo	974	1,069	1,153	1,369	1,275
Equatorial Guinea	447	447	447	400	187
Gabon	3,203	3,612	3,996	4,388	4,522
Congo Basin Total	59,510	75,609	81,611	99,644	102,779

Source: United Nations 2009

Table 1.4: Charcoal Production from Charcoal Plants (metric tons, thousand)

	1990	1995	2000	2005	2007
Cameroon	216	289	99	105	232
Central African Republic	0	0	21	120	182
Democratic Republic of Congo	791	1,200	1,431	1,704	1,826
Republic of Congo	77	102	137	165	181
Equatorial Guinea					
Gabon	10	13	15	18	19
Congo Basin Total	1,094	1,604	1,704	2,112	2,440

Source: United Nations 2009.

Box 1.1: Urbanization Shaped by Rural Lifestyles – Bangui, Central African Republic

Greater Bangui, the capital of the Central African Republic, presents a specific profile with most households still relying on fuelwood. With an estimated 800,000 inhabitants, greater Bangui grows at an annual rate of nearly 3 percent; the city is characterized by uncontrolled urbanization, linked to poverty and insecurity. It still contains plenty of partially rural areas and open spaces. Firewood constitutes 92 percent of household energy consumption in the area, and urban attitudes are strongly influenced by rural lifestyles. Wealthier people are significantly more likely than poor people to use coal and gas. Wood energy consumption ranges between 280,000 to 500,000 metric tons of wood per year—an informal turnover of around CFA 2 to 3 billion (Marien 2009).

Urbanization usually changes the way that people consume energy, generally being associated with a more energy-intensive lifestyle. Households in urban areas are often smaller than in rural areas, contributing to less efficient fuel use for cooking per capita. Besides being used by households, charcoal is also often the primary cooking fuel for many small-scale roadside restaurants and in kitchens of larger public institutions, such as schools and universities, hospitals, and prisons. Charcoal is also widely used for cottage industries, for example, bread baking, small metal smelting operations, and brick kilns. The multiplier effect, triggered by urbanization, is not to be underestimated; one study for Dar es Salaam suggests that 1 percent of urbanization leads to a 14 percent rise in charcoal consumption (Hosier, Mwandosya, and Luhanga 1993).

PRODUCTION OF CHARCOAL

Charcoal is produced mostly using traditional techniques, with low transformation efficiencies. Earth pit kilns or the slightly more efficient earth mound kilns are traditionally used for charcoal production in many parts of the world. In the former, wood is stacked in a pit, whereas in the latter it is stacked in a polygonal shape. The wood is then covered with grass and sealed with a layer of soil in both cases before the kiln is lit. Both types of kilns yield only low-quality charcoal. Once the earth pit kiln has been lit, it requires between 3 to 15 days of continuous attention, depending on the size of the kiln. The efficiency of earth mound kilns is higher than that of pit kilns, but can still be as low as 8 percent (Seidel 2008). A multitude of interventions in many SSA countries have attempted to overcome this challenge by promoting more efficient kilns for charcoal production, however, adoption rates have been limited. The informal—and often illegal—nature of charcoal production may be responsible for this. Higher material costs, increased labor input, but also lack of knowledge all represent disincentives for charcoal burners to adapt improved technologies in situations where they are not rewarded with increased prices or where the risk of discovery may require abandoning the production site.

A CRITICAL SECTOR BUT MOSTLY INFORMAL

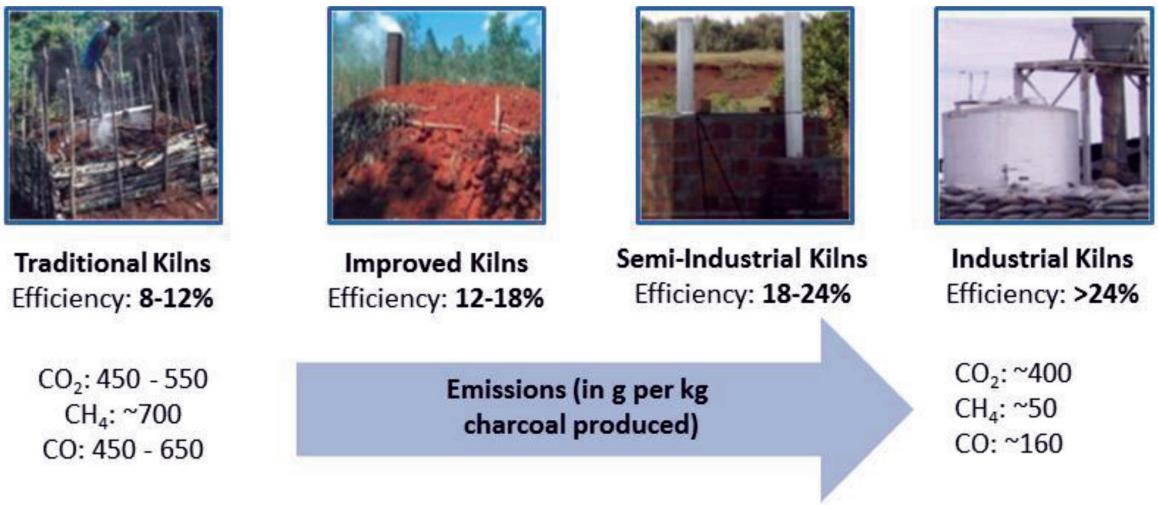
A Large Contributor to the Economy

In most Sub-Saharan African countries, the wood-based biomass energy sector employs a significant workforce, generally providing a regular income to tens—if not hundreds—of thousands of people. A large number of traders are generally involved in buying, transporting, and re-selling wood-based biomass. Those basing their livelihood on the sector tend to be members of the poorer households (who work as small-scale producers/collectors, traders, transporters, or retailers) who often have limited alternatives for earning cash income.

