An Approach to Promote REDD+ Compatible Wood-fuel Value Chains

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SNV SMART DEVELOPMENT WORKS

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Executive summary

SNV Netherlands Development Organisation (SNV) has established the REDD+ Energy and Agriculture Programme (REAP) to advance understanding on the interface between agriculture and energy use across different forest landscapes in order to support low emission, pro-poor development pathways. To this end, a number of knowledge products, or solutions, are being developed. These are being tested within different sectors which are recognised as important drivers of deforestation and forest degradation; this includes the wood-fuel sector.

Wood based fuels remain the primary energy source for households in developing countries. In Sub-Saharan Africa, 93 per cent of households in rural areas and 58 per cent of households in urban zones rely on wood-fuel.[1] The extraction of wood for fuel can lead to encroachment into forested areas and has been identified as one of the principal drivers of forest degradation in national programmes on Reducing Emissions from Deforestation and Degradation of forests (REDD+), particularly for Sub-Saharan Africa. Wood-fuel can potentially be a renewable energy and a critical income source for the poor, if managed properly. The wood-fuel value chain is generally characterised by the presence of many actors, informal practices and often unequal distribution of benefits, leading to a situation where there is little incentive to extract wood-fuel sustainably; with the poorest groups often suffering the most.

SNV undertook research to examine the wood-fuel value chain and to identify key issues that preclude wood-fuel from being used sustainably. Based on this, SNV developed an approach that can help policy makers and practitioners to better understand the wood-fuel value chain and to target interventions in ways that contribute to reducing forest degradation and improve the livelihoods of those communities involved in the sector. While this approach may have wider application, the focus is Sub-Saharan Africa.

This paper outlines the approach. It follows three basic steps: firstly, to understand the main actors along the wood-fuel value chain; secondly, to identify the key issues which preclude sustainability of the wood-fuel value chain; and thirdly, to identify interventions to address sustainability along the value chain. This includes ascertaining risks and institutional measures to mitigate such risks. Based on the three steps, an approach, encapsulated in a simple model, has been developed to facilitate design of interventions to ensure a more sustainable wood-fuel value chain. Following these steps can assist policy makers and practitioners to take an inclusive approach to understanding the different stages of wood-fuel value chains, to identify possible solutions, risks and institutional requirements and to target their interventions in ways that achieve greatest benefits in terms of reduced degradation of forested areas and benefits to the poorest communities. This links with the REDD+ objectives of assessing how interventions could contribute to reducing emissions from deforestation and forest degradation while improving co-benefits for the many actors involved. In the report the steps are examined with respect to two target countries, namely Burkina Faso and the Democratic Republic of Congo; both of which are heavily reliant on wood-fuel as an energy source.

SNV plans to apply this model in different contexts and countries to support the sustainability of their wood-fuel sector and ultimately to lower greenhouse gas (GHG) emissions. It is expected that through further application of the model it will be refined and updated in subsequent versions.

1. IEA, 2010. World Energy Outlook. Paris: OECD, International Energy Agency.

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Abbreviations

COCAFELOL	La Labor Ecological Coffee Cooperative
CDM	Clean Development Mechanism
DRC	Democratic Republic of Congo
GHG	greenhouse gases
FMA	forest management areas
ICS	improved cook stoves
NAMAs	Nationally Appropriate Mitigation Actions
REAP	REDD+ Energy and Agriculture Programme
REDD+	Reducing Emissions from Deforestation and Degradation of Forests
SNV	SNV Netherlands Development Organisation

Introduction

Wood based fuels remain the primary energy source for households in developing countries. Worldwide, 2.7 billion people use wood-fuel for cooking and heating.[2] In Sub-Saharan Africa, 93 per cent of households in rural areas and 58 per cent of households in urban zones rely on wood-fuel[3] and the number of biomass users is estimated to increase by more than 40 per cent to 922 million by 2030. In Asia, where absolute numbers are decreasing, there will still be approximately 1.75 billion people depending on wood-fuel by 2030.[4]

Wood-fuel definition

Wood-fuel is defined as all types of fuels originating directly or indirectly from woody biomass. The main types of wood-fuel in Sub-Saharan Africa are fuel-wood and charcoal. Fuel-wood is understood as wood-fuel in which the original composition of the wood is preserved. This category includes wood in its natural state and residues from wood-processing industries. Charcoal is defined as the solid residue derived from carbonisation, distillation, pyrolysis and torrefaction of wood.

Source: Food and Agriculture Organization. (2004). UBET Unified Bioenergy Terminology. Rome: FAO

The extraction of wood for fuel can lead to encroachment into forested areas and has been identified as one of the principal drivers of forest degradation in national programmes on Reducing Emissions from Deforestation and Degradation of Forests (REDD+), particularly for Sub-Saharan Africa. In 2009 it was estimated that charcoal production caused 14 per cent of total deforestation in Sub-Saharan Africa (29,760 km2)[5] and total emissions from wood-fuel (64 per cent from wood and 36 per cent from charcoal) were equal to 76 million tons of carbon, accounting for 96 per cent of total household energy Greenhouse Gases (GHG) in Sub-Saharan Africa.[6] In Sub-Saharan Africa, sustainable biomass extraction could reduce GHG emissions by 36 per cent.[7]

It is recognised that wood-fuel could potentially be a renewable energy and critical income source for the poor, if managed properly. Despite the importance of wood-fuel in the lives of millions of people it is rarely targeted in development interventions. Policies and projects regarding the wood-fuel sector often address parts of the value chain in relative isolation.

SNV Netherlands Development Organisation (SNV) undertook research to examine the wood-fuel value chain to identify key sustainability issues. Based on this, SNV developed an approach that can help policy makers and practitioners to better understand the wood-fuel value chain and to introduce interventions that contribute to reducing forest degradation and improve the livelihoods of the poor. While this approach may have wider application, the scope of the research is Sub-Saharan Africa, with two countries explored in greater depth: Burkina Faso and the Democratic Republic of Congo (DRC). Both countries have identified the introduction of a more sustainable wood-fuel sector as key elements of their national REDD+ strategies.

This paper outlines the approach. It follows three basic steps: firstly, to outline and identify the main actors along the value chain; secondly, to identify the key issues which preclude sustainability of the wood-fuel value chain; and thirdly, to identify interventions to address sustainability along the value chain. This includes ascertaining risks and institutional measures to mitigate such risks. In Section 4 we present a basic model which illustrates the three steps and which can be applied as a basis for developing REDD+ compatible wood-fuel value chains. Finally, conclusions are provided.

2. IEA, 2010. World Energy Outlook. Paris: OECD, International Energy Agency.
3. Ibid
4. Ibid
5. Chidumayo, E. N. and D. J. Gumbo, 2013. The Environmental Impacts of Charcoal Production in Tropical Ecosystems of the World: A Synthesis, Energy for Sustainable Development 17(2): 86-94.
6. Bailis, R., Ezzati, M., & Kammen, D. M., 2005. Mortality and greenhouse gas impacts of biomass and petroleum energy futures in Africa. Science 308(5718): 98-103.
7. Ibid

Section 1

Actors along the wood-fuel value chain

Box 1: Wood-fuel value chain

A value chain comprises a system of persons, organisations and activities that are needed to produce, transform and deliver a product or service via suppliers to the final consumer. Value chain analysis consists of mapping the chain and its actors and assessing market dynamics and governance issues.[8] Studies on wood-fuel have started to integrate value chain analysis over the past years, while recognising that related social and environmental issues often go beyond those of rural production and subsistence use, involving commercial supply, urban actors and wider ecosystems.[9, 10, 11] For wood-fuel, the value chain starts where the tree grows. It then goes through a process of cutting, drying and possible carbonisation. It is then packaged and transported to local and regional markets where it is consumed by households and businesses.

Market channels for urban supply vary from direct sales by producers to consumers, to indirect chains that involve intermediaries and/or wholesalers and retailers who organise the sales to consumers.[12] Wood-fuel value chains in Africa are mostly restricted to domestic levels following demand patterns of nearby urban centres, unlike the international trade of processed types of wood-fuel (wood pellets, ethanol), due to high transport costs for bulky fuel-wood or charcoal.

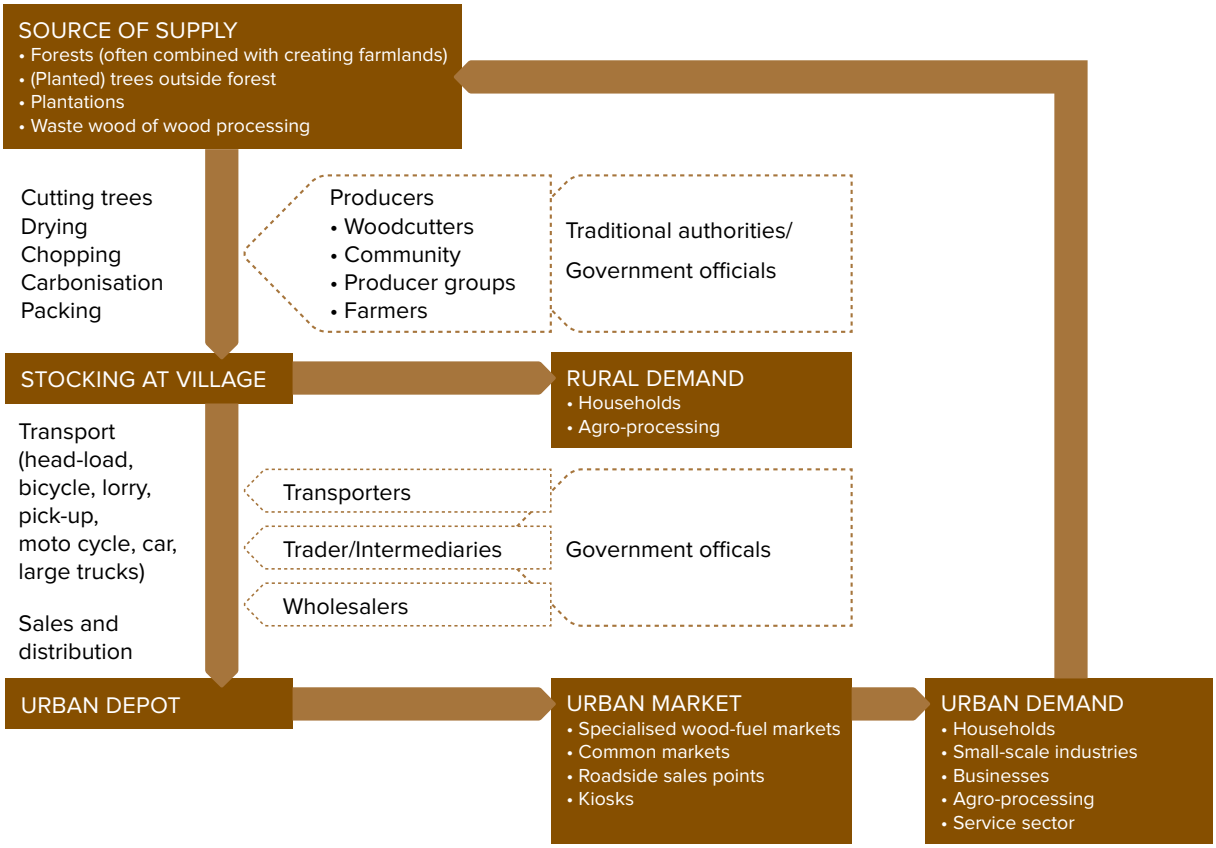
8. SNV, 2012. Manuel de Facilitation des Chaines de Valeur pour les Conseillers SNV. The Hague: Organisation Néerlandaise de Développement.
9. Bailis, R., 2009. Modeling climate change mitigation from alternative methods of charcoal production in Kenya, Biomass and Bioenergy, 33 (11), 1491-1502.
10. Kambewa, P. S., B. F. Mataya, W. K. Sichinga and T. R. Johnson, 2007. Charcoal: The Reality a Study of Charcoal Consumption, Trade and Production in Malawi. Technical Report to Forest Governance Learning Group. Malawi: Community Partnership for Sustainable Resource Management in Malawi.
11. Ribot, J. C., 1998. Theorizing Access: Forest Profits Along Senegal's Charcoal Commodity Chain, Development and Change 29(2): 307-341.
12. Kambewa, P. S., B. F. Mataya, W. K. Sichinga and T. R. Johnson, 2007. Charcoal: The Reality a Study of Charcoal Consumption, Trade and Production in Malawi. Technical Report to Forest Governance Learning Group. Malawi: Community Partnership for Sustainable Resource Management in Malawi.

