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Wood Energy

Renewable, profitable and modern

Published by: Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

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Content

Introduction

For millennia, wood served as the sole source of energy for humankind. During the course of industrialisation, wood energy was supplemented by fossil fuels and, in the recent past, nuclear power on a grand scale. However, wood still remains the principal fuel in developing countries – owing to the mounting scarcity of fossil fuels coupled with growing concerns about climate change – and it has regained a great degree of significance in many developed countries. In Europe, for example, the demand for wood energy is set to more than double by 2020. Demand is expected to overtake potential supply sometime between 2015 and 2020, likely requiring imports from other regions of the world *[10]*.

The increasing demand for wood energy, especially by urban consumers in developing countries, places heavy pressures on forest resources. Undervaluation of wood fuels translates into wasteful and inefficient production and consumption practices, and creates a formidable disincentive for forest management and tree cultivation.

Many developing countries' national policies and energy-sector programmes tend to consider wood-based fuel as a 'backward' and ecologically risky energy source, and seek to discourage its use, and/or mitigate its prevalence. Consequently they seek to replace wood energy with fossil fuels as soon as possible.

Technological advancements over the last decades in the production and conversion of wood into both heat and electrical power have removed many of the barriers to the expanded use of wood as a clean and renewable energy source. Renewed interest in wood energy is largely being driven by social, economic and environmental concerns – which are finally being recognised and valued even within international initiatives and organisations.

Modernisation of the wood energy value chain in developing countries must be matched with progressive policies to foster the potentials of biomass for poverty alleviation and sustainable rural development. One vital condition for approaching sustainability in development is for wood resources and environmental services not to be undervalued or underpriced; a condition that is frequently violated in practice. Appropriate incentives for sustainable forest management (SFM) by local wood energy producers along with the introduction of more efficient conversion and combustion technologies would help maintain existing forest resources and even create new ones.

The key message for policymakers is: Give wood energy a fair chance in the energy mix of your country in order to make the world a more sustainable and more environmentally friendly place.

Key Advantages of Wood-based Fuels

1.0

- **1.1** Wood energy is widely used and renewable
- **1.2** Sustainable wood production safeguards forest functions
- **1.3** Wood energy is available locally
- **1.4** Wood energy provides employment and income
- **1.5** Wood energy supports domestic economies
- **1.6** Wood energy is modern and leads to innovation
- **1.7** Wood energy can make a country independent of energy imports

1.1 Wood energy is widely used and renewable

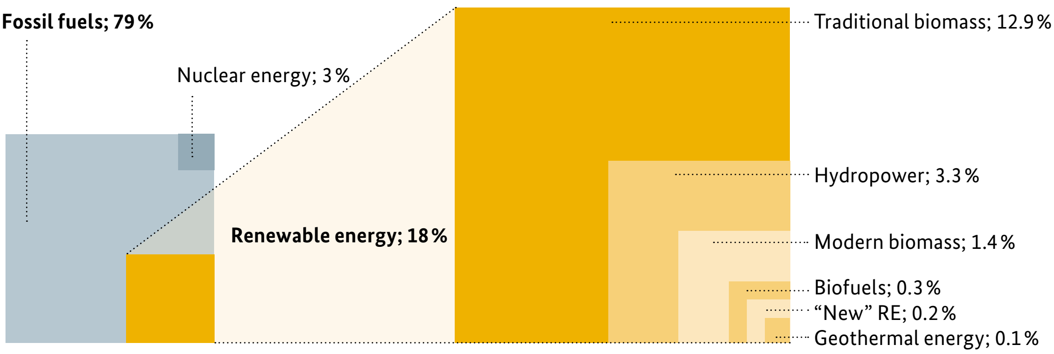
I. Wood is the most widespread renewable source of energy

- Renewable energy (RE) accounts for 18 % of the global energy supply; nearly 13 % of this can be attributed to traditional biomass*.
- Wood energy accounts for more than 80 % of household energy consumption in many developing countries (93 % in Burundi, 93 % in the Dominican Republic, 97 % in Bhutan, 80 % in Paraguay, 92 % in Nepal) [11].
- Within the EU, wood comprises 58 % of energy from renewable sources (Germany 41 %).
- About one half of the global round-wood production is used for fuel (1.8 billion m^3) [12].
- By 2030, roughly 2.7 billion people in developing countries will depend on wood as a fuel.

Projection of dependence on woodfuel (millions of people) by 2030 [3]

	2004	2015	2030
Sub-Saharan Africa	575	627	720
North Africa	4	5	5
India	740	777	782
China	480	453	394
Indonesia	156	171	180
Rest of Asia	489	521	561
Brazil	23	26	27
Rest of Latin America	60	60	58
Total	**2 528**	**2 640**	**2 727**

Structure of the global energy supply in 2006 [2]