The charcoal trade chains in Congo Basin[2] consist of a multitude of "small" actors with limited power over the entire chain. However, this does not mean that their work is not profitable. Furthermore, actors have recently been starting to employ strategies of vertical

2 The cases of Kinshasa and Lubumbashi were thoroughly studied and are believed to represent the situation more generally in the Congo Basin.

Figure 1.3: Efficiencies of Alternative Kiln Technologies



Source: Sepp 2008.

integration, trying to fill several positions within the supply chain in order to increase their profit margins. This is particularly the case for transporter/traders and depot owners operating their own trucks.

The contribution of the wood-based biomass energy sector to the wider economy is estimated to be several hundred million dollars for most SSA countries. It is often considered to be the most vibrant informal sector, with the highest value added in SSA. Despite the sector's importance to local economic development, its contribution to government revenues is limited due to widespread evasion of licensing fees and transport levies. National and local governments are estimated to lose several tens or even hundreds of millions of dollars annually due to their failure to effectively govern the sector.

A Poorly Organized Supply Chain

Fuelwood utilization—especially the extraction of fuelwood from forest resources—tends to be characterized by poor policy frameworks often following a "command and control" structure rather than facilitating sustainable management of forests and extraction of fuelwood in collaboration with local stakeholders. In most countries, regulations set up for the woodfuel sector tend be overcomplicated, costly, bureaucratic, and often unenforceable, given the limited means available to local government representatives for executing their duties.

Generally, regulations relate to the way forests should be managed and harvested for energy purposes. The regulatory burden mainly falls on producers, requiring them to engage in sustainable management of their forests. Most of the time, these requirements are impossible to fulfill for various reasons—incapacity to prove "land/tree ownership," costly preparation and implementation of sustainable forest management plans, bureaucratic processes (from fiscal and/or forest administrations)—which makes informality the only solution for the woodfuel sector.

At present, only small numbers of urban-based fuelwood traders are typically able to obtain exploitation permits, often resulting in an oligopolistic fuelwood industry. Rural users often have to compete with demands from urban and industrial users and among the rural users themselves (Arnold and Persson 2003). Most license systems still operate as mere revenue collection systems (a colonial-era heritage), without the number of licenses or quantities of harvestable wood licensed linked to any kind of sustainability measures.

In most countries, transporters and/or wholesalers dominate the woodfuel supply chain and reap disproportionately large profits, leaving the producers with marginal benefits.

The political economy of the charcoal trade network has been analyzed for Kinshasa and Lubumbashi (Trefon et al. 2010), giving a detailed account of the different actors, including their strategies, relationships, and power (see box 1.2).

The Defaulting Price Structure

Woodfuel is largely under-priced. The pricing structure of the woodfuel relies on incomplete consideration of the different costs all along the value chain. In most cases, the primary resource (wood) is taken as a "free" resource: uncontrolled open access to trees tend to significantly undermine the production costs. The larger part of the price is composed by the transportation and retailing costs, down the supply chain.

The under-priced woodfuel generates inefficient and unsustainable practices. Prices paid to the producers are not high enough to stimulate adoption of sustainable practices. However, a study of the case of Rwanda illustrates the fact that a price properly paid against the value of the resource can generate more sustainable behaviors (see box 1.3).

There is an urgent need to modernize the sector. Corruption and oligopolistic marketing structures obstruct any attempt to formalize the woodfuel value chains. Governments have put in place regulations that limit access rights to local resources, but it is perceived that if communities benefit from their new rights and responsibilities, government forest officers may lose personal (albeit illegal) advantages, and wholesalers

Box 1.2: Political Economy of the Charcoal Trade Network (Kinshasa and Lubumbashi)

The supply chain begins with charcoal producers who obtain (often temporary) access to trees through a process of negotiation involving tribal chiefs, private farmers, and, to a lesser extent, state officials. The specifics of gaining access to primary resources depend on whether the producer is local to the area, and whether he is working with a group or alone. Once the producer has obtained the right to cut some trees, a charcoal kiln is constructed for production. Because charcoal production provides a means of earning money with relatively few up-front investments (compared with agriculture), it has become an increasingly popular profession. During the dry season, charcoal producers are joined by farmers trying to earn extra cash.

Charcoal producers have several different options for selling their produce. In some cases, they take their charcoal to the city by bicycle, sometimes renting one for this purpose. If operating in a group, charcoal producers may designate one or several members of the group to sell their produce, sharing the profits. Roadside sales of charcoal also take place, with charcoal producers selling to drivers passing by. These may be travelers returning to the city, or professional traders who travel back and forth between the outskirts and city center to buy and sell charcoal (and other produce). In Lubumbashi, it is common for these traders to operate by bicycle, whereas the greater distances in Kinshasa mean that trucks are generally used. In rural areas, intermediaries collect charcoal produced in their region until they have enough to fill a truck, arranging a trader to pick up their produce. Trucks are also frequently used for transporting charcoal to Lubumbashi. Traders tend to form groups in order to share a truck and sell their charcoal to vendors in the large charcoal depots, or to depot owners, who in turn sell it to smaller-scale retailers or those consumers who are able to buy entire bags of charcoal at once. The small-scale retailers then resell the charcoal on urban markets or street corners, where consumers purchase charcoal on a daily basis.