A typical value chain follows the basic steps outlined in Figure 1.

Figure 1: Basic steps of a typical value chain

The major groups of actors involved in the wood-fuel value chain are producers, transporters, traders, wholesalers, retailers, consumers and (traditional and official) authorities. As seen from Figure 2 the wood-fuel value chain is complex, involving many different groups. Participatory mapping by actors and stakeholders can assist in identifying roles, stakes and bottlenecks within the value chain. Less visible or marginalised groups need to be actively included in these exercises.

Figure 2: Wood-fuel value chain and main actors involved



The different steps along the value chain and the actors' involved are further described below.

Production

Wood-fuel can be sourced from a number of places; including natural forests, trees on farms, plantations, residues from forest harvesting, salvage harvesting (sick or damaged trees) and silvi-cultural thinning.[13] Wood-fuel for urban demand is often derived when

13. FAO, 2010. 'Criteria and Indicators for Sustainable Wood-fuels' FAO Forestry Paper. Rome: FAO.

forestlands are converted to farmlands, or, when markets are attractive, it is directly harvested from forests or agroforestry systems. Smaller quantities are sourced from plantations or from waste wood of timber operations.[14, 15] Production essentially entails cutting the trees, chopping to a practical or requested size, drying and packing for transport.

The main actors involved at the level of production are specialised woodcutters, community members, farmers and formal and informal authorities. Producers are the primary actors in terms of the number of income generating opportunities created. In DRC, an estimated 290,000 people are involved at the level of production for supply to Kinshasa.[16] Farmers and their family members often partake in wood-fuel production year-round.[17] Wood-fuel harvesting for subsistence use has traditionally been a task carried out by women and children.[18] In spite of the relatively low profit margin in this stage of the value chain, wood-fuel production can be an important part of the overall revenues of rural households. Profits at the level of production can be ascribed to high demand and the low costs of investment, including the use of low cost labour and cheap resources.

Formal and informal authorities exercise control over tree resources and commercialisation. In many African countries it is the local traditional authorities that provide access to land; government officials control official land registration and monitor production and trade regulations. Regulatory tools regarding wood-fuel extraction can constitute producer or trader taxes, licenses, permits, fees and imposing minimum harvestable tree diameters or restrictions on certain tree species.[19]

Processing

Processing can be carried out by the same people involved in production or by specialised wood processing groups. In the case of charcoal producers, two types of charcoal makers are generally distinguished: (1) rural citizens, mostly farmers, who produce charcoal as a by-product of transforming forestlands into farmlands ((and sometimes of timber logging)),[20] and; (2) specialised producers, urban or rural citizens working in groups who are moving around, following production frontiers.[21] Sometimes, it is urban merchants who hire woodcutters to produce the charcoal.[22] Charcoal making for commercialisation, nowadays, is mainly an activity executed by men.[23]

Although charcoal is popular for its energy density (it contains around 33 MJ/kg, or twice that of wood) and it is easier to store and transport compared to fuel-wood, the low energy efficiency of traditional earth charcoal kilns means that around 7 kg of wood is needed to produce 1 kg of charcoal. Most carbonisation takes place in traditional earth kilns with an energy efficiency of around 13-15 per cent.[24]

14. Chidumayo, E. N. and D. J. Gumbo, 2013. The Environmental Impacts of Charcoal Production in Tropical Ecosystems of the World: A Synthesis, Energy for Sustainable Development 17(2): 86-94.
15. Schure, J., Marien, J-N., de Wasseige, C., Drigo, R., Salbitano, F., Dirou, S., and Nkoua, M., 2012. Contribution of wood-fuel to meet the energy needs of the population of Central Africa: prospects for sustainable management of available resources. In de Wasseige C., de Marcken P., Bayol N., Hiol Hiol F., Mayaux Ph., Desclée B., Nasi R., Billand A., Defourny P and Eba'a R. (Eds.), The Forest of the Congo Basin – State of the Forest 2010 (pp. 109-122). Luxembourg: Publications Office of the European Union.
16. Schure, J., V. Ingram, S. Assembe-Mvondo, E. Mvula-Mampasi, J. Inzamba and P. Levang, 2013a. La Filière Bois Énergie des Villes de Kinshasa et Kisangani, in J.-N. Marien, E. Dubiez, D. Louppe and A. Larzilliere (eds) Quand la ville mange la foret, pp. 27-44. France: Editions QUAE.
17. Openshaw, K., 2011. Supply of Woody Biomass, Especially in the Tropics: Is Demand Outstripping Sustainable Supply? International Forestry Review 13(4): 487-499.
18. Ingram, V., Schure, J., Tieguhong, J. C., Ndoye, O., Awono, A., and Iponga, D. M, 2014. Gender implications of forest product value chains in the Congo Basin. Forest, Trees and Livelihoods, 23, DOI: 10.1080/14728028.2014.887610
19. Namaalwa, J., O. Hofstad and P. L. Sankhayan, 2009. 'Achieving Sustainable Charcoal Supply from Woodlands to Urban Consumers in Kampala, Uganda', International Forestry Review 11(1): 64-78.
20. Hulusjö, D, 2013. A Value Chain Analysis for Timber in Four East African Countries.
21. Trefon, T., T. Hendriks, N. Kabuyaya and B. Ngoy, 2010. L'economie Politique de la Filière du Charbon de Bois à Kinshasa et à Lubumbashi. IOB Working Paper 2010.03. Antwerp: University of Antwerp.
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23. Gumbo, D. J., K. B. Moombe, et al, 2013. Dynamics of the Charcoal and Indigenous Timber Trade in Zambia: A Scoping Study in Eastern, Northern and Northwestern Provinces. Occasional Paper. Bogor: CIFOR.
24. Namaalwa, J., O. Hofstad and P. L. Sankhayan. 2009. Achieving Sustainable Charcoal Supply from Woodlands to Urban Consumers in Kampala, Uganda. International Forestry Review 11(1): 64-78.

Transport and trade

Transport varies from head-loading, bicycles and motorcycles, to donkey carts, cars, pick-up trucks, lorries and large trucks. Modes of transport depend on the distances that have to be covered and the financial means of the traders. Transporters, or traders, are often men, mostly urban based, who travel around production zones to collect wood-fuel or travel to a village after being contacted by producer groups.[25]

Wholesalers, who have their own means of transport, are also sometimes involved in transport and trade.

Traders fulfil an important role in collecting the product at the production sites and co-ordinating and financing production, transport and sales. Involvement in transport and trade is relatively expensive, which is why fewer people are able to engage in this activity.[26] The extent of their role and influence varies among countries and locations. In Burkina Faso, for example, merchants hold a relatively high level of power in the value chain, as they are the owners of the trade quotas.[27] In the DRC, however, traders play more of a logistical role, so producers are not so dependent on the rest of the value chain.[28]

Distribution and retail

Wholesalers can be characterised into two groups: those with their own transport and those which hire transportation. Wholesalers without their own transportation pay a fixed price for a truckload before organising further sales, directly, or via retailers.[29] Retailers buy fuel-wood and charcoal from the wholesaler. Sales are either organised via depots or direct to markets and semi-industrial consumers. Retailers buy fuel-wood and charcoal from the wholesaler and repack the product in smaller quantities for sale in the different neighbourhoods.[30] Retailers resell at specialised wood-fuel markets, common markets, at roadsides in local neighbourhoods or in small kiosks. Their clients are generally the poorer urban citizens who cannot afford to buy an entire bag of charcoal.[31]

Wholesalers in Burkina Faso fix seasonal prices, which determine market prices and the share of producers' revenues. In general, it is motorised transporters, merchants and wholesalers who gain the most revenues. Wholesale-transporters in Burkina Faso receive 28 per cent of the product's end prices, followed by retailers who receive 12 per cent.[32] In DRC, for supply to Kinshasa, wholesalers receive around 20 per cent of the end price and retailers obtain 23 per cent for charcoal and 35 per cent for fuel-wood.[33]

25. Shively, G., P. Jagger, D. Sserunkuuma, A. Arinaitwe and C. Chibwana, 2010. Profits and Margins Along Uganda's Charcoal Value Chain. International Forestry Review 12(3): 271-284.
26. Kambewa, P. S., B. F. Mataya, W. K. Sichinga and T. R. Johnson, 2007. Charcoal: The Reality a Study of Charcoal Consumption, Trade and Production in Malawi. Technical Report to Forest Governance Learning Group. Malawi: Community Partnership for Sustainable Resource Management in Malawi.
27. Ouédraogo, B, 2007. Filière Bois d''Énergie Burkinabé: Structuration des Prix et Analyse de la Répartition des Bénéfices. Bois et forêts des tropiques(294): 4.
28. Schure, J., Marien, J-N., de Wasseige, C., Drigo, R., Salbitano, F., Dirou, S., and Nkoua, M, 2012. Contribution of wood-fuel to meet the energy needs of the population of Central Africa: prospects for sustainable management of available resources. In de Wasseige C., de Marcken P., Bayol N., Hiol Hiol F., Mayaux Ph., Desclée B., Nasi R., Billand A., Defourny P and Eba'a R. (Eds.), The Forest of the Congo Basin – State of the Forest 2010 (pp. 109-122). Luxembourg: Publications Office of the European Union.
29. Ibid
30. Ibid
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32. Ouédraogo, B, 2007. Filière Bois d''Énergie Burkinabé: Structuration des Prix et Analyse de la Répartition des Bénéfices. Bois et forêts des tropiques(294): 4.
33. Schure, J., V. Ingram, S. Assembe-Mvondo, E. Mvula-Mampasi, J. Inzamba and P. Levang, 2013a La Filière Bois Énergie des Villes de Kinshasa et Kisangani. in J.-N. Marien, E. Dubiez, D. Louppe and A. Larzilliere (eds) Quand la ville mange la foret, pp. 27-44. France: Editions QUAE.

Consumption

Households are the main consumers of wood-fuel for cooking, followed by small-scale industries, the agro-processing sector and the services sector,[34] which includes businesses such as bakeries, breweries, restaurants, brick makers and aluminium forgers.

The energy mix is different for rural and urban households. Rural households are more likely to depend on naturally available fuels such as fuel-wood, agriculture waste and cow dung. Urban households use fuel-wood, charcoal and petroleum or LPG or electricity depending on the country. At a household level, the choice for energy is part of a complex decision-making process influenced by: size of household, area of residence, fuel availability, income, education, available labour, cultural preferences and oil price.[35, 36]

General estimates of urban wood-fuel consumption in entral Africa (0.99 m^3 per capita per year) are almost twice the quantity of West Africa (0.58 m^3 per capita per year).[37] Demand for wood-fuel is relatively inelastic for Burkina Faso, meaning that price increases do not easily lead to fuel switching, which explains why substitution and price policies have weak impacts on wood energy demand.[38] The use of improved cook stoves (ICS) to reduce wood-fuel consumption remains low in most African countries. In urban areas of Ouagadougou and Bobo-Dioulasso, an estimated 9.6 per cent of households use ICSs.[39] In DRC, only 4 per cent of households in Kinshasa and 3 per cent of households in Kisangani use improved stoves.[40]

34. IEA, 2006. World Energy Outlook. Paris: OECD, International Energy Agency.
35. Maconachie, R., A. Tanko and M. Zakariya, 2009. Descending the Energy Ladder? Oil Price Shocks and Domestic Fuel Choices in Kano, Nigeria. Land Use Policy 26(4): 1090-1099.
36. Masera, O. R., B. D. Saatkamp and D. M. Kammen, 2000 .From Linear Fuel Switching to Multiple Cooking Strategies: A Critique and Alternative to the Energy Ladder Model. World Development (Oxford) 28(12): 2083-2103
37. Tomaselli, I, 2007. Forests and Energy in Developing Countries. Forests and Energy Working Paper 2. Rome: FAO.
38. Ouédraogo, B, 2013. Assessing Wood-Energy Pricing Policies in Urban Ouagadougou (Burkina Faso). International Journal of Energy Sciences 3(5): 362-375.
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40. Schure, J., V. Ingram, S. Assembe-Mvondo, E. Mvula-Mampasi, J. Inzamba and P. Levang, 2013a. La Filière Bois Énergie des Villes de Kinshasa et Kisangani. in J.-N. Marien, E. Dubiez, D. Louppe and A. Larzilliere (eds) Quand la ville mange la foret, pp. 27-44. France: Editions QUAE.