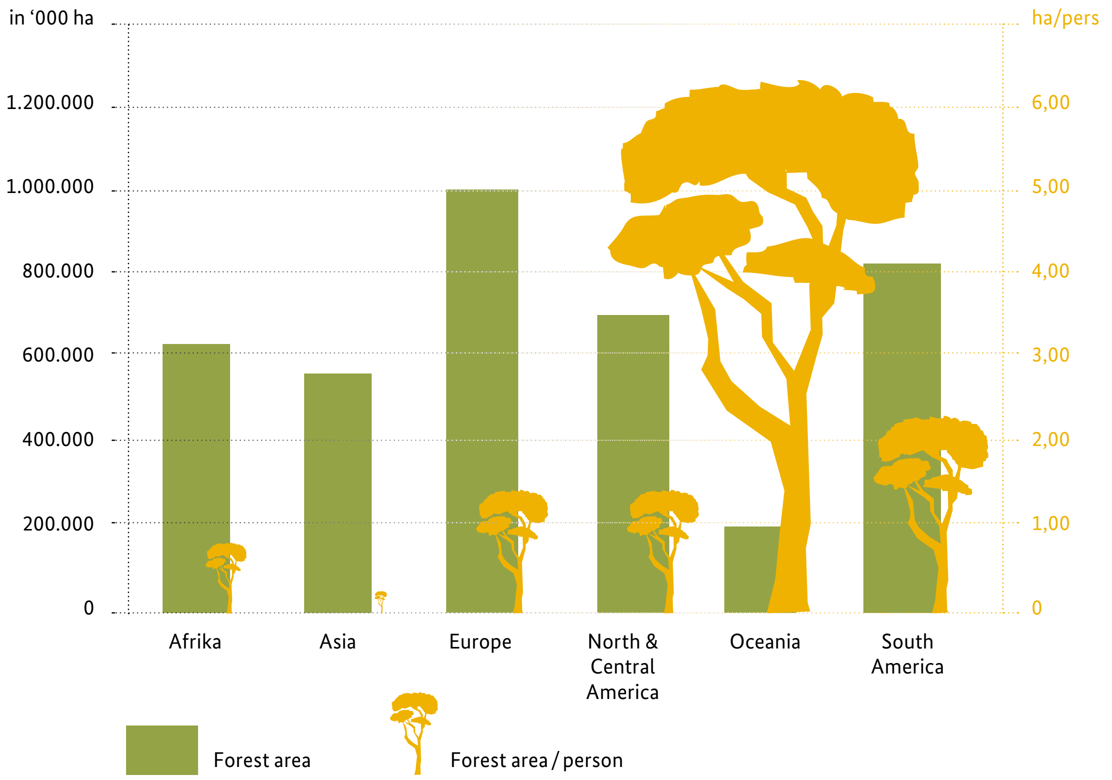


* Note that although wood energy can be a renewable energy resource, the management regimes in many countries prevent it from becoming sustainable. According to the FAO, 13 million hectares of forests are destroyed annually through human activities [4].

II. Wood resources grow everywhere – within and outside forests

- Nature produces about 170 billion tonnes of biomass annually, equivalent to 25 times the annual production of crude oil.
- Worldwide, forests cover about 4 billion hectares (40 million km^2) or 30.3 % of the total land area [4].
- According to a range of studies, the annual surplus wood supply* from forests is estimated to be between 0.3–1.4 billion m^3 [12] compared to the current global demand of 1.8 billion m^3.
- In Asia, where the forest area per inhabitant ratio is low, trees grown outside of forests (TOFs) account for upwards of 50 % of the wood energy used [13]. Whereas on a global scale 30 % can be assumed [14].

Total forest area per region and per person [4]

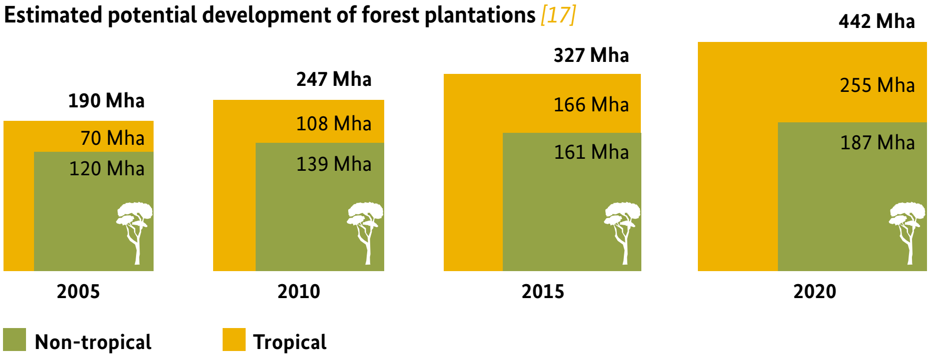


* Differences in the figures originate from various reduction factors applied to the global theoretical potential of surplus wood supply by different authors. The reduction factors are determined by technical, economic and ecological considerations and exceed 85 % of the theoretical potential when combined.

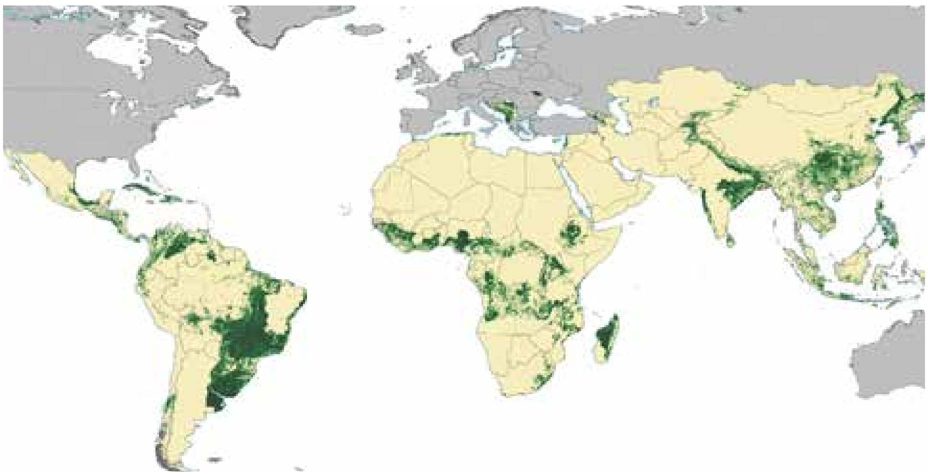
III. There is important dormant potential for wood production