Source: Trefon et al. 2010.

Box 1.3: Rwanda: Scarcity of Forests Spurs Reforestation

The example of Rwanda provides evidence of a feedback mechanism called the "forest scarcity" hypothesis, meaning that deforestation makes forest products scarcer and increases the economic value of remaining forests. This increased value in turn directly translates into better forest management and the establishment of woodlots and tree plantations. With growing scarcity of woodfuel, agricultural production gradually loses its relative advantage, and woodfuel production becomes a viable option for local landholders. As a consequence, forest cover begins to rise. However, this development comes at a price, as forest ecosystems undergo the transition from a (semi-)natural state with rich biodiversity, to more artificially planned plantations and often fragile monocultures.

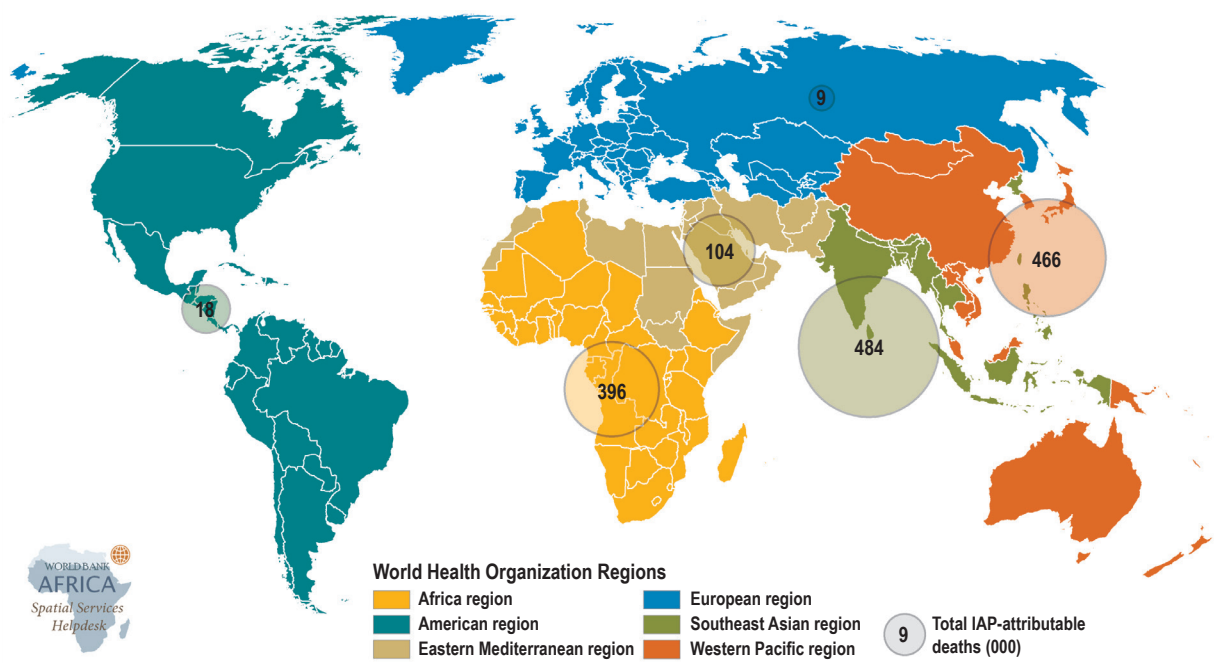
Source: ESMAP 2010.

may see their economic dominance diminished. Most of the time, strengthening existing law and governance systems cannot provide a solution to the biomass energy supply chain, and a profound reform of the policy and regulatory frameworks is necessary to "modernize" the sector (ESMAP 2010).

AIR POLLUTION AND IMPACTS ON HEALTH

With the vast majority of households in the Congo Basin region using wood-based biomass energy, indoor air pollution constitutes an important threat to people's health, with women, traditionally in charge of housekeeping and cooking, particularly at risk. Traditional stoves commonly used in SSA burn inefficiently, with smoke and gases produced by incomplete combustion causing long-term respiratory health complications and deaths. Particulate matter levels from solid biomass fuel use in households may be 10–50 times higher than the World Health Organization (WHO) guideline

Figure 1.4:Death attributable to indoor air pollution



Source: WHO 2009b.