Section 2

Sustainability issues along the wood-fuel value chain

2.1 Sustainable wood-fuel value chains

Challenges and issues related to the sustainable use of wood-fuel should be examined for the different steps along the value chain. Of particular importance in the context of REDD+ is the impact on deforestation, forest degradation and the associated GHG emissions. There is uncertainty regarding the magnitude of emissions from wood-fuel extraction. Griscom, B. et al. (2009) reference a number of studies indicating that emissions from forest degradation, due mostly to wood-fuel extraction, constituted around 57 per cent of forest emissions in Africa, while in Asia this ranged from 25-42 per cent, with most of the wood harvest likely to be for fuel.[41] In determining emissions, the critical issue is the amount extracted which is deemed to be non-renewable. Renewable wood-fuel extraction would imply the amount of biomass being extracted is being offset by growth in the biomass. In 2012 the Clean Development Mechanism (CDM) Executive Board produced an Information Note providing default values for the fraction of non-renewable biomass for least developed countries and small island developing states.[42] Of the 58 countries where values were calculated, most fell into the range of 80-95 per cent, which indicates high levels of emissions from wood-fuel extraction. It is for this reason that many national REDD+ strategies, particularly in Africa, have identified wood-fuel use as a major cause of forest degradation and GHG emissions. REDD+ strategies therefore offer an opportunity to promote more sustainable wood-fuel value chains.

Sustainability looks beyond just environmental issues and must also ensure any intervention has positive social impacts, particularly on the most vulnerable groups. In defining sustainable wood-fuel value chains in the context of REDD+ the key issues centre round the renewability of extraction and the impacts on the poorest groups.

41. Griscom, B., D.Ganz, N.Virgilio, F.Price. J.Hayward, R.Cortez, G.Dodge, J.Hurd, F.L.Lowenstein, B.Stanley, 2009. The Hidden Frontier of Forest Degradation: A Review of the Science, Policy and Practice of Reducing Degradation Emissions, The Nature Conservancy, Arlington
42. UNFCCC Information note (Ref: EB 67, Report; Annex 22)

2.2 Wood-fuel and REDD+

Fuel-wood collection and charcoal production are seldom a single cause of deforestation, but are often connected to other drivers of deforestation, especially to shifting cultivation. Charcoal production has also been reported as a driver for continuation of the deforestation process when timber harvesting is no longer profitable.[43] Although the availability of net biomass could be sufficient on a national scale,[44] many studies have reported pressures at local scales which contribute to resource depletion of peri-urban tree sources.[45, 46] The impact of charcoal production on deforestation in Sub-Saharan Africa is estimated at about 14 per cent of total deforestation,[47] and wood-fuel production has shown to be an important cause of forest degradation.[48, 49] However, the reality is that the impacts of wood-fuel production on forests are quite diverse as it is location-specific and mostly temporal. Therefore, understanding the role of fuel-wood and charcoal as drivers affecting forests is a prerequisite to tailoring appropriate measures.[50, 51]

Burkina Faso and DRC have adopted targets for reducing CO_2 emissions from the wood energy sector. Burkina Faso's yearly emissions reduction objective (19 million tCO_2e) from deforestation and forest degradation includes one million tCO_2e (i.e. 5.26 per cent of the overall objective) from the reduction in use of fuel-wood and charcoal.[52] It is believed that the country could reach this target through promoting better carbonisation techniques, the introduction of improved cook stoves and alternative energy sources. The yearly objective for sequestration to be achieved through afforestation (53,200 tCO_2e) and agroforestry measures (700,000 tCO_2e) is 753,200 tCO_2e, which is almost 4 per cent of the overall target.[53] An exploratory study indicated that DRC could potentially reduce 130 million tCO_2e/year through improved cooking stoves and 419 million tCO_2e/year through the substitution of wood-fuel by electricity.[54] The contribution from the wood-fuel sector could therefore represent 15 per cent of its overall 3700 million tCO_2e yearly emission reduction and absorption target.[55] Reaching the targets set in Burkina Faso (10-20 years) and in DRC (30 years) would require considerable efforts to transform wood-fuel value chains.

Burkina Faso and DRC are both engaged in the REDD+ policy process. DRC has been involved in the policy process since its onset in 2005 under the UNFCCC and appears among the most advanced REDD+ participants in Africa with the implementation of its preparation plan well advanced, the investment phase launched and the drafting process of its national REDD+ strategy being implemented. Current plans indicate the types of activities that

43. Ahrends, A., N.D. Burgess, S.A.H. Milledge, M.T. Bulling, B. Fisher, J.C.R. Smart, G.P. Clarke, B.E.
44. Mhoro, and S.L. Lewis, 2010. Predictable waves of sequential forest degradation and biodiversity loss spreading from an African city. Proceedings of the National Academy of Sciences 107: 1-6.
45. Openshaw, K, 2011. Supply of Woody Biomass, Especially in the Tropics: Is Demand Outstripping Sustainable Supply?. International Forestry Review 13(4): 487-499.
46. Chidumayo, E. N. and D. J. Gumbo, 2013. The Environmental Impacts of Charcoal Production in Tropical Ecosystems of the World: A Synthesis. Energy for Sustainable Development 17(2): 86-94.
47. Luoga, E., E. Witkowski and K. Balkwill, 2000. Economics of Charcoal Production in Miombo Woodlands of Eastern Tanzania: Some Hidden Costs Associated with Commercialization of the Resources. Ecological Economics 35(2): 243-257.
48. Chidumayo, E. N. and D. J. Gumbo, 2013 The Environmental Impacts of Charcoal Production in Tropical Ecosystems of the World: A Synthesis. Energy for Sustainable Development 17(2): 86-94.
49. Kissinger, G., M. Herold, V. De Sy, 2012 Drivers of Deforestation and Forest Degradation: A Synthesis Report for REDD+ Policymakers. Vancouver Canada: Lexeme Consulting.
50. May-Tobin, C, 2011. Wood for Fuel, pages 3-11 in Boucher, D., C. May-Tobin, K. Lininger, S. Roquemore, P. Elias and E. Saxoncal, Editors. The Root of the Problem: What 's Driving Tropical Deforestation Today? Union of Concerned Scientists, Cambridge, MA, USA
51. Kissinger, G., M. Herold, V. De Sy, 2012. Drivers of Deforestation and Forest Degradation: A Synthesis Reportfor REDD+ Policymakers. Vancouver Canada: Lexeme Consulting.
52. Rademaekers K., Eichler L., Berg J., Obersteiner M., Havlik P, 2010. Study on the evolution of some deforestation drivers and their potential impacts on the costs of an avoiding deforestation scheme. Prepared for the European Commission by ECORYS and IIASA. Rotterdam,Netherlands.
53. Ministère de l'Environnement et du Développement Durable, 2012. Aménagement Participatif Des Forêts Naturelles dans La Région du Centre-Ouest. MEDD. Ouagadougou.
54. Ministère de l'Environnement et du Développement Durable, 2012. Aménagement Participatif Des Forêts Naturelles dans La Région du Centre-Ouest. MEDD. Ouagadougou.
55. MECNT, 2009. Potentiel REDD+ De La RDC. Kinshasa: MECNT.

will be carried out to face wood energy issues. In DRC, seven pillars have been identified in the framework strategy as priority action areas: agriculture, energy, governance, forests, demography, territory planning and land tenure.[56] The pillar two on energy aims at reducing unsustainably produced wood-fuel while, at the same time, responding to the national demand for energy (see Box 2).[57]

This clearly indicates that the developing REDD+ strategies and activities could be an important catalyst to introducing more sustainable wood-fuel value chains.

Box 2: Activities relevant to wood-fuel in the DRC's framework strategy for REDD+

Biomass provides for the energy needs of over 90 per cent of DRC's population. Extraction rates of wood-fuel outpace regrowth rates and the current situation is unsustainable. Given an increasing population ((estimated at 4 per cent for Kinshasa)), urban migration and low access to alternative sources of energy, reliance on biomass energy is expected to increase over the medium-term. In Kinshasa alone, over five million people consume biomass energy, resulting in a yearly consumption of around 4.7 million m^3 of wood coming from peri-urban forests, involving over 300,000 people and generating around US$150 million in business - more than three times the value of all formal timber exports per year.[58]

Recognising this issue, the DRC national REDD+ programme highlights wood-fuel as a major driver of deforestation and forest degradation and plans to introduce a raft of measures. The pillar two on energy aims at reducing unsustainably produced wood-fuel while, at the same time, responding to the national demand for energy. It contains the following elements:

1. Finalise the framework for energy (legal, institutional and fiscal) to enable the development of alternatives to wood-fuel and the sustainable provision of fuel-wood.
2. Put in place a consultation framework among the public sector, the private sector and civil society for the management of public service related to energy.
3. Carry out analysis of the current and forecasted demand and supply of energy for the great basins of production/consumption and model the impact on the land planning policy.
4. Carry out an analysis of the potential, costs and feasibility of the production of diverse energy alternatives to wood-fuel in diverse regions of the country.
5. Carry out an analysis of the potential for the substitution of fuel-wood by diverse types of energy, in particular electricity.
6. Develop a national expertise on diverse types of alternative energies to wood-fuel and on the sustainable production of wood-fuel.
7. Develop national expertise on energy efficiency.
8. Design a national strategy for wood-fuel and alternative energies to wood-fuel in the short, middle and long terms.
9. Promote wood-fuel produced in a sustainable manner, alternative energies to wood-fuel and technologies that are energy effective.
10. Raise awareness and support among the potential projects initiators.
11. Implement at a large scale the national strategy of wood-fuel and alternative energies to wood-fuel, including agroforestry projects and improved cook stoves.

Source: MECNT (2013) 'Stratégie-Cadre Nationale REDD de la République Démocratique Du Congo. FCPF and UN REDD' Kinshasa: MECNT.

56. MECNT, 2009. Potentiel REDD+ De La RDC. Kinshasa: MECNT.
57. MECNT, 2013. Stratégie-Cadre Nationale REDD de la République Démocratique Du Congo. Fcpf and Un-REDD. Kinshasa: MECNT.
58. Ibid

2.3 Understanding sustainability issues along the wood-fuel value chain

Given that issues around sustainability are similar for some of the steps along the value chain they have been merged into three main groups: (1) production and processing related to the source of supply; (2) transport and trade; and (3) demand (consumption). For each of these themes sustainability issues are examined in greater detail below.

At the level of the source of supply, the main sustainability issues are:

1. ***Pressure on the resource and deficit of sustainable supply:*** These pressures are greatest in regions where there is a high demand for wood-fuel and less abundant resources. In Burkina Faso, it was estimated that only 61 per cent of wood energy needs could be met sustainably, with a total deficit of 2.6 million m^3.[59] A lack of data on wood-fuel supply patterns makes most predictions on deficits unreliable.