- In developing countries, areas with potential for afforestation amount to 750 million hectares (= 7.5 million km²) [15].
- In recent years, the broader significance and importance of planted forests have been recognised internationally. Standards for their responsible management have been established, carrying social and environmental as well as economic benefits [6].
- Large tracts of suitable land can be found in South America (46 % of all suitable areas globally) and Sub-Saharan Africa (27 %).
- Utilising this land could ensure sustainable energy supplies for more than 3 billion people annually.
- Each additional hectare of forest also has carbon mitigation potential in that it absorbs an average of 10 tonnes of CO_2 annually [16].
- Afforestation on this scale would have the potential to offset the annual global increase in CO_2 and other GHGs [16].
- The importance of forest plantations will increase over time.

Estimated potential development of forest plantations [17]



Global map indicating suitable land with potential for afforestation and reforestation (AR) (dark green) [15]

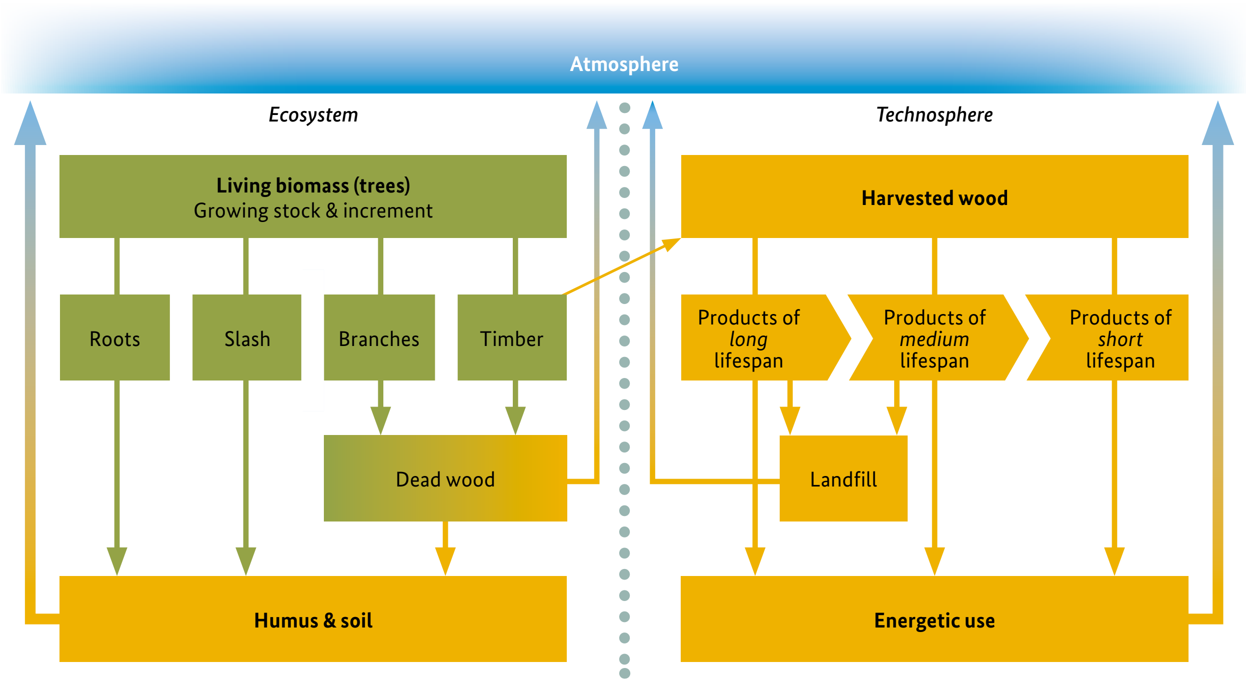


1.2 Sustainable wood production safeguards forest functions

I. Sustainably sourced wood energy achieves carbon sequestration

- Substituting a fossil fuel with sustainably produced wood offsets 2–3 kilograms of CO_2 for each kilogram of fossil fuel.
- Consumption of sustainably sourced wood energy is likewise carbon-neutral. Burning wood does not releases any more CO_2 than was absorbed during a tree's life cycle. The same amount would have been released through natural decay if the wood was left to rot in the forest.
- Wood-fuel is an environmentally friendly, low-risk energy carrier; it fosters safe handling and storage and has short transport distances.
- Sustainably sourced wood-fuel can be promoted through carbon funding instruments.