Table 1.5: Estimated Deaths and DALYs Attributable to Indoor Air Pollution, 2004

	Population using solid fuel (%)	Deaths per year	DALYs /1000 people per year
Cameroon	83	11,400	21
Central African Republic	>95	3,000	23
Democratic Republic of Congo	>95	75,600	44
Republic of Congo.	85	1,000	8
Equatorial Guinea	no data	–	–
Gabon	28	100	2

Source: WHO 2009a. Percentage of population using solid fuels, source: WHO Millennium Development Goals, including World Health Survey 2003 results.
Note: Health outcomes: Estimates of deaths and DALYs (Disability Adjusted Life Year) from acute respiratory infections (children under age 5), chronic obstructive pulmonary disease (adults over 30 years) and lung cancer (adults over 30 years) attributable to indoor smoke from solid fuels are based on the methods outlined in WHO (2009a), using the exposure data and GBD 2004 update of WHO estimates of national health data (WHO 2009b).

values (Pennise et al. 2009; WHO 2005) and strong scientific evidence links indoor air pollution resulting from the use of solid fuels to preventable diseases such as child pneumonia (Smith et al. 2000; Dherani et al. 2008). Additional daily discomfort for women, such as cough, headache, stinging eyes, and backache are commonly associated with traditional cooking methods (World Health Organization, 2009b).

According to WHO estimates, in 2004, more than 90,000 deaths in the Congo Basin region could be attributed to indoor air pollution, with 75,600 occurring in the Democratic Republic of Congo, where more than 95 percent of the population uses solid fuel. The Democratic Republic of Congo is among the 20 countries affected most by indoor air pollution, with approximately 5 percent or more of the total burden of disease caused by indoor air pollution (CREFES 2010).[3]

The problem of indoor air pollution can be addressed in several different ways, including changes in behavior to reduce exposure to smoke, improved ventilation, improved cookstoves, or cleaner fuels. Improved stoves deliver a range of benefits and co-benefits, increasing energy efficiency and saving fuel, while reducing emissions that negatively impact people's health and climate change.

3 The 19 worst-affected countries are: Afghanistan, Angola, Benin, Burkina Faso, Burundi, Chad, the Democratic Republic of Congo, Eritrea, Ethiopia, Guinea-Bissau, Liberia, Madagascar, Malawi, Mali, Niger, Rwanda, Sierra Leone, Somalia, and Tajikistan.

CHAPTER 2

Impacts on Forests

WOOD SUPPLY FOR THE WOOD – BASED ENERGY SECTOR

Wood extraction for domestic fuelwood or charcoal production constitutes one of the major threats to forests in the Congo Basin, with a steady increase in wood removals in recent years. It is estimated that more than 90 percent of the total volume of wood harvested in the Congo Basin is for woodfuel (see table 2.1) and that on average 1 cubic meter of woodfuel is required per person per year.

Plantations can supply wood-based biomass for energy. Pointe-Noire, located on the edge of a forest savannah mosaic, is a port and industrial city with about 1 million inhabitants. Despite being located at the center of an oil production area, domestic energy consumption is based primarily around wood. About half of the estimated 500,000 m^3 of woodfuel consumed each year is harvested informally in gallery forests, while 53 percent of the total wood energy is produced as a by-product of the 40,000 ha of industrial eucalyptus plantations (managed by the firm Eucalyptus Fibers Congo). The eucalyptus plantations, within 20 to 40 km of the city, provide most of the fuelwood consumed in Pointe-Noire, while considerations of cost and transport mean that the wood harvested from gallery forests up to 80 km from Pointe-Noire tends to be converted to charcoal. Pointe-Noire's domestic energy supply is relatively sustainable, with little deforestation and degradation (Marien 2009). Plantations of Mampu acacia in the Kinshasa area are helping to provide wood energy sustainably; 8,000 ha of plantations, managed in blocks of 25 ha, feature a combination of crop rotation and wood energy plantations (Marien 2009). The example of the IBI Bateke project is certainly one of the most promising pilot initiatives in the vicinity of Kinshasa, on the Plateau Bateke (see box 2.1).

Table 2.1: Basic Data on the Wood Energy Sector in Central Africa

FAO Classification	Amount
Countries	
Area (million ha)	529
Population (million inhabitants)	105
Forests	
Area (million ha)	236
Area (ha/inhabitant)	2.2
Standing stock	
Volume (m^3/ha)	194
Total volume (million m^3)	46,760
Biomass (m^3/ha)	315
Total biomass (million m^3)	74,199
Carbon (ton/ha)	157
Total carbon (million tons)	37,099
Production	
Wood energy (x 1,000 m^3)	103,673
Industrial timber	12,979
Sawnwood	1,250
Some calculated ratios	
Consumption of wood energy (m^3/inhabitant)	0.99
Production of wood energy/total woody production (%)	90

Source: Marien 2009.
Note: Estimates indicate that most of the removed wood is used as fuelwood; however, because the majority of fuelwood collection activities are within the informal economy, the quantities of wood removals may be underestimated. FAO = Food and Agriculture Organization.

IMPACTS ON DEFORESTATION AND FOREST DEGRADATION

In rural areas, fuelwood consumption is no longer considered a major direct cause of deforestation and forest degradation. Nevertheless, fuelwood is often still portrayed as a fuel source associated with energy poverty and forest depletion, a remnant of the "fuelwood crisis" era of the 1970s and 1980s (Hiemstra-van der Horst and Hovorka 2009). However, it is now acknowledged that demand for woodfuel in rural areas usually comes from dispersed rural populations and does not represent a threat to fuelwood natural resources. Analyses showed that a great portion of the fuelwood supply in rural areas comes from trees outside forests, dead branches and logs, and even forest residues. When woodfuel is collected from natural forests, the regeneration capacity largely offsets the biomass withdrawals. It is thus is seldom a primary source of forest degradation or forest loss.