2. ***The large number of poor income households involved in production:*** Many people are involved at the level of wood-fuel production and processing and these activities provide important socio-economic benefits for these people, notably cash income; for example, an estimated 290,000 producers are located in the supply zone of Kinshasa. Wood-fuel income often represents an important part of overall household income in areas where alternative income-generating opportunities are few.[60, 61]
   It is therefore critical that any intervention fully understands the impact on these groups and ensures that they will not be negatively affected by changes.

3. ***The lack of awareness and knowledge of sustainable management practices:*** In many regions, local populations have no knowledge of planned felling or sustainable extraction methods. Furthermore, there is little practice of tree planting and the transfer of techniques and awareness has been insufficient.

4. ***The failure of large scale wood-fuel plantations:*** Plantations have been hampered by unclear ownership, low wood-fuel prices (due to undervaluation of the resource) and a lack of replanting experiences by the local population.

5. ***An overall lack of good resource governance*** leads to indiscriminate resource extraction by small or large actors. Local administrations have conflicting interests and lack capacity for effective control.

6. ***Tenure and access rights are not secured:*** Tree planting requires a long-term investment, which is often unrealistic for the immediate needs of poor populations. Traditional authorities often assign land for agriculture purposes and for a shorter period of time. Official land tenure procedures can be complicated and costly.

7. ***A possible conflict of interest in using trees or land for fuel*** and using these resources for other purposes, such as timber, food, medicinal use, fruits etc., as well as clearing for infrastructure. It is important that

59. Information from the DRC ER Pin
60. MEDD, 2008. Deuxieme Rapport Sur L'etat de L'environnement Au Burkina Faso. S. CONEDD. Ouagadougou.
61. Ouédraogo, B, 2007. Filière Bois d''Énergie Burkinabé: Structuration des Prix et Analyse de la Répartition des Bénéfices. Bois et forêts des tropiques(294): 4.

social considerations are taken into account in determining use of land: for example for food security, energy security etc.

8. ***Producers encounter unequal distribution of benefits*** *vis-à-vis* the traders and wholesalers, which is sometimes reinforced by the permit and quota systems.[62]

9. ***Charcoal kilns have low energy efficiency:*** Carbonisation of wood into charcoal generally takes place in traditional earth kilns that are constructed underground or aboveground.[63] Most carbonisation takes place in traditional earth kilns with an energy efficiency of around 13-15 per cent.[64] Thus, the present transition to charcoal in Africa's urban centres puts additional pressure on peri-urban wood resources.

10. ***The kilns introduced are not locally appropriate:*** For example, the Casamancaise Kiln that was introduced in Burkina Faso has not been adopted due to costs and lack of materials. The Metal Kilns introduced by CILLS, also in Burkina Faso, were not apt for wet weather conditions and rusted.

At the level of transport and trade, the major issues include:

1. ***Higher costs for transport due to longer distances:*** With growing scarcity in the supply of wood-fuel, the distances and the costs of accessing and transporting wood-fuel have increased. Road networks and means of transport are often in bad condition, hampering transport - especially during the rainy season. The bad condition of roads, the use of old and badly maintained vehicles and lack of storage facilities increase GHG emissions.

2. ***Wood-fuel prices do not reflect their true economic value:*** Under-pricing of the resource leads to an economic incentive for conversion of the resource base to other economic uses which are traded for higher returns.

3. ***The illegal wood-fuel trade:*** In many countries there is a parallel wood-fuel trade besides the legal one, which is largely uncontrolled and evades taxes. Also forestry officials may be prone to bribes while doing the work.

4. ***At the level of the market, additional regulations are sometimes applied by local government regarding sales.*** A multitude of government departments in the value chain can lead to confusion with producers and traders and competition among the tax levying bodies. For supply to the city of Kinshasa, a total of 12 state services impose taxes on wood-fuel transporters and sellers.[65]

5. ***The influential role of the transporter and intermediary in wood-fuel value chains:*** In spite of the high transportation costs, it is motorised transporters, merchants and wholesalers who gain most revenues, because they receive a relatively high share of the product's end price and handle large quantities. The extent of their roles and influence varies among countries and locations. In Burkina Faso, for example, merchants hold a relatively high level of power in the

62. Schure, J., Levang, P. and Wiersum, K.F, 2014. Producing woodfuel for urban centers in the Democratic Republic of Congo: a path out of poverty for rural households?. World Development, DOI: http://dx.doi.org/10.1016/j.worlddev.2014.03.013
63. Schure, J., Ingram, V., Sakho-Jimbira, M.S., Levang, P. & Wiersum, K.F., April 2013. Formalisation of charcoal value chains and livelihood outcomes in Central- and West Africa. Energy for Sustainable Development 17(2): 95-105.
64. Namaalwa, J., O. Hofstad and P. L. Sankhayan, 2009. Achieving Sustainable Charcoal Supply from Woodlands to Urban Consumers in Kampala, Uganda. International Forestry Review 11(1): 64-78.
65. Namaalwa, J., O. Hofstad and P. L. Sankhayan, 2009. Achieving Sustainable Charcoal Supply from Woodlands to Urban Consumers in Kampala, Uganda. International Forestry Review 11(1): 64-78.

value chain, as they are the owners of the trade quotas.[66] This is often at the expense of woodcutters who are being pressured to not respect sustainable harvesting rules and to exceed official quotas.[67] The intermediary role of transporters and traders has been insufficiently taken into account in policy interventions.

6. ***Demand side pressure on the transporters/traders*** for particular - often endangered and illegal - species of wood is not often considered in the design of interventions while it can have a marked influence on degradation of forested areas and loss of key species.

At the level of demand, common sustainability issues are:

1. ***Energy security of the poorest groups:*** The major benefit of wood-fuel is the energy-security it provides to the vast majority of Sub-Saharan African households. With the continuing increase of wood-fuel consumption and largely unsustainable production, prices for urban households continue to increase. The poorest households pay a higher price because they purchase the relatively expensive small bags of charcoal or bundles of fuel-wood, as they cannot afford to buy a larger stock at once. Fuel switching is hampered because of costs and lack of access to alternative energy sources. Any efforts to internalise the environmental costs of unsustainable use will invariably hit the poorest hardest. It is therefore critical that ways to fulfil the basic energy needs of the poorest households are met.

2. ***A growing demand for fuel-wood and charcoal in urban centres*** puts growing pressure on wood resources. This results in more time and effort needed for collecting wood for domestic use by the rural populations (mostly women and children) and increasing prices for urban populations. Insufficient data on wood-fuel demand complicates supply-demand planning.

3. ***Fuel switching is hampered because of the costs and the lack of access:*** A full comprehension of cooking energy's lifecycle is needed to compare GHG emissions. However a move towards technologies such as improved biomass-, biogas- and producer gas-fired stoves, can provide a lower cost and lower emissions alternative.[68] Bio-digesters need initial investment and availability of cow dung, water and continuous management of the installation. The initial investment can be an obstacle in a rural context where wood-fuel is generally considered a free good. Innovative finance options to allow the poor to access funds need to be introduced.

4. ***The low use of improved cooking stoves:*** In rural areas, the purchase costs of more energy efficient stoves can be an obstacle for poor families. Consumers lack information or cash for improved stoves (even though they would save costs eventually). The use of ICS to reduce wood-fuel consumption remains low; around 6 per cent throughout Sub-Saharan Africa.

66. Trefon, T., T. Hendriks, N. Kabuyaya and B. Ngoy, 2010. L'economie Politique de la Filière du Charbon de Bois à Kinshasa et à Lubumbashi. IOB Working Paper 2010.03. Antwerp: University of Antwerp.
67. Ouédraogo, B, 2007. Filière Bois d''Énergie Burkinabé: Structuration des Prix et Analyse de la Répartition des Bénéfices. Bois et forêts des tropiques(294): 4.
68. Sawadogo, L, 2006. Adapter les Approches de l'Aménagement Durable des Forêts Sèches aux Aptitudes Sociales, Economiques et Technologiques en Afrique. Le Cas Du Burkina Faso. Bogor: Center for International Forestry Research.

Table 1 provides a summary of the steps of the value chain and some of the most pressing sustainability issues. Table 2 presents data for the environmental and social impacts along the wood-fuel value chain for the cases of Burkina Faso, DRC and Sub-Saharan Africa at large.

Table 1: Main issues related to sustainable wood-fuel supply

Step of value chain	Issues identified
Source of supply	1. Pressure on the resource and deficit of sustainable supply 2. The large number of poor income households involved in production 3. The lack of awareness and knowledge of sustainable management practices 4. The lack of (successful) wood-fuel plantations 5. An overall lack of good resource governance 6. Tenure and access rights are not secured 7. Conflicting interests in use of trees and land for fuel and for other purposes 8. Producers encounter unequal distribution of benefits 9. The low energy efficiency of charcoal production 10. The kilns introduced are not locally appropriate
Transport and trade	1. High costs for transport, due to increasing distances and bribes 2. Wood-fuel prices do not reflect their true economic value 3. The illegal wood-fuel trade 4. Additional regulations by the city regarding sales and insufficient capacity for control and corruption management 5. The role of transporters and traders has been insufficiently taken into account 6. Demand side pressure for specific tree species resulting in degradation of forested areas
Demand	1. Energy security for the poor 2. A growing wood-fuel demand with growing pressure on wood resources 3. Fuel switching is hampered because of costs and lack of access 4. The low use of improved cooking stoves

Table 2: GHG emissions and impacts on the poor at different steps of the wood-fuel value chain: Burkina Faso and DRC

	Production and processing	Trade and transport
GHG emissions	• 2-3% of charcoal for Kinshasa is from sustainable sourcing.[c] • 6% of charcoal for Ouagadougou is from sustainable sourcing.[d] • In Kinshasa supply zone the carbon stock has diminished by 20% over the past 28 years and the carbon stock of degraded forests by 67%.[a] • Around Ouagadougou, wood-fuel is the main reason for depletion of forest resources in a radius of 150 km.[e] • Charcoal production contributes to around 14% of total deforestation in Sub-Saharan Africa.[b] • Emissions released (g-C in CO_2 equivalent (20-yr GWP)) during production from renewable source per MJ-delivered to the pot (CO_2, CH_4 and N_2O):[h] LPG 8.5 Kerosene wick stove 5.7 Eucalyptus in open fire 0.0 Eucalyptus in ceramic stove 0.0 Charcoal 174.1 • Energy efficiency of charcoal kilns varies around 15%.[e]	• To supply Kinshasa, distance wood-fuel is transported is, on average, 102 km and average for charcoal is 135 km.[c] • Emissions released (g-C in CO_2 equivalent (20-yr GWP)) during production from renewable source per MJ-delivered to the pot (CO_2, CH_4 and N_2O):[h] LPG 0.6 Kerosene wick stove 0.7 Eucalyptus in open fire 1.1 Eucalyptus in ceramic stove 0.7 Charcoal 1.6
Social impacts	• 13 million people are employed in the Sub-Saharan Africa biomass (mostly wood) energy sector.[k] • 290,000 producers are located in the supply zone of Kinshasa.[c] • Around 46,000 producers in the supply zone of Ouagadougou.[f] • Wood-fuel contributes 75% of the household income of charcoal producers and 47% of the household income of fuel-wood producers in the Kinshasa supply zone.[c] • Wood-fuel contributes 83% of the household income of charcoal producers in the Ouagadougou supply zone.[m] • Producers in the Kinshasa supply zone receive 57% of the end price of charcoal.[c] • Producers in Ouagadougou supply zone receive 20% of the end price.[f]	• 900 transporters and 21,000 retailers are in the supply zone of Kinshasa.[c] • 134 wholesalers are in the Ouagadougou supply zone.[f] • Charcoal wholesalers receive 20% of the end price and retailers receive 23% of the end price of charcoal in Kinshasa.[c] • Charcoal wholesalers receive 50% of the end price and retailers receive 30% of the end price of charcoal in Ouagadougou.[f]