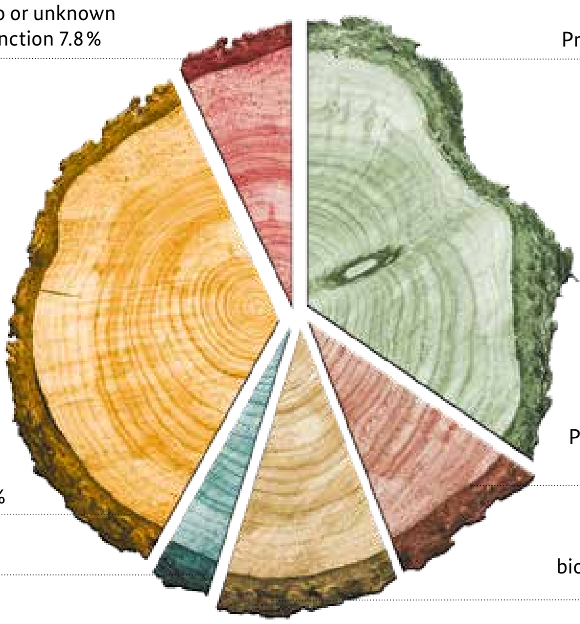
Forest biomass and wood products in the carbon cycle [18]: *Deforestation accounts for up to 20 percent of the global greenhouse gas emissions that contribute to global warming.*



II. Wood fuel production safeguards forest resources and promotes multiple uses

- Woodfuel production creates an incentive for sustainable forest management (SFM). In many cases, the use of wood for energy can provide an economic basis for taking care of land in forests.
- Sustainably managed forests provide added value:
  - Soil protection: Forests protect soils against erosion, prevent floods through enhanced water retention, lock-up large quantities of carbon in rich and intact forest soils, and generally enhance the structure and functional integrity of top-soil layers.
  - Ecosystem support: Micro-climatic benefits (protection against high winds, mitigation of extreme temperatures); provision of habitats for fauna and flora (conservation of biological diversity); purification of air and water, release of oxygen.

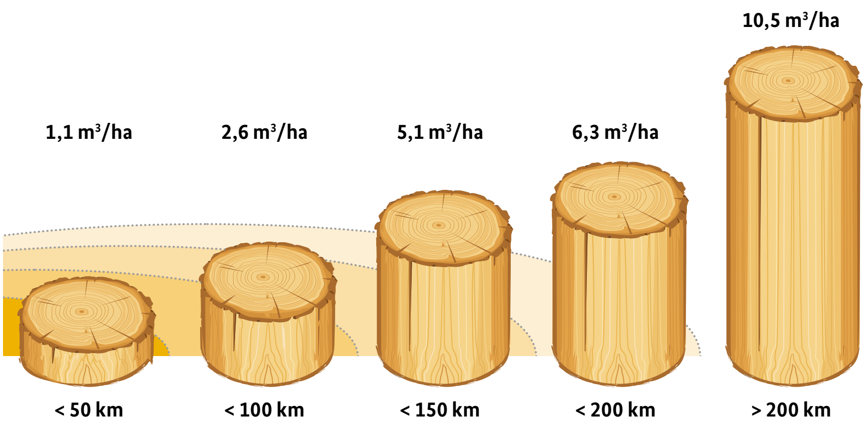
Designated functions of forests – natural and planted worldwide in 2005 *[4]*



1.3 Wood energy is available locally

- Woodfuel is widely and locally available, ensuring a secure and steady supply of energy when sustainable extraction techniques are used.
- Wood is directly usable as fuel. Wood may, however, undergo further processing before being marketed as fuel, especially in urban settings*.
- Wood lends itself to recycling following primary uses in construction, furniture-making or packaging. Wood residue from saw mills, for example, likewise qualify as a fuel.
- In contrast to solar and wind energy, which are only available during limited times and require energy storage systems, wood energy can be used on demand.**
- Most countries have established markets for wood and wood-based fuels.

Average standing stock around N'Djamena *[7]*

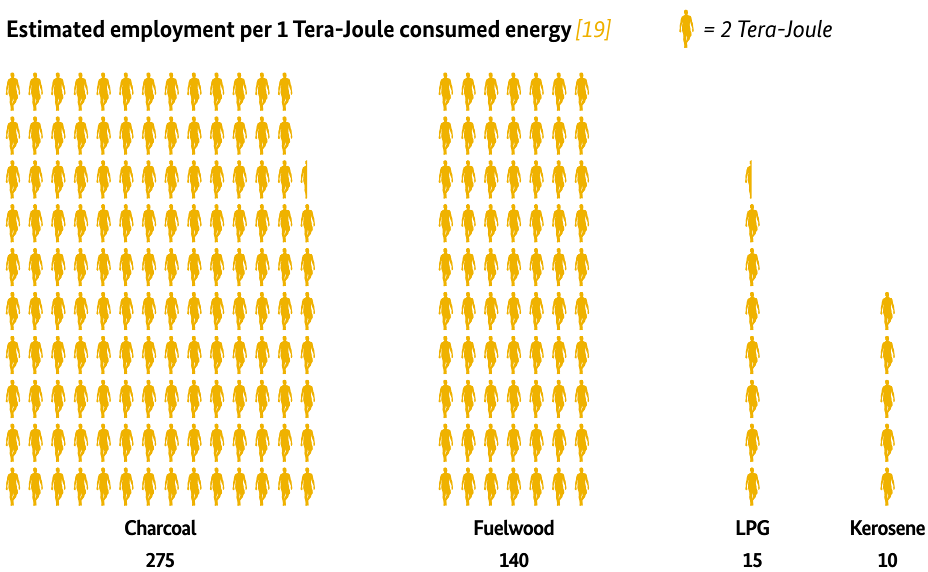


* The three most common forms of wood fuel besides firewood are charcoal, wood chips and wood briquettes or pellets.
** Wood is essentially a form of stored solar energy that is convenient to use.