Clearance of land for agriculture, commercial and residential development, and other permanent land-use changes are the main contributors (Dewees 1989; ESMAP 2001; Arnold, Köhlin, and Persson 2005). Fuelwood harvesting for energy is most likely not depleting wood stocks beyond what would be cleared for these activities. In this it differs from charcoal production, which exerts pressure on the region's forests, particularly in peri-urban areas (Martinet, Megevand, and Streck 2009).

Woodfuel collection becomes a serious threat to forests in densely populated areas. Woodfuel can be a cause of severe forest degradation and eventually deforestation when demanded by concentrated markets, such as urban household markets, industries, and other businesses. In densely populated rural areas, the supply—consumption balance is usually defined by a high deficit for fuelwood, which creates huge pressure on forested areas surrounding the cities. With weak regulations and control over woodfuel harvesting, operators are likely to harvest as close to markets as they can in order to maximize their profit, resulting in forest degradation in forest areas around urban markets (Angelsen 2009). Similarly, industrial and other business demand for woodfuel can

Box 2.1: Ibi Bateke (Democratic Republic of Congo) – Tree Intercropping Afforestation in Degraded Savannah Lands

In 2009, through its BioCarbon Fund, the World Bank began financing an afforestation and clean energy project in the Democratic Republic of Congo that was based on intercropping techniques; it intended to purchase 500,000 tons of carbon credits to be generated by the project until 2017. The initiative is being carried out by a local Democratic Republic of Congo organization called NOVACEL, which has been exploring tree planting, agricultural intercropping, and carbon sequestration techniques to be used in degraded savannah grasslands on the Bateke Plateau targeting some 4,220 hectares. The land has been legally titled by the government in the form of a 25-year lease to directors of NOVACEL.

The project uses forestry and agroforestry plots to introduce cassava intercrops, which have so far been successful. NOVACEL is also researching agroforestry techniques for intercropping trees with manioc plantations, using various species of acacia and eucalyptus trees. The project serves multiple purposes, with the main goal of increasing the yield of fuelwood for charcoal supply to high-demand markets in Kinshasa, while reducing degradation and deforestation of the remaining forests. Other important goals are to reduce water loss and improve soil fertility, promote carbon sequestration, create permanent and temporary employment (an estimated 55 to 60 permanent jobs and up to 400 temporary jobs), enhance community development, and reduce poverty. The project has the potential to create a carbon sink capable of sequestering around 1 million tons of CO_2 until 2017 and 2.4 million of tons of CO2 over 30 years.

Source: World Bank 2009.

be a serious threat to local forest resources if not properly regulated, given a potentially large demand within a small geographic area.

Supply basins extend over time to satisfy the growing urban demand for energy, as figure 2.1 shows for Kinshasa, a megacity of 8 to 10 million inhabitants, located in a forest-savanna mosaic environment on the Bateke Plateau in the Democratic Republic of Congo. The city's wood energy supply of about 5,000,000 cubic meter per year is mostly informally harvested from degraded forest galleries within a radius of 200 km from Kinshasa. With gallery forests most affected by degradation from wood harvesting, even forests beyond the 200 km radius are experiencing gradual degradation, while the peri-urban area within a radius of 50 km of Kinshasa has suffered total deforestation. It is estimated that 60,000 ha per year are cleared for fuelwood.

The conflicts can also severely impact the forests, through the settlement of refugees and their associated needs, including energy. The eastern Democratic Republic of Congo has endured several decades of conflict and faces numerous interconnected challenges—humanitarian crises as a result of the displacement of more than a million refugees in the Goma area, as well as the ecological crisis affecting the Virunga National Park, more than half of its surface area having suffered deforestation (Marien 2009). In addition to meeting the energy requirements of Goma city,[4] an estimated 200,000 metric tons of woodfuel are needed for refugees each year. Several projects have tried to address the energy challenge, including projects by the World Wildlife Fund or United Nation Refugee agency (UNHCR), typically focusing on strategies to increase wood resources through the establishment of community plantations of fast-growing species such as acacia and eucalyptus (Marien 2009).

Box 2.2: Cameroon: Different Supply Areas Power the Urban Centers

The market for fuelwood in Cameroon consists of a set of supply areas to urban centers. These areas coincide with the main zones of vegetation: the Sahel supply chain (area of Marouam, Garoua, and Kaélé Mokolo), the savannah supply chain (area of Bamenda), and the forestry supply chain (area of Yaounde). The fuelwood supply chains are experiencing a crisis that is both physical and economic. The pressure of urban demand for fuel is leading to deforestation, particularly in the Sahelian and savannah areas.

Source: Koto-Same et al. 2002.

4 The 300,000 inhabitants of Goma city consume an estimated 500,000 m^3 of fuelwood per year, depending on it largely to meet their energy needs, with 97 percent of the population relying entirely on woodfuel (Forests Monitor 2007; Marien 2009).