Consumption

- Uptake of more efficient cooking stoves is round 6% of households in SSA.[i]
- In Ouagadougou and Bobo-Dioulasso, 9.6% of households use improved stoves.[g]
- In Kinshasa 4% of households use improved stoves.[c]
- Emissions released (g-C in CO_2 equivalent (20-yr GWP)) during production from renewable source per MJ-delivered to the pot (CO_2, CH_4 and N_2O):[h]

LPG	35.4
Kerosene wick stove	39.2
Eucalyptus in open fire	22.6
Eucalyptus in ceramic stove	26.7
Charcoal	39.6

- The Kinshasa market produces 4.8 million m^3 of wood equivalent representing 143 million USD.[c]
- General estimates of urban wood-fuel consumption in Central Africa (0.99 m^3 per capita per year) are almost twice the quantity of West Africa (0.58 m^3 per capita per year).[j]
- In Kinshasa alone, over 5 million people consume biomass energy, resulting in yearly consumption of around 4.7 million m^3 of wood coming from peri-urban forests, involving over 300,000 people and generating around US$150 million in business .
- 87% of the urban population of Kinshasa,[c] and 95% of the urban population of Ouagadougou,[l] depend on wood-fuel.
- 5% of the population in Burkina Faso and 0% of the population in DRC uses LPG as main cooking fuel.[n]
- 15% of the population in Burkina Faso and 15% of the population in DRC has access to electricity.[n]
- Woodfuel disease related death: 350,000 child deaths and 34,000 adult female deaths in SSA.[j]

Table 2 sources: a=Boulogne et al., 2013; b=Chidumayo and Gumbo, 2013; c=Schure et al., 2013; d= Ministère de l'Environnement et du Cadre de Vie (2004) '*Contribution Du Secteur Forestier à L'économie Nationale et à la Lutte Contre La Pauvreté*'. Ministère de l'Environnement et du Cadre de Vie. Ouagadougou.; e= Ouédraogo, B. (2006) 'Household Energy Preferences for Cooking in Urban Ouagadougou, Burkina Faso', *Energy Policy* 34(18): 3787-3795.; f= Sawadogo, L. (2006) 'Adapter les Approches de l'Aménagement Durable des Forêts Sèches aux Aptitudes Sociales, Economiques et Technologiques en Afrique. Le Cas Du Burkina Faso' Bogor: Center for International Forestry Research., 2002; g= Bensch, G., M. Grimm, K. Peter, J. Peters and L. Tasciotti (2013) 'Impact Evaluation of Improved Stove Use in Burkina Faso - Fafaso' Essen/ Rotterdam: RWI, ISS; h= Bailis, R., Pennise, D., Ezzati, M., Kammen, D. M., & Kituyi, E. (2004). Impacts of greenhouse gas and particulate emissions from woodfuel production and end-use in sub-Saharan Africa. *Berkeley, CA: Renewable and Appropriate Energy Laboratory.* (These figures have left CO_2 out of the assessment for wood and charcoal, assuming full biomass regeneration); i= Tomaselli, I. (2007) 'Forests and Energy in Developing Countries' Forests and Energy Working Paper 2. Rome: FAO.; j= Chidumayo and Gumbo, 2012, k= Openshaw, K. (2010). Biomass energy: Employment generation and its contribution to poverty alleviation. *Biomass* and *Bioenergy*, 34 (3), 365-378.; l= Ministère de l'Environnement et du Cadre de Vie. (2010). *Evaluation économique de l'environnement et des ressources naturelles au Burkina Faso: Analyse économico-environnementale au niveau national (Phase I)*. Ouagadougou: SBA, Ecosys Genève, CEDRES, UNDP, UNEP.; m= Ouédraogo, 2007; n= World Bank (2013) 'World Bank Open Data'. http://data.worldbank.org/(accessed 13 October 2013).

Section 3

Interventions to address sustainability issues along the wood-fuel value chain

3.1 Addressing sustainability issues along the wood-fuel supply chain

The potential solutions to promote more sustainable wood-fuel supply are categorised along the different steps of the wood-fuel value chain with text boxes illustrating examples of best practices identified. These options point to the possible interventions that may be selected and supported as part of national REDD+ mechanisms. The solutions and best practices identified are drawn from expert interviews and literature review.[69] Successful interventions should integrate the entire wood-fuel value chain and involve a mix of technological and regulatory solutions that fit local circumstances. In order to determine the appropriate mix of interventions it is critical that the different stakeholders along the value chain are brought together to identify and elaborate solutions for more sustainable wood-fuel management practices.

69. Bhattacharya, S. and P. Abdul Salam, 2002. Low Greenhouse Gas Biomass Options for Cooking in the Developing Countries. Biomass and Bioenergy 22(4): 305-317. (Bensch et al, 2013. Bisiaux et al, 2013. Dubiez et al, 2012. Gautier et al, 2009. Hautdidier and Gautier, 2005. Hofstad et al, 2009. Karpe and Dubiez, 2013. Marien and Mallet, 2004. Mwampamba et al, 2013. Ouédraogo, 2006. Ouédraogo, 2013. Ouédraogo, 2012. Pinta et al, 2013. Schure et al, 2011. UICN Burkina Faso, 2009. Westholm and Kokko, 2011. Yaméogo and Doulkom, 2009. Yaméogo et al, 2009. Zahonogo, 2009).

Production and processing

Potential interventions at the level of production include (1) improved forest management; (2) improved energy efficiency; and (3) alternative wood sources.

(1) Improved management of tree resources (i.e. management of fallows and degraded forests, agroforestry and plantations)

- Management of tree resources, including public and private initiatives in fallows and degraded forests, agroforestry and plantations, should be improved. This could include providing start up finance and/or transferring rights, skills and techniques, for example: assistance in the development of forest management plans, assisted natural regeneration techniques for preservation of multiple-purpose tree species, reintroducing trees in agricultural systems and managing village plantations with species for multiple uses.[70] Decentralised wood-fuel management should be part of wider landscape planning and decentralisation processes. This could build upon lessons of Burkina Faso's Forest Management Areas (see Box 3).
- The indiscriminate chopping of wood - including young trees and the trampling of new shoots - is considered to be a major impediment for regrowth. Interventions should consider improvement of tree harvesting techniques in both managed and unmanaged areas.
- Initiatives for public and private reforestation and plantations need to be introduced. Examples, such as the Mampu agroforestry experience in DRC (see Box 4), suggest that degraded lands can be reforested and contribute to carbon sequestration objectives, wood-fuel supply and improving livelihoods and food security. Legal options that ensure tenure of private or community plantations are a key element to ensure sustainability and need to be coordinated within broader national policies.
- Wood-fuel from plantation forests, sustainably managed forests and/or agroforestry plots needs to be promoted over wood-fuel from uncontrolled harvesting or threatened tree species. The promotion of land use for the purpose of tree planting may need to be subsidised, given the lower returns compared to production of agriculture crops and the long term investments needed.
- Ways to address land rights and use issues should be established at the community level. For instance, a solution should be found for those who are willing to plant trees but are prevented from doing so by present rules. This implies support for more community based management systems and structures.

70. Dubiez, E., C. Vermeulen, R. Peltier, V. Ingram, J. Schure and J.-N. Marien, 2012. Managing Forest Resources to Secure Wood Energy Supply for Urban Centers: The Case of Kinshasa, Democratic Republic of Congo. Nature and Faune 26(2): 52-57.

Box 3: Forest management areas for sustainable wood-fuel production in Burkina Faso

In Burkina Faso, wood-fuel production can officially only take place within dedicated forest management areas (FMA) and in designated cutting sites. FMAs are based on management plans, with the local population organised into forest management groups (Groupements de Gestion Forestieres (GGF) for harvesting and commercialisation of wood. Woodcutters within FMAs are being trained on harvesting techniques and regeneration of woodlots in a rotation scheme.[71] Specific 'sites de coupe', indicated by the government as zones where charcoal making is permitted, are forest zones that are being cleared for infrastructure projects. The production potential from these dedicated production sites is rather limited as most are located far away from urban centres and at least 175 km from Ouagadougou.[72]

Decree 98-306/PRESS/PM/MEE/MCIA that regulates the exploitation and marketing of forest products, defines the actors involved in the commercial exploitation and describes the taxes and fees payable for these products. The official price of a cubic meter of wood from FMAs is fixed at 2200 FCFA. Half of this price (1100 FCFA) is dedicated to the wood cutters, 600 FCFA to the Forest Management Fund aimed to restore forests; 200 FCFA for the Village Investment Fund allocated to communal investments at the village level; and 300 FCFA for payment of forestry taxes - half of which goes to the decentralised communities and the other half to the national treasury. The current management systems under FMAs are recognised for their participatory approach, the strong technical team that runs the GGF and the payment of salaries to the team members of the Forest Management Fund. Moreover, the Village Investment Fund contributes to social improvement projects at the local level. In Burkina Faso, managed forests generated more than USD 1.4 million in 2009.[73] It was estimated that forest management has led to an increase of annual income of USD 29.3 per person.[74]

Despite these benefits from FMAs, many difficulties remain. The largest issue may be that the wood-fuel production capacity of FMAs is not sufficient to meet demand and is estimated to contribute only around 6 per cent of total wood-fuel demand,[75] mainly supplying the urban centres of Ouagadougou and Bobo-Dioulasso (with 25-30 per cent and 15-20 per cent respectively).[76] This indicates the high proportion of informal, illegal and uncontrolled production, associated with free riding behaviour of producers and traders, and a loss of potential tax revenues of an estimated USD 2 million for the country.[77] Even for the wood-fuel that is being taxed, the costs are relatively low and the end price of charcoal does not reflect the real environmental and social costs, which hampers transition to other sources of energy.[78] FMAs suffer difficulties that threaten sustainable production practices, such as: insufficient knowledge of the technical teams, lack of monitoring capacity of the Forestry Service, sustainable management rules (units and prices) are not being respected and competition for land acquisition by agro-businesses.[79, 80]

71. Sawadogo, L, 2006. Adapter les Approches de l'Aménagement Durable des Forêts Sèches aux Aptitudes Sociales, Economiques et Technologiques en Afrique. Le Cas Du Burkina Faso. Bogor: Center for International Forestry Research.
72. Ouédraogo, J, 2012. Le Charbon De Bois: Quelles Opportunités Pour la SNV au Burkina Faso? (Rapport De Stage). Ouagadougou: SNV.
73. DURADEVE Consulting Group, 2011. Formulation Harmonisée des appuis Suédois et Luxembourgeois au secteur de l'environnement: Capitalisation des acquis et des bonnes pratiques en Matière de gestion durable des ressources rorestières. Ouagadougou: Lux-Dev, ASDI, MEDD.
74. (Thiam, 1998b in Kaboré, C, 2002. Aménagement des Forêts au Sahel: Point Sur Vingt Années de Pratiques au Burkina Faso. Direction Générale des Eaux et Forêts. Ouagadougou.
75. Ministère de l'Environnement et du Cadre de Vie, 2004. Contribution Du Secteur Forestier à L'économie Nationale et à la Lutte Contre La Pauvreté . Ministère de l'Environnement et du Cadre de Vie. Ouagadougou.
76. Burkina Faso, 2007. La Filiere Bois Énergie Au Burkina Faso. Ouagadougou.
77. Ouédraogo, B, 2006. Household Energy Preferences for Cooking in Urban Ouagadougou, Burkina Faso. Energy Policy 34(18): 3787-3795.
78. Ouédraogo, B, 2007. Filière Bois d''Énergie Burkinabé: Structuration des Prix et Analyse de la Répartition des Bénéfices. Bois et forêts des tropiques(294): 4.
79. Burkina Faso, 2007. La Filiere Bois Énergie Au Burkina Faso. Ouagadougou.
80. Sawadogo, L, 2006. Adapter les Approches de l'Aménagement Durable des Forêts Sèches aux Aptitudes Sociales, Economiques et Technologiques en Afrique. Le Cas Du Burkina Faso. Bogor: Center for International Forestry Research.