1.4 Wood energy provides employment and income

- Use of domestically produced and sustainably harvested wood for fuel creates lasting demand for regional goods and services.
- Regional production stimulates employment, especially in economically disadvantaged regions.
- The production, transport and marketing of woodfuel creates employment and income for the rural poor.
- The value of the wood energy sector often outweighs that of a country's main agricultural crops. For example, the revenues of the wood energy sector with appox. 450 Mio. US$ corresponds to the tea industry in Kenya.
- Attempts to replace woodfuel with fossil fuels can reduce employment in the energy sector.

Estimated employment per 1 Tera-Joule consumed energy *[19]*



Examples of people involved in charcoal production and trade *[20–23]*

	Amount of charcoal produced (tonnes)	Value million USD / year	Charcoal producer*	People involved in charcoal trade*
Country				
Kenya	1.600.000	400	200.000	500.000
Malawi	231.177	41	46.500	46.300
Urban areas				
Maputo	130.000	13	20.000	20.350
Dar es Salaam	440.000	44	54.000	71.200
Lusaka	250.000	25	37.000	40.700

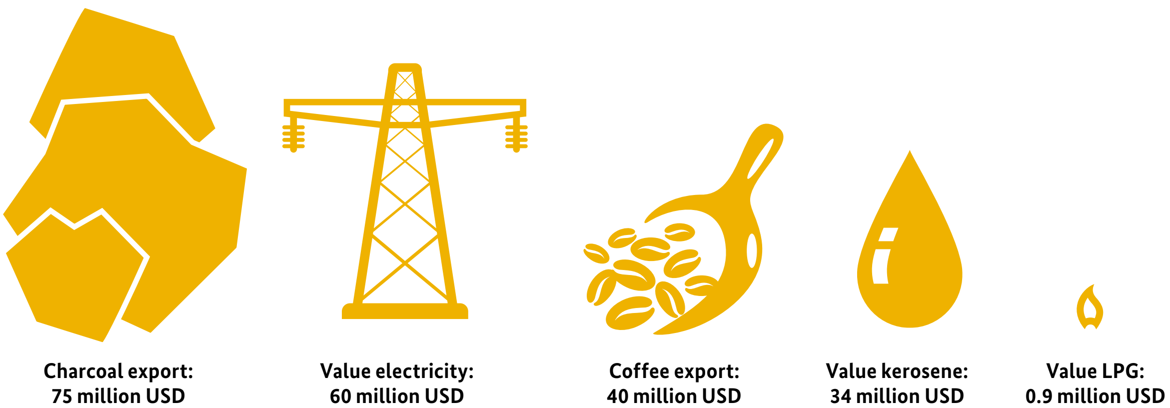
*By including the dependants in each household, the amount of people being supported by the charcoal business can be at least quadrupled

1.5 Wood energy supports domestic economies

- The total value of global woodfuel production is estimated to be in the range of 4 billion to 26 billion USD annually *[24]*. These figures are likely to underestimate its true significance since wood-fuel production mostly remains locked up in the informal sector.
- Wood-fuel production is essentially a localised business, one that boosts commerce, especially in rural areas. By contrast, the use of fossil fuels drains 60–70 % of the money through foreign earnings. Wood energy purchases ensure that 100 % of their value remains in the domestic economy, about half of which directly benefits rural producers.
- Wood-fuel prices are comparatively stable and easily predictable.

Example Rwanda *[25]***:**

Rwanda produces 150,000 tonnes of charcoal annually with an estimated value of 75 million USD. Some 50 % of this value remains in rural areas. For comparison, here are some macroeconomic figures on agricultural export and energy consumption:



1.6 Wood energy is modern and leads to innovation

I. Wood energy can be converted to other useable forms of energy

Wood is an energy carrier that can be converted to produce heat, electricity, transport fuel or in the manufacture of products.

The energy content of wood can be released in two principal ways:

1. Direct combustion: Combustion is a thermo-chemical process in which wood is combined with oxygen and converted into carbon dioxide and water (and other constituents), releasing energy.

2. Gasification or pyrolysis: These are also thermo-chemical processes which convert wood into a gaseous or liquid fuel. The gaseous or liquid fuel is then combusted in a second step to release energy.

A biochemical process converts wood into ethanol, which can be used in vehicle engines for transport applications or for cooking.