CHAPTER 3

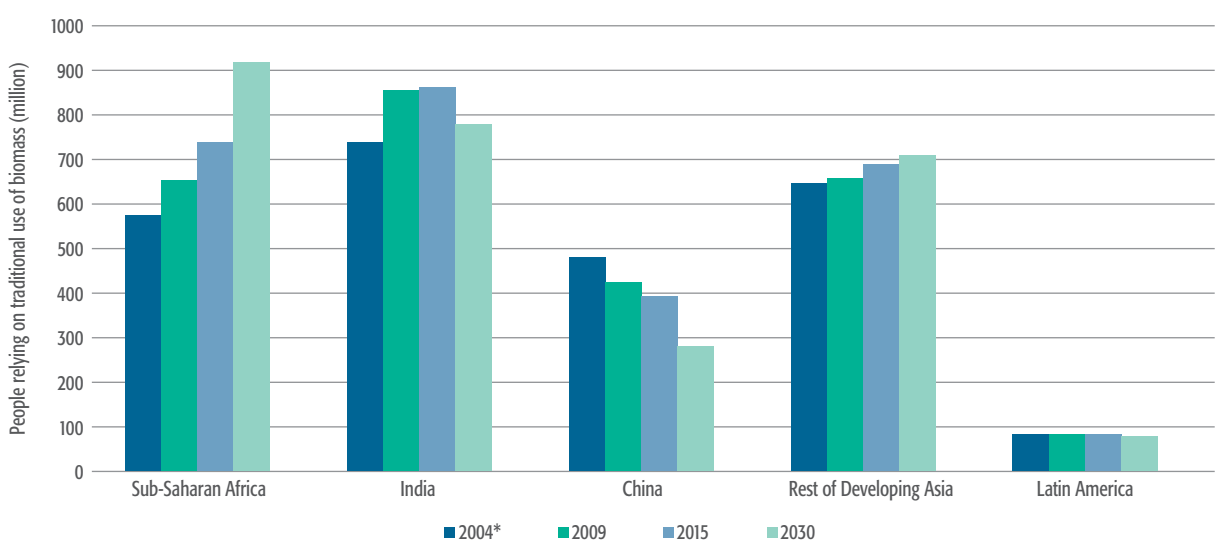
Prospects and Recommendations

TRENDS IN ENERGY PROFILES IN THE CONGO BASIN

In contrast to China, India, and much of the developing world, where the use of wood-based biomass energy has peaked or will be peaking in the very near future, consumption of wood-based biomass energy is likely to remain at very high levels in SSA and may even continue to grow for the next few decades. Estimates in the *World Energy Outlook 2010* predict that by 2030 more than 900 million people in Sub-Saharan Africa may rely on wood-based biomass energy (IEA 2010b).

Charcoal consumption in the Congo Basin is expected to remain very high or even increase in absolute terms over the next decades, based on prospects of population growth, increased urbanization, and relative price changes of alternative energy sources for cooking. High oil prices may prevent the poor from ascending the "energy ladder." It was anticipated that with rising income and stable prices, consumers would be able to move from fuelwood to charcoal, and then to fossil fuels (for example, liquefied petroleum gas); however, examples in different countries show that this phenomenon has not applied. A regional study for Southeast Africa estimated that charcoal consumption between 1990 and 2000 grew by about 80 percent in both Lusaka and Dar es Salaam (SEI 2002). Between 2001 and 2007, the number of households in Dar es Salaam using charcoal for cooking increased from 47 percent

Figure 3.1: Number of People Relying on the Traditional Use of Biomass in the IEA New Policies Scenario (millions)



Source: IEA 2010 (*IEA 2006).

to 71 percent, while the use of liquefied petroleum gas (LPG) has declined from 43 percent to 12 percent. In Senegal, consumers also switched back en masse to using wood-based biomass for cooking after the elimination of subsidies caused prices for LPG to increase significantly (World Bank 2009).

In some cases, rising fuel prices may even force wealthier segments of society to revert to wood-based fuels. In Madagascar, for example, the upper-middle class—increasingly unable to afford LPG —has begun to switch back to charcoal. The reliability of supply is another issue that keeps consumers using wood-based biomass: not only can the purchased quantity be adjusted to the cash availability of the household, but wood-based biomass is also available through a wide network of retailers, and there is never a shortage of wood-based biomass. In contrast, the supply of other fuel options—especially LPG—has been reported by consumers to be unreliable and, thus, unattractive for regular use.

RECOMMENDATIONS: HOW TO LIMIT ADVERSE IMPACTS ON NATURAL FORESTS

Woodfuel energy use is very often reported as one of the major drivers of deforestation and forest degradation in the Congo Basin. In the Democratic Republic of Congo, for instance, fuelwood collection has been cited as the primary cause of forest degradation and one of the three most important deforestation factors. However, the impacts of woodfuel collection on forest are rather diverse and complex and certainly deserve more analysis. Moreover, the informality of the sector has generated a vacuum for reliable data (in terms of both quantity and quality).

This chapter aims to provide some recommendations and guidance on how the REDD+[5] agenda can provide Congo Basin countries with appropriate incentives to transform their energy sector, particularly for households. Wood-based biomass energy has so far been seen as a traditional sector and has been generally given very little attention. The REDD+ mechanism could offer an opportunity to "modernize" this segment of the energy sector. The below recommendations should be considered as pillars for any future REDD+ activities that aim to tackle the challenge of biomass energy in the Congo Basin.