Box 4: The Mampu Project: Agroforestry for charcoal supply to Kinshasa [81, 82]

The Mampu plantation of 8,000 ha of *Acacia auriculiformis* is the largest plantation for urban wood-fuel supply in DRC. From 1995 onwards, the original reforestation scheme was divided into 25-hectare plots dedicated to 320 farming families with funding from the European Union and support from the Hanns Seidel Foundation. The separate plots function on a system of rotational tree plantations combined with agroforestry. Total charcoal production from the plantation varies from 8,000 to 12,000 tons per year, in addition to 10,000 T/year of cassava, 1,200 T/year of maize and 6 T/year of honey. This 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. The annual value of charcoal from the Mampu plantation is estimated at USD 2.6 million, with owners of the agroforestry plots earning at least a quarter. Since 2009, farmers have official land titles and a farmers union manages the plots independently. Key lessons learnt from the project are that land rights need to be taken into account together with testing and applying diversification of income generating activities and production processes. In this way it can support not only urban energy needs but also meaningful local development. The Hanns Seidel Foundation is currently implementing a new farmers' plantation on the Batéké plateau called 'N'tsio', where it will integrate different tree species and various income-generating activities.

(2) Increased energy efficiency of carbonisation

- Increasing the energy efficiency of carbonisation is one of the solutions with the highest potential for reducing GHG emissions.[83] Charcoal kilns in Africa are often traditional earth kilns with low energy efficiency. Improving kiln technology and technical skills on how to build kilns could improve these efficiencies and diminish the amount of wood-fuel needed. This involves the introduction of improved carbonisation techniques, materials and skills. The relative high energy-efficiency (29 per cent compared to an average 15 per cent) of charcoal kilns at the Congolese Plateau Bateke is mainly attributed to the skills and past training of the experienced charcoal producers. Factors that influence the efficiency are the way and direction the wood is piled; the size and humidity of the wood, and; the monitoring of airflow during carbonisation.[84] In traditional kilns, half of the wood energy is lost in pyrolysis gases. Cogeneration of heat and electricity from these pyrolysis gases can reduce the

81. Boulogne, M., A. Pennec, et al, 2013. Évolution du Couvert Végétal et des Stocks de Carbone Dans le Bassin d'Approvisionnement de Kinshasa. in J.-N. Marien, E. Dubiez, D. Louppe and A. Larzilliere (eds) Quand la Ville mange la Forêt, pp. 45-62. France: Editions QUAE.
82. Bisiaux, F., S. Diowo, et al, 2013. Les Plantations Agroforestiere d'Acacia Auriculiformis de Mampu. in J.-N. Marien, E. Dubiez, D. Louppe and A. Larzilliere (eds) Quand la Ville mange la Forêt, pp. 135-148. France: Editions QUAE.
83. AFREA, 2011. Wood-based biomass energy development for Sub-Saharan Africa: Issues and approaches. Washington: The World Bank.
84. Pinta, F., Dubiez, E., Kalala, D., Volle, G., and Louppe, D, 2013. Amélioration de la carbonisation en meule traditionnelle. in J.-N. Marien, E. Dubiez, D. Louppe and A. Larzilliere (eds) Quand la ville mange la foret, pp. 95-106. France: Editions QUAE.

carbon footprint by over 50 per cent and it is a promising technique for rural development in Sub-Saharan Africa.[85]

- Availability of finance to allow the transition to improved kilns, particularly for the poorest households, will be critical for uptake.

(3) Use of alternative wood or biomass

- Improving the use of alternative wood or biomass sources requires tapping into other available opportunities such as (1) the waste wood of timber companies or wood processing industries and (2) the production of charcoal briquettes from charcoal dust, waste wood and alternative biomasses, such as waste from agriculture production. A case in Ghana, which consists of replacing wood energy with a mix of oil palm residue and oil palm kernels as fuel, is reported to produce good results to mitigate wood-fuel related deforestation. SNV has piloted technologies to produce energy from coffee waste in Honduras (see Box 5). A useful tool is available – the Alternative Charcoal Tool – to assess the suitability of a biomass feedstock, technology and market and related production costs: see http://www.btgworld.com/en/references/publications/alternative-charcoal-tool. In addition, SNV is developing a waste to energy guidance manual to help practitioners assess the potential of different agriculture waste for energy production.[86]

Diverting away from wood-fuel production would need consideration of possible alternative income generating activities for those who would lose this livelihood activity.

85. Miranda, R. C. de, R. Bailis and A. de OliveiraVilela, 2013. Cogenerating Electricity from Charcoaling: A Promising New Advanced Technology. Energy for Sustainable Development 17 (2): 171-176.
86. This manual is expected to be completed in Q3 2014 and will be available at www.snvworld.org/redd

Box 5: Coffee waste to energy production and reduced GHG emissions: Honduras

The coffee sector in Honduras is one of the most important sectors for job creation (approximately 1 million jobs along the production chain with 95 per cent produced by smallholders) and foreign exchange generation; in 2011 Honduras was the largest exporter in the region. It was recognised that there was a need to improve environmental performance during wet processing and energy efficiency during dry milling, reducing water consumption and implementing alternative waste treatment for its use as a source of renewable energy. This in turn would reduce the need for wood-fuel for the purposes of energy production.

SNV successfully installed bio-digesters to treat honey waters - a by-product of coffee production - reducing the environmental impact of coffee processing, while producing both a clean source of energy (biogas) and organic fertiliser. A process to use the biogas produced by the bio-digester system to generate electricity for various coffee processing activities is being developed. Small scale coffee producers´ companies ARUCO and La Labor Ecological Coffee Cooperative (COCAFELOL) are participating in this initiative, while VIOGAZ is providing technical support. Implementation of the project has helped reduce 280 tons of CO_2 equivalent per year through the installation of biogas plants (partially through switching away from the use of wood-fuel); reduced water consumption during coffee pulping and washing to 264m^3 per year; and ensured the proper handling of 575 metric tons of pulp and 906m^3 of coffee effluent, resulting from the wet milling of coffee.

Carbon footprints were calculated in order to design a Green Plan which sets out actions to reduce GHG emissions, so that through future activities, COCAFELOL and ARUCO could achieve carbon neutral certification and potentially obtain a better price for their coffee.

Transport and trade

The main categories of interventions to improve outcomes of wood-fuel transport and trade are (4) promoting sustainable transport and trade; (5) more energy efficient trade and transport, and; (6) organisation of the wood-fuel value chain.

(4) Promote and control sustainable transport and trade

- Sustainable transport and trade that promotes wood-fuel from plantation forests and avoids wood extraction from valuable or threatened tree species can be promoted by targeting corruption and violations of sustainable management norms by the different actors along the value chain. This requires raising awareness on rights and responsibilities among all actors, providing sufficient salaries to controlling officials and implementation of other anti-corruption measures or grievance mechanisms (e.g. a hotline).
- Wood-fuel needs to be sold at a price that reflects its true economic cost which reflects the sustainability of supply. Higher prices will stimulate more investment in the sector. However, as indicated before,

the relative costs will invariably fall on the poorest, so supporting measures targeting the poor should accompany any price increases.

- There need to be stiffer penalties for the illegal extraction of wood for fuel, particularly for the illegal extraction of valuable or threatened tree species; this would need to be backed up by stronger enforcement.
- Differentiated taxes could be introduced to stimulate wood-fuel supply from sustainable management practices and/or specific regions. Such a differential tax system was successfully introduced into the rural wood markets in Mali and Niger (see Box 6).

Box 6: Rural wood markets in Mali and Niger: A differential tax system

The domestic energy strategies of Mali and Niger have promoted wood-fuel management by village organisations and granted exclusive rights to communities to sell wood-fuel via rural wood markets. The system of the rural wood market involves a delimited forest with a harvesting quota, a sales point and a management structure.

In Mali, the 95-003 Forestry Law regulates the exploitation, commerce and transport of wood and defines rural management structures and wood-fuel markets. Commercial exploitation of wood-fuel requires a cutting permit. Different taxes are being applied for wood-fuel from controlled wood-fuel markets and wood-fuel from uncontrolled exploitation.[87] The differentiated tax regime linked to sustainability of production zones is an important mechanism to promote sustainable forest management. Local communities can gain rights to exploit forest resources via rural wood-fuel markets, based on a sustainable management plan.

In Niger, the 92-037 Forestry Law sets the legal framework for management of natural forests, the exploitation, commercialisation and transport of wood-fuel and the mechanisms for redistribution of wood-fuel tax revenues.[88] Niger also imposes differentiated taxation based on the status of the supply zone (uncontrolled exploitation and controlled rural wood-fuel markets) and includes" distance from urban centre" as another factor for calculating taxes.[89]

The local participation in resource management, community funds and tax incentives for sustainably produced wood-fuel, have positive outcomes for people's livelihoods and the forest resource base.[90] However, difficulties remain related to complex design, fair distribution of benefits, keeping uncontrolled production out of the market, corruption and lack of monitoring capacity of the Forest Services.[91]

87. Gazull L, Gautier D, Raton G, 2006. Analyse de l'évolution des filières d'approvisionnement en bois-énergie de la ville de Bamako: mise en perspective des dynamiques observées avec les politiques publiques mises en oeuvre depuis 15 ans. Montpellier: CIRAD.
88. PREDAS and CILLS, 2005. La Stratégie Energie Domestique au Burkina Faso. Ministère des mines. Ouagadougou.
89. Ibid.
90. Hautdidier, B. and D. Gautier, 2005. What Local Benefits Does the Implementation of Rural Wood Markets in Mali Generate?. in M. A. F. Ros-Tonen and A. J. Dietz (eds) African Forests between Nature and Livelihood Resources, pp. 191-220. Lewiston: Edwin Mellen Press.
91. Ibid.

(5) Energy efficient trade and transport

- Infrastructure, storage and market facilities should be improved for more energy and cost efficient transportation. Examples of activities that can contribute to this are promotion of sustainable production at minimum distances from urban markets; provision of warehouses to keep the product from deteriorating; and scaling-up and organisation of transport.

(6) Better organisation along the wood-fuel value chain

- The wood-fuel value chain needs to be organised in a way that gives a voice to the many actors involved and that addresses the unequal distribution of power and benefits. Transporters and intermediaries may play an active role in this, as they know both sides of the value chain. There needs to be awareness raising on rights and obligations among all actors and avoiding of regulations that stimulate a monopolistic position of transporters/ traders in determining prices, harvesting practices and qualities *vis a vis* the producers.
- Transporters/wholesalers, producers and consumer groups should be brought together to strategise for sustainable supply. In Burkina Faso, the association of transporters/ wholesalers (*Tiis-la-Viim*) and producers launched common tree plantations some years ago. Though the effectiveness of this initiative is still to be proven, this synergy shows promise.

Consumption

Several options exist at the level of consumption and their outcomes and possible leakages deserve close attention within the context of a low carbon economy. Solutions include (7) wood-fuel efficient technology; (8) fuel switching; and (9) revaluing wood energy within the national energy strategy.

(7) Promote wood-fuel efficient technology

- The use of ICS for higher energy efficiency at the level of consumption should be promoted. These improved stoves need to rely on market mechanisms, be supported with awareness raising campaigns and be adapted to the local context. For example, introduction of the improved dolo cook stove in Burkina Faso shows that there are gains in terms of reducing CO_2 emissions, preserving women's health and increasing their income.
- Other energy efficiency measures such as use of dry wood and use of autocookers/hotboxes to reduce wood consumption should also be promoted.
- Modern techniques, such as cogeneration of charcoal to produce electricity or production of charcoal briquettes for commercial or industrial demand, need to be introduced.
- Major impediments to introducing wood-fuel efficient technology are the upfront costs and the availability of capital to pay for the initial investment. Innovative financing options need to be explored. SNV is currently exploring financing options to support the uptake of renewable energy technologies. This is first being piloted in Nepal.[92]

92. The SNV report on innovative financing and renewable energy will be available in Q 2014.

(8) Fuel switching

- Facilitating the transition to other types of energies, based on proper information on costs and benefits as well as emission comparisons, is important. LPG, ethanol gel and biogas are potential household fuels that reduce not only GHG emissions but also negative health impacts. Such a transition needs to be supported by awareness raising campaigns and (temporary) subsidising policies (prices, quantities, up-front costs), with special consideration given to energy access by poor households. With regard to local industries, the dolo gas stove for the local millet beer breweries in Burkina Faso offers an interesting example that eliminates wood-fuel entirely and at the same time underlines how new solutions need to be supported by subsidies and appropriate financial mechanisms (see Box 7).