II. The wood energy value chain allows for gradual development

	Traditional phase	Transition phase	Semi-industrial phase	Industrial phase
Value chain	**Informal**	**Informal / formal**	**Formal**	**Formal**
Energy planning	none	consumption planning	regional energy master plans	integrated energy planning
Forest management	open access	open access/ sustainable	sustainable/certified	certified
Marketing	unregulated	semi-organised (rural wood-fuel markets)	organised/proof of origin (established markets)	out-grower schemes/ energy-contracting
Conversion and consumption technologies	low efficiency			high efficiency

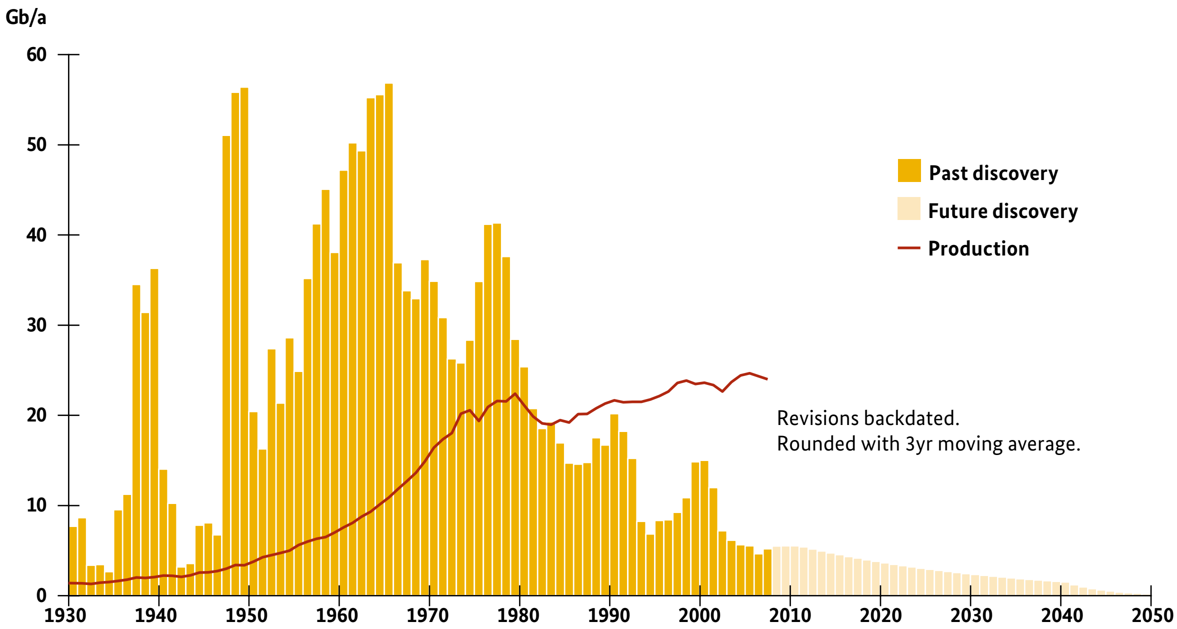
1.7 Wood energy can make a country independent of energy imports

- Among 47 of the world's poorest countries, 38 are net oil importers – the majority of them in Africa.
- Wood energy is a strategic option for increased energy security, particularly in countries that have large forest areas or in areas that are amenable to reforestation and depend on energy imports.
  - It makes communities independent of decreasing oil reserves
  - it makes people independent of international energy prices
  - it provides security in times of crises
  - it keeps energy dollars local to build strong rural economies.

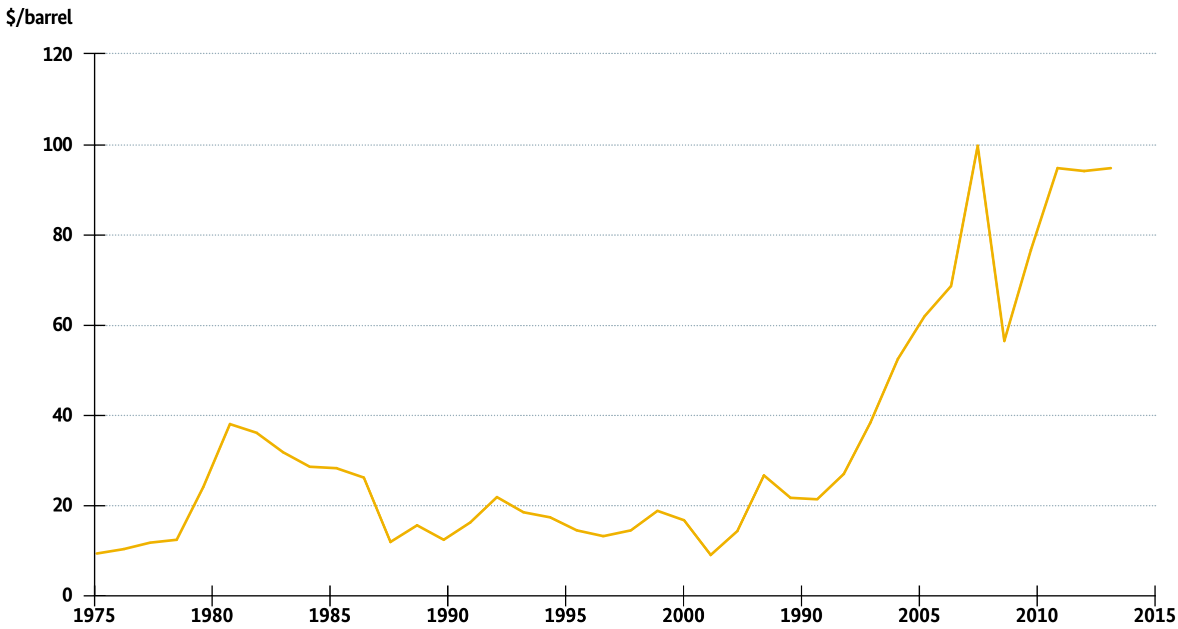
The EU Green Paper 'Towards a European Strategy for the Security of Energy Supply' states that *'If no measures are taken, in the next 20 to 30 years 70 % of the Union's energy requirements, as opposed to the current 50 %, will be covered by imported products'* [8]. Furthermore, the paper quotes *'...transport, the domestic sector and the electricity industry depend largely on oil and gas and are at the mercy of erratic variations in international prices'.* Wood, as an indigenous energy source, can significantly contribute to reducing import dependences and to improving trade balances.