Put the Woodfuel Energy Sector Higher on the Political Agenda

The wood-based energy sector deserves greater attention from policy makers. The importance of woodfuel as a source of energy in Africa is undisputed. However, until now, very little attention has been given to it in the policy dialogue, and accordingly the sector is poorly featured in official energy policies and strategies. There are many reasons for this, including (1) the wood-based energy sector is perceived as "old-fashioned" and "backward" and policy makers are more interested in more modern and supposedly cleaner sources of energy; (2) the wood-based energy sector is usually associated with forest degradation and deforestation and is seen as a harmful sector that needs to be eradicated; (3) the sector is poorly documented and does not benefit from any reliable statistical data (which tends to minimize its role in terms of contribution to economic growth, employment, and so on); and (4) the mostly informal governance of this sector often motivates rent-seeking behaviors, and conflicting interests may hamper any reforms. This last situation applies particularly in the Congo Basin countries.

There is a need to change the perception of policy makers: wood energy is generally perceived as traditional and old-fashioned, which sometimes diverts the technical and political attention of energy ministries, despite the fact that a vast majority of the population heavily relies on wood energy for their subsistence needs.

Lessons could be drawn from Europe and North America that place wood energy among the most modern energy sources. Wood energy (for heating,

5 REDD+ encompasses activities related to avoiding deforestation and forest degradation, as well as conservation, sustainable forest management, and enhancement of forest carbon stock in developing countries.

electricity generation, and sometimes cooking) is indeed the fastest-growing renewable energy source in Europe and North America. Very modern, high technology is developed to increase efficiency when using wood for energy purposes; the European Union is investing heavily in wood energy technology and plantations. This can also happen Africa—as one of several pillars of future energy development—with advanced cookstove technology, advanced charcoaling technology (potentially with co-generation of electricity as done in Brazil), and improved forest management.

Formalize the Fuelwood/Charcoal Value Chain

The informal nature of the wood-based energy sector is probably one of the biggest barriers to the development of a sustainable sector. The inappropriate economic structure of the supply chain curbs the capacity for actors in the chain to adopt sustainable practices —at all levels, but specifically at the production level, where farmers bear the largest burden of the costs with little leverage on the end-product price.

The formalization of the fuelwood/charcoal value chain should be given a priority and should lead to the revision and modernization of the regulatory framework (as described above). This formalization will break the oligopolistic structure of the sector and open up to a more transparent marketing framework. The economic value of the resources will thus be better reflected in the pricing structure and appropriate incentives could be set up. To do so, the following steps are necessary:

- *Understand the "political economy" of the informal fuelwood/charcoal value chain.* A political economy analysis of the sector should be a prerequisite to the revision/adjustment of the legal and regulatory framework, as proposed below. As a matter of fact, the informal sector involves a large number of operators, including small-scale producers/collectors, traders, transporters, or retailers. Robust understanding of interactions among the various stakeholders as well as their roles in the informal charcoal value chain will help inform the preparation of a legal/regulatory framework.
- *Adapt the legal and regulatory framework in a participatory manner.* Formulation of a national or regional woodfuel policy must be based not only on sound baseline information but also on a consensual vision, high-level commitment, and ownership. Such a policy must combine "upstream" and "downstream" aspects of the value chain. This requires streamlining sector policies as well as cross-sectoral coordination of such policies. Developing a cross-sectoral woodfuel strategy can represent a valuable starting point, especially if led by a joint working group or some other central government office (for example, the office of the prime minister or ministry of finance). The process for developing such a woodfuel strategy should facilitate contributions from all relevant stakeholders through an intensive consultation process and assigning clear roles and responsibilities. It is expected that such participatory approaches enhance the ownership of policy reforms at all stakeholder levels, which is important for long-term success and sustainability. After that, objectives and content should be translated into sectoral or regional "action plans," and communicated to a wider public so as to foster acceptance of and to provide confidence in the upcoming measures and changes.

Diversify the Supply Side of the Value Chain

The charcoal value chain in the Congo Basin currently relies overwhelmingly on natural forests. Although natural forests are expected to continue supplying much of the raw material for charcoal production, they will be unable to meet demand in a sustainable manner, since it is expected to increase substantially. There is a need to ensure that the whole charcoal value chain properly integrates sustainability of the wood supply. To do so, policy makers should consider the following two options.

- *Maximize potential of sustainable harvests from natural forests.* Due to a lack of reliable data on forest resources, harvesting and licensing decisions are made without accurate estimates of the standing stock or resources available; thus, it is vital to conduct more accurate assessments. Once this is accomplished and harvesting plans are developed,

Box 3.1: Lesson Learned: Long-term Rights to Forest Land and Devolution of Management Authority Provide Strong Motivation for Communities to Participate in Sustainable Woodfuel Production

In Niger and Senegal, a considerable annual increase in the forest stock was reported after local communities took over the management of their forest resources. Community-based woodfuel production (CBWP) has proven instrumental in promoting forest rehabilitation and reducing deforestation rates.

Decentralization and devolution of management authority have taken hold in natural resource management. Local communities readily respond to these government initiatives because they provide improved autonomy and self-reliance at the local level. Furthermore, evidence suggests that households involved in sustainable woodfuel production markedly increase their income and thus improve their economic security. In turn, community members observe local rules—established in local conventions or contracts—and engage in sustainable management and control of access. In areas where CBWP has taken hold, incidences of fires and illegal exploitation have declined significantly.

In countries where communities benefit from tax collection (for example, Niger, Senegal), revenues are used for investments in social infrastructure (schools, wells, primary care health centers, etc.). Furthermore, the community members' concomitant rise in social status is not merely symbolic, but translates into increased bargaining power with forestry officials and traders. On the other hand, it must be noted that low management capacities and weak transparency within local management structures remain pressing problems that require continuous external support.