(9) Revalue the place of wood-fuel in national energy strategies

- It is important to recognise the economic value and the importance of wood-fuel as a source of energy and contributor to energy security of households and businesses.
- The ecological and climatic value of wood-fuel energy as a renewable energy source that can restore degraded land, enhance biodiversity and reduce CO_2 emissions must also be recognised.
- Data on wood-fuel consumption, which includes quantification of costs, livelihood benefits and CO_2 emission savings from demand side interventions, should be collected.

Box 7: Dolo gas stoves in Burkina Faso[93]

Brewing of dolo, or millet beer, is a wide-spread practice of deep cultural significance and an important source of revenue for women entrepreneurs. It is also considered to be a leading cause of deforestation, possibly ahead of agriculture and bush fires in Burkina Faso. It is estimated that 65 per cent of all wood-fuel in Ouagadougou is burned for the production of dolo.

For the past three years, the Ministry of Mines and Energy of Burkina Faso has promoted the use of dolo gas stoves in Ouagadougou, as part of the Energy Access Project (PASE). Other institutions or organisations that have been supporting this initiative are UNDP/GEF, SNV, Total and SODIGAZ. The project aims to replace use of wood-fuel by gas in millet beer breweries. Over the past three years, 11 gas stoves have been introduced in dolo breweries in Ouagadougou to test the effectiveness and efficiency of the technology.

Women from the coordination unit of the dolotiere associations of Ouagadoudou (CAD/K) have been involved in the pilot to compare the use of the gas dolo stoves with the use of the improved wood-fuel dolo stoves. The gas stove provides a continuous energy flow, which helps women to save time for other activities. Another important advantage of gas stoves is the absence of smoke, which reduces pollution and health issues. In the context of Ouagadougou, where wood-fuel is expensive, the women estimate that use of gas is two times more cost-effective than wood-fuel (USD72 vs. USD34 for one preparation of dolo). However, the dolo gas stove needs a large initial investment (the cost for one gas stove is USD7200 i.e., USD50,000 for one brasserie with seven units), which is a major obstacle for the dolotieres. Appropriate financial mechanisms to assist spreading the up-front costs would help to extend the technology to the estimated 2500 members of the CAD/K in Ouagadougou and its surroundings.

3.2 Assessing the impact of interventions along the wood-fuel value chain

This list of nine intervention areas provides general options which will support sustainability within the wood-fuel value chain. The impact of the (combination of) interventions will differ depending on the context in which they are introduced. While it is not possible to say which intervention is most appropriate until a deeper understanding of the wood-fuel value chain is achieved, experience has shown that changes at the supply end tend to have the most potential in terms of reduced emissions from forest degradation and improved livelihoods for the poorer segments of the population.

In order to provide a general understanding of the impact of each of these nine intervention areas (in terms of reducing forest degradation and providing co-benefits) we can apply the

93. The information was provided by SNV Renewable Energy Advisor

3E approach[94] which has been applied in the context of REDD+ to assess the effectiveness, efficiency and equity of any intervention. The leading questions are:

a. How well can the intervention achieve GHG emission reductions (effectiveness)?

b. How cost efficiently can this target be achieved (efficiency)?

c. How fairly are costs and benefits distributed (equity)?

Each question is underpinned with criteria meant to support the assessment of a proposed intervention (see Table 3). To enable comparison of interventions a simple ranking can be used (high, moderate, low or 3, 2, 1), supplemented by qualitative information. A general overview of the ranking of the nine intervention areas using the 3E approach is shown in Table 4. This could be carried out in greater detail in a more participatory manner as part of any wood-fuel value chain assessment. Alternatively other impact assessment frameworks could be applied.

94. Angelsen, A. and Wertz-Kanounnikoff, S, 2008. What are the key design issues for REDD and criteria for assessing options? pp. 11-22. In. Angelsen, A. (ed.) 2008 Moving ahead with REDD: Issues, options and implications. CIFOR, Bogor, Indonesia. The 3E Principle (originally proposed by Stern, 2008 and further developed by CIFOR) and can be applied to: (1) assess proposed options and expected outcomes of an intervention; (2) evaluate actual outcomes of an intervention Evaluation requires a separate impact assessment and is beyond the scope of this paper. This paper focuses on assessing and choosing options for interventions.

Table 3: Criteria to support 3E assessment[95]

Carbon Effectiveness		Cost Efficiency	
Criteria	Explanation	Criteria	Explanation
Depth and additionality	Additionality requires reductions to be additional to what would occur in the absence of REDD. This needs to be "worth it" in relation to the other criteria and significant enough to assume lasting impact.	Start-up (upfront capacity-building) costs	Costs of setting up a REDD scheme, including establishing technical infrastructure and governance structures, and training and capacity building can be relatively high, so a certain scale is required to ensure a return on investment.
Breadth/scope	The scope needs to be wide enough to capture all major parties that influence the value chain.	Running costs (forest protection costs)	Operational costs of a REDD regime should –besides monitoring – budget for implementation of policies and measures, such as forest law enforcement and tenure reforms.
Flexibility and robustness	Ability to adapt to meet both diverse local conditions and unknown future changes at all scales. Potential trade-offs between flexibility and robust-ness need to be considered.	Landowners' opportunity costs	Opportunity costs are the foregone economic benefits from the best alternative (non-forest)land uses, e.g., the minimum amount a landowner must be paid to be willing to stop deforestation and forest degradation.
Verifiability	Verifiability depends on (i) the technology used to make accurate and complete measurements; and (ii) the capacity to carry out such measurements.	Landowners' transaction costs	To participate in the REDD scheme, the landowner is likely to incur additional costs (e.g. put up fences, get certified), which need to be factored into the compensationpayments.
Displacement of emissions (leakage)	Generally, the larger the scale and the broader the scope of REDD, the lower the risk of leakage.		
Permanence and liability	Permanence relates to ensuring long-term reductions, i.e. avoiding emissions reductions that are simply postponed for a short period of time.		
Effect on other mitigation measures	REDD efforts need to be designed in such a way that they do not come at the expense of other climate mitigation measures.		

95. Sources: Angelsen, A. and Wertz-Kanounnikoff, S. (2008). What are the key design issues for REDD and criteria for assessing options? pp. 11-22. In. Angelsen, A. (ed.) 2008 Moving ahead with REDD: Issues, options and implications. CIFOR, Bogor, Indonesia; Hofstad, O., Köhlin, G., Namaalwa, J. (2009). How can emissions from wood-fuel be reduced? In. Angelsen, A. (Ed.) Realising REDD+ National strategy and policy options. Bogor: CIFOR; Graham, K. (2011). REDD+ and energy: a cross-sectoral approach to REDD+ and implications for the poor. REDD-net/ Overseas Development Institute.

Equity & Co-benefits	
Criteria	Explanation
Fair distribution	This relates to the ability to participate in a REDD scheme and not penalising early action or rewarding bad policies. It also relates to equitable distribution of costs and benefits across parties.
Effects on local and indigenous communities	Traditional rights need to be recognized and –if present- indigenous communities need to be included in the REDD decision- making process.
Economic development and poverty reduction	REDD may enable or constrain economic development and effect those economically dependent on forests as well as national economies as a whole.
Biodiversity	Carbon and biodiversity aims are largely compatible, but there could be trade-offs, for example, in the geographical targeting of funds (biodiversity and carbon hotspots may not overlap).
Rights and forest governance	REDD has the potential to improve forest governance and rights, e.g. through more transparent forest information systems. But, it also entails risks such as when the potentially large sums of money generated by REDD triggers corruption, mismanagement and capture by elites.

Table 4: Assessing interventions in the wood-fuel value chain and using the 3E approach[96]

Step of value chains	Intervention	Effectiveness	Efficiency	Equity
Production and processing	Improve management of tree resources	High	Low to moderate depending on costs of enforcement	Positive if includes local community groups, including landless
	Increase energy efficiency of processing	Moderate	Moderate	Require upfront costs for investment; should reduce costs over longer term
	Use alternative wood/biomass source	High	Moderate	
Trade and transport	Control for sustainable trade	High, depending on enforcement	Moderate to high; depends on good governance of tax revenues	Permits often restricted to wealthier/powerful actors; producers bear costs of sustainable production
	Efficient trade and transport	Moderate	Low	Needs capital for investment
	Organisation of the value chain	High to moderate	Moderate	Positive so long as less powerful groups included
Demand	Increase energy efficiency of consumption	Moderate	High	Needs capital investment
	Fuel switching	High for clean energy; low for fossil fuels	Low for clean energy; moderate for fossil fuels	Needs capital investment and price subsidy
	Revalue wood energy in national policy	High	Moderate	Development objectives need to be included

Identifying interventions implies the need to better understand any associated risks of introducing the options and to put in place enabling institutional conditions that help in managing these risks. This issue of potential risks and necessary enabling institutional conditions are further examined.

96. Sources: Angelsen, A. and Wertz-Kanounnikoff, S. (2008). What are the key design issues for REDD and criteria for assessing options? pp. 11-22. In. Angelsen, A. (ed.) 2008 Moving ahead with REDD: Issues, options and implications. CIFOR, Bogor, Indonesia; Hofstad, O., Köhlin, G., Namaalwa, J. (2009). How can emissions from wood-fuel be reduced? In. Angelsen, A. (Ed.) Realising REDD+ National strategy and policy options. Bogor: CIFOR; Graham, K. (2011). REDD+ and energy: a cross-sectoral approach to REDD+ and implications for the poor. REDD-net/ Overseas Development Institute.

3.3 Risks

The sustainability of the wood-fuel value chain will in large part be determined by institutional and policy factors. It is therefore critical to understand the institutional factors shaping the wood-fuel value chain. In general, the sector is perceived as one that lacks coherence or misses an inclusive supply-demand planning, and is rather steered by fragmented approaches and conflicting statutory and traditional rules. Legal options for more sustainable wood-fuel management do exist, but implementation remains insufficient. The wood-fuel value chain is characterised by the presence of many actors, informal practices and unequal distribution of benefits. At the level of the government, there may be a lack of collaboration between the relevant ministries (environment, agriculture, energy) and competition is rife. Under-paid officials conducting market and road checkpoint controls are unmotivated to enforce the official permit system. Intermediaries providing logistical support in markets secure their profit margin by avoiding or negotiating market taxes, contradicting or bribing the efforts of tax collection officers.

General difficulties related to interventions in wood-fuel value chains include investment costs, the complex socio-economic and cultural issues around traditional biomass use and the transaction costs associated with providing equipment and guaranteeing reliable wood-fuel supply. The unsecure land tenure and competition of land use for agro-businesses and for growing food crops is a major risk to long-term investments for managing wood-fuel resources. The vested interests and opportunities for rent seeking and general difficulties in distinguishing sustainably produced wood-fuel from uncontrolled production are impediments to improving sustainable trade. Understanding institutional mechanisms of formal and informal wood-fuel management and broader systems are key in mitigating these risks.

Wood-fuel policies are generally less focused on including developmental objectives and considering the livelihoods of those involved in production and trade. In general, it is expected that wood energy needs will keep increasing in the context of urbanisation and population growth. This means higher prices, especially when measures for more sustainable wood-fuel supply translate into higher costs. These relative costs will fall heavily on the poorest groups who need to be supported in order to be able to afford access to renewable energy sources. New rules and types of organisation of the sector need to consider changes that affect the poor, as they could risk exclusion. Diverting away from wood-fuel production would need consideration of possible alternative income generating activities for those who would lose this livelihood activity.