Fossil oil is a finite resource subject to depletion and thus steadily increasing oil prices *[26, 27]*

The growing gap – regular conventional oil



Oil price


$/barrel
120
100
80
60
40
20
0
1975
1980
1985
1990
1995
2000
1990
2005
2010
2015


NO SMOKING

Principal Challenges

2.0

2.1 Political support is needed

I. Energy policies in developing countries must reflect political commitment

Problems

- Most energy policies in developing countries are focused on electrification, whilst wood energy is ignored, discriminated against, or down-played. National budgets bear witness to this fact.
- Baseline data on wood energy demand and supply as well as on wood energy value chains are outdated or simply lacking.
- Inter-sectoral policy coherence is often unsatisfactory.

Action required

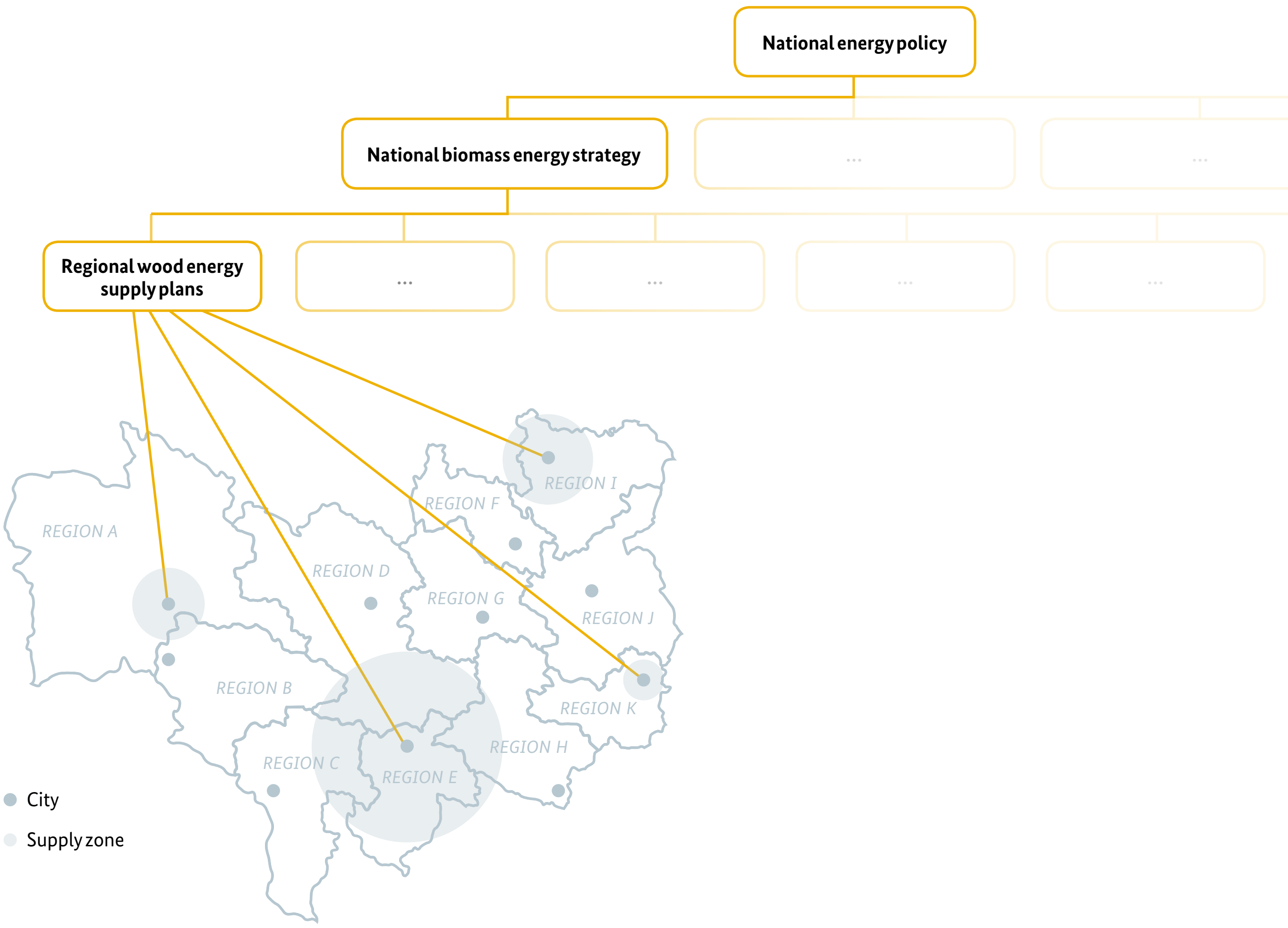
Targeted support to create more enabling pre-conditions, including regulatory frameworks, better informational basis and strategy development.

Impact

- Informed policy decision-making
- integration of wood energy into forest and energy policies and strategies
- public services and supporting agencies operating in line with clear-cut policy guidance and coherent normative frameworks.

II. Energy policies need to be put into operation through strategies and implemented down through the local level

- Energy policies address challenges and set goals for change and should include biomass as part of the future energy mix.
- Biomass energy strategies analyse the different options on how to achieve the goal; they propose appropriate intervention guidelines and set out concrete solutions through/with which goals can be achieved [9].
- Regional wood energy supply plans are coordinated planning tools that enable planners to identify priority production zones and put adequate preconditions for sustainable forest management into place with the aim of providing a sustainable supply of fuel for the population.



2.2 Regulatory frameworks require adjusting

I. Wood energy requires realistic market prices

Problems

- Market prices currently do not reflect the cost of (sustainable) production.
- Use of wood energy is not controlled, preventing any attempt at sustainable forest management.
- Efficient conversion technologies and energy-efficient appliances are not used.
- Fuel substitution often fails and thus requires costly, continuous subsidies.

Action required

Support for economic policy measures (differentiated taxes and charges) and enhanced enforcement.

Impact

- The willingness of rural populations to invest in forestry production is strengthened.
- Wood is used more efficiently.
- Substitute fuels gain in competitiveness.

II. Sustainable wood energy supplies require regulation and enforcement

Differentiated taxation sets out to penalise uncontrolled forest exploitation of free access areas, whilst rewarding sustainable forest management activities.

2.3 The technology gap needs closing

I. Conversion technologies, e.g. carbonisation

Problems

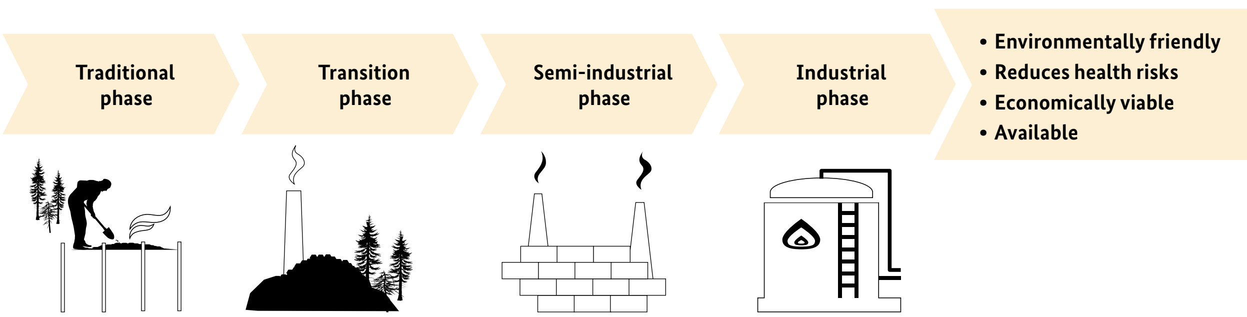
- High demand, non-sustainable biomass use and inefficient conversion technologies are to blame for 10–20 % of deforestation occurring around urban centres.

Action required

Expansion in use of improved appliances (e.g. kilns).

Impact

- Increased revenues
- decreased wood consumption and resulting CO_2 emissions
- decrease in loss of forest cover.



II. End-user technologies

Problems

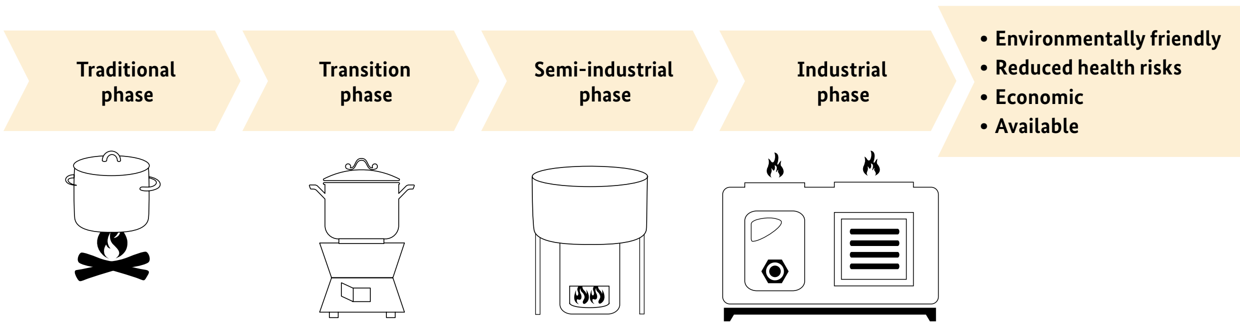
- Inefficient combustion causes high levels of indoor air pollution and significantly increases the risk of respiratory illness (acute lower respiratory infections (ALRI), chronic obstructive pulmonary disease (COPD)).
- Inefficient consumption increases the demand for wood-fuel and impairs sustainable wood-fuel supplies.

Action required

Promotion and dissemination of improved stoves.

Impact

- Reduced health hazards
- reduced spending on fuel
- lower CO_2 emissions
- reduced deforestation.



2.4 Modernisation is necessary across the entire value chain

I. Value chain approach

Problems