Source: ESMAP 2010.

their compliance in their implementation must be continually monitored.

Special consideration should also be given to timber waste management in logging concessions: a large portion of the timber logged in industrial concessions is usually left in the concession and could be valorized for charcoal. However, thus far, there is no integration of the two value chains (timber and charcoal) and potential synergies are not fostered in existing regulations.

- *Increase sustainable wood supply through tree plantations and agroforestry.* Small-scale plantations and woodlots could increase the supply of wood to produce charcoal and trigger economic opportunities and land-use planning in rural areas. Private or group-based woodlots/plantations could, in the long term, complement supplies. Similarly, planting trees in farmlands ("trees outside forests"), through agroforestry systems adapted to Congo Basin areas, represents a significant opportunity to maximize timber production, while at the same time increasing agricultural productivity rates.

  Adequate incentive frameworks might be necessary in the early stages to trigger local-level investments in establishing planted woodlots and agroforestry systems. As farmers begin to secure financial benefits from the sale of wood for charcoal, it is likely that other farmers would engage in similar activities. In this context, the potential of carbon-finance opportunities must be further explored.

Foster Community Involvement through Clear Devolution of Rights

Community-based forest management approaches can successfully expand the supply and relieve natural forests from unsustainable withdrawals. However, communities will invest in adopting sustainable forest practices or tree plantations/agroforestry systems only if they are given enough visibility on land/tree tenure issues. In many cases, clarification of land/tree rights is an important prerequisite to any actions to support sustainable forest management practices for the woodfuel sector.

- *Strengthen the devolution of rights and responsibilities over forest resource management* provides incentives for local stakeholders to engage in managing their resources by applying core principles of sustainable forestry. Ideally, technical oversight, including capacity building, is provided by community authorities. This model entails community involvement in the sustainable management of public forests and the use of sustainable resources for commercial purposes.

  Community-based woodfuel production schemes have already been implemented in a few African countries, such as Niger, Senegal, Rwanda, and Madagascar. The almost 20 years of experience shows promising results and proves that sustainable production of woodfuel can be achieved through a devolution of rights and responsibilities to the local stakeholders (see box 3.1).
- *Adjust the role of government entities.* By decentralizing management of local forest resources, the role of central government could be reduced to the primary function of setting up a supportive policy framework, while local government institutions would be able to concentrate on serving their clients regarding technical matters, capacity building, and providing advice on sustainable forest management, in addition to enforcing modern, progressive laws and revenue collection systems.

Identify Priority Areas with Potential for Charcoal Plantations

An integrated land-use approach should guide the identification of areas for the establishment of plantations and woodlots for sustainable charcoal production. The following principles could be used to guide the decision-making process: no natural forest area should be converted to plantations—even for degraded natural forests, it is preferable to improve production through enrichment planting rather than full conversion to plantations or woodlots—and plantations should be established on degraded lands.

Growing urban needs in terms of both food and energy must be addressed. Pressures on forests around urban centers are not only driven by energy needs but also respond to growing demands for food. Most of the time, fuelwood collection is directly linked with agricultural practices (slash-and-burn) and in some cases, is seen as a by-product of agricultural expansion. Growing urban needs in food and energy consumption and increasing pressure on forest in these densely populated areas can thus not solely be addressed through a purely energy perspective but require a more integrated approach that would address the various driving forces of forest degradation and deforestation.

Conclusion and Outlook

Reliance on wood-based biomass for energy in the Congo Basin is expected to remain at very high levels or even increase in absolute terms over the next decades, based on prospects on population growth, increased urbanization, and relative price changes of alternative energy sources for cooking. Under a business-as-usual scenario, it is thus likely to become the number one driver of forest degradation and deforestation.

New environmental finance mechanisms can help Congo Basin countries transition toward a forest-friendly development path. Environmental finance includes climate funding for adaptation and mitigation efforts in general, and REDD+ in particular, but also financing for biodiversity, wetlands, or soil restoration. When accessing these new resources, countries may consider a number of issues to prioritize activities and effectively allocate these new funds. It is therefore up to national governments to define how these various mechanisms fit into their own development, how to best use such resources, and whether and how to meet the relevant criteria of funds or mechanisms, and to assess the benefits and risks associated with particular funds, including the costs of putting into place relevant information and institutional conditions.

REDD+ provides an important opportunity for Congo Basin countries to develop strategies that work toward sustainable development while protecting the natural and cultural heritage of the region. This new, dedicated focus on forest protection within international climate agreements, in combination with the availability of new financial resources, moves sustainable forest management up in the political agenda and has in many countries facilitated a dialogue among forest agencies and those ministries and entities that regulate broader industrial and agricultural development.

In that specific context, the Congo Basin countries could define a transformational approach to their energy sector. Political action is crucial to foster development and enable forest protection, in particular through the necessary formalization of the sector and the establishment of a regulatory framework that properly factors the "real value" of the resources. In addition, ambitious plans for plantations could drastically contribute to an increase in timber supply, while limiting the pressure on natural resources.

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Deforestation Trends in the Congo Basin: Reconciling Economic Growth and Forest Protection

WORKING PAPER 5 | WOOD-BASED BIOMASS ENERGY

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