In order to align sustainability of the wood-fuel value chain with efforts currently under the REDD+ mechanism there remains the risk related to how the REDD+ mechanism will be structured and what funds will flow through it. For instance, the bodies in charge of managing funds, registry for carbon and social and environmental safe-guards are still to be created in most countries. To date, few REDD+ earmarked funds have been provided to support actual activities that can lead to reduced emissions at the subnational level. If this continues there is the risk that the REDD+ process will be undermined.

3.4 Institutional conditions to mitigate risks

Specific institutional requirements to overcome risks to the sustainability of wood-fuel supply chains include:

- Implementation of a clear legal framework to formalise wood-fuel value chains that builds upon pro-poor benefits of existing community systems and regards development objectives (for the many people involved) as well as environmental objectives.
- The ability of national governance structures to address land tenure issues, handle grievances and redistribute benefits to value chain actors.
- Enhancing technical skills and supporting rights and use of communities to manage the forest land have often proved successful in promoting more sustainable forest management.[97]
- Revision of wood and charcoal taxation in order to make it transparent, equitable and an incentive for the different actors in the value chain to produce sustainably (differentiated taxes for different products).
- A coherent approach and cooperation between the ministries involved: security and sustainability of wood-fuel needs to be integrated into relevant sectoral policies such as in those dealing with land planning, decentralisation, poverty and energy. Wood-fuel policies need to be coherent with those on food security, poverty reduction and energy access.
- Reinforcement of the capacity of the different structures monitoring and representing interests within the value chain, including the planning and regulation capacity of forestry services.
- Baselines to monitor both carbon flux and the impact on the poorest groups. Collect quality data on the supply and demand of wood-fuel, stratified by socio economic status and population density of actor groups. This needs to include quantification of related CO_2 emissions.
- A benefit sharing mechanism that is effective, transparent and equitable in transferring money to producers.
- Involvement of private sector and markets in designing technological improvements, such as improved technologies during the carbonisation and cooking process.
- Improved access to finance, particularly for the poorest, to allow them to overcome the initial costs of moving to improved (and ultimately cost saving) technologies.
- In order to realise sustainability of the wood-fuel value chain as a major component of a countries REDD+ strategy requires the following institutional requirements: capacity to generate data and monitor management practices (and GHG emissions) at the production and consumption level; transfer of management power and capacity to local levels; well-functioning groups and structures involved in the value chain; and a coherent supply-demand wood-fuel policy linked to REDD+.

97. Pagdee, A., Y. Kim, and P.J. Daugherty. 2006. What Makes Community Forest Management Successful: A Meta-Study From Community Forests Throughout the World. Society and Natural Resources 19:33-52.

It is possible to examine the typical risks and institutional conditions necessary to overcome these risks at the different steps along the wood-fuel value chain (see Table 5). An example of risks and efforts to overcome these are shown for Burkina Faso in Box 8.

Table 5: Steps of the value chain, major risks and institutional conditions to mitigate risks

Step of value chains	Intervention	Major risks	Institutional conditions
Production and processing	Improve management of tree resources	• Other drivers of deforestation; wood-fuel is combined with other drivers • Unsecure access and tenure rights • Competition of land use for other sectors • Loss of livelihood activities; reduced participation by poorest	• Baseline and date to monitor changes in forest areas (GHG emissions); impacts on poor • Support for participatory forest management • Providing tenure rights • Appropriate benefit sharing mechanism
	Increase energy efficiency of processing		
	Use alternative wood/biomass source		
Trade and transport	Control for sustainable trade	• Regulation can exclude groups and distort market • Conflicts of interest over tax revenues • Difficult to keep free riders out of the system	• Monitor capacity of local management units and forest services • Associations which effectively represent different actor groups (including the poor) • Framework for dialogue between actor groups
	Efficient trade and transport		
	Organisation of the value chain		
Consumption	Increase energy efficiency of consumption	• Higher prices for consumers • Increasing energy needs (urbanisation and population growth) • Emission balance of fuel switching can be negative • Uncertainties of adopting new technologies	• Coherent wood-fuel policy based on supply/demand and sustainability • Monitoring and data on consumption • Effective technology extension agencies
	Fuel switching		
	Revalue wood energy in national policy		

Box 8: Potential risks and institutional conditions to mitigate risks in Burkina Faso

Potential risks	Institutional conditions to mitigate risks
Burkina Faso faces uncertainties in the REDD+ policy process and therefore outcomes of the REDD+ mechanisms are not clear. The unsecure land tenure prevents clear rights and responsibilities of those groups involved in the wood-fuel value chain. Competition of land use for agro-businesses and for growing food crops is a major risk to long-term investments for managing wood-fuel resources. The vested interests in bribery of transporters and traders, and general difficulties in distinguishing sustainably produced wood-fuel from uncontrolled production, are impediments to improving sustainable trade.	Burkina Faso is developing a national REDD+ architecture, although it still needs testing, improving and completion. It is also seeking alternative sources of financing for reduced emissions from carbon markets and Nationally Appropriate Mitigation Actions (NAMAs). Burkina Faso is in the process of reviewing its legal framework to formalise wood-fuel value chains. While this may take time at a national level, the government's agreement to pilot a local approach with wood-fuel transporters ("marchés du bois", or "wood markets") is indicative of a pro-active approach. SNV is supporting efforts to re-discuss wood taxation in order to make it transparent, equitable and an incentive for the different actors in the value chain to produce more sustainably (differentiated taxes for different products).

Section 4

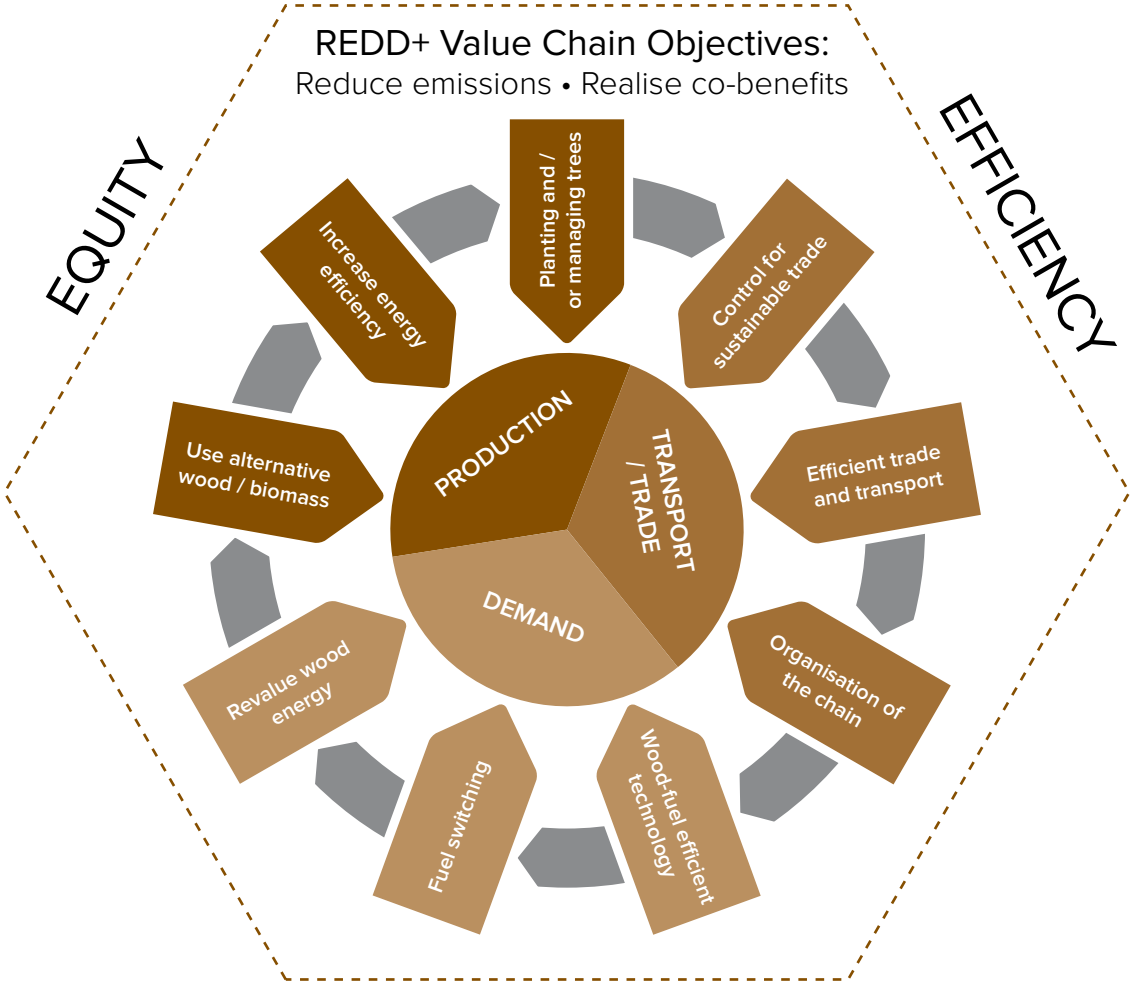
An approach to design sustainable ‘REDD+ friendly’ wood-fuel value chains

Based on the three steps outlined in this report and the associated challenges and solutions identified, a basic model has been developed to facilitate design of REDD+ - friendly wood-fuel value chains. This can assist policy makers and practitioners to take on an inclusive approach to different steps of wood-fuel value chains, to identify possible solutions, risks and institutional requirements and to target their interventions in ways that achieve greatest benefits in terms of reduced degradation of forested areas and greatest benefits to the poorest communities. Figure 3 depicts the REDD+ compatible wood-fuel value chain model.

Figure 3: Overview of the REDD+ compatible wood-fuel value chain approach

REDD+ Outcomes (Co-benefits)
Reduced poverty
Enhanced livelihoods
Reduced vulnerability
Enhanced access to renewable energy

REDD+ Outcomes (Emissions control)
Reduced emissions
Carbon conservation
Enhanced carbon stocks Sustainable management of forests



Risks

Insecure land tenure
Competition with agriculture
Conflict with short term objectives / immediate needs

Regulation can cause market distortions and exclusion
Conflict of interest over tax revenues and keeping "free riders" out of the system
Higher prices for end users (households)

Increasing demand
Potential for negative emission balance when switching fuels
Uncertainties in adopting new technologies

Institutional conditions (risk mitigation)

Secure tenure rights
Transferal of management rights to local level
Baseline and data for carbon monitoring Benefit sharing mechanism

Capacity of local management units and forestry officials
Associations that effectively represent benefits of actors
Promote dialogue framework of actors

Coherent policy on wood-fuel supply / demand
Data and monitoring mechanism on consumption
Effective institutions for technology extension

Section 5

Conclusion

The extraction of wood for fuel has been identified as one of the principal drivers of forest degradation in national programmes on REDD+, particularly for Sub-Saharan Africa. The sector lacks coherence and is steered by fragmented approaches, and its value chain is characterised by the presence of many actors, informal practices and often unequal distribution of benefits. This often leads to unsustainable extraction.

SNV has developed an approach that can assist policy makers and practitioners to better understand the wood-fuel value chain and to target interventions in ways that contribute to reducing forest degradation and which improve the livelihoods of those communities involved in the sector. While this approach may have wider application, the focus is Sub-Saharan Africa. The approach follows three basic steps: firstly, to understand the main actors along the wood-fuel value chain; secondly, to identify the key issues which preclude sustainability of the wood-fuel value chain; and thirdly, to identify interventions to address sustainability along the value chain. Based on these three steps a basic model has been developed to facilitate design of interventions to ensure a more sustainable wood-fuel value chain. The approach aligns with national REDD+ objectives to assess how interventions could contribute to reducing emissions from deforestation and forest degradation while improving co-benefits for the many actors involved.

SNV plans to apply this approach in different contexts and countries to support the sustainability of their wood-fuel sector. It is expected that through further application it will be refined and updated in subsequent versions.

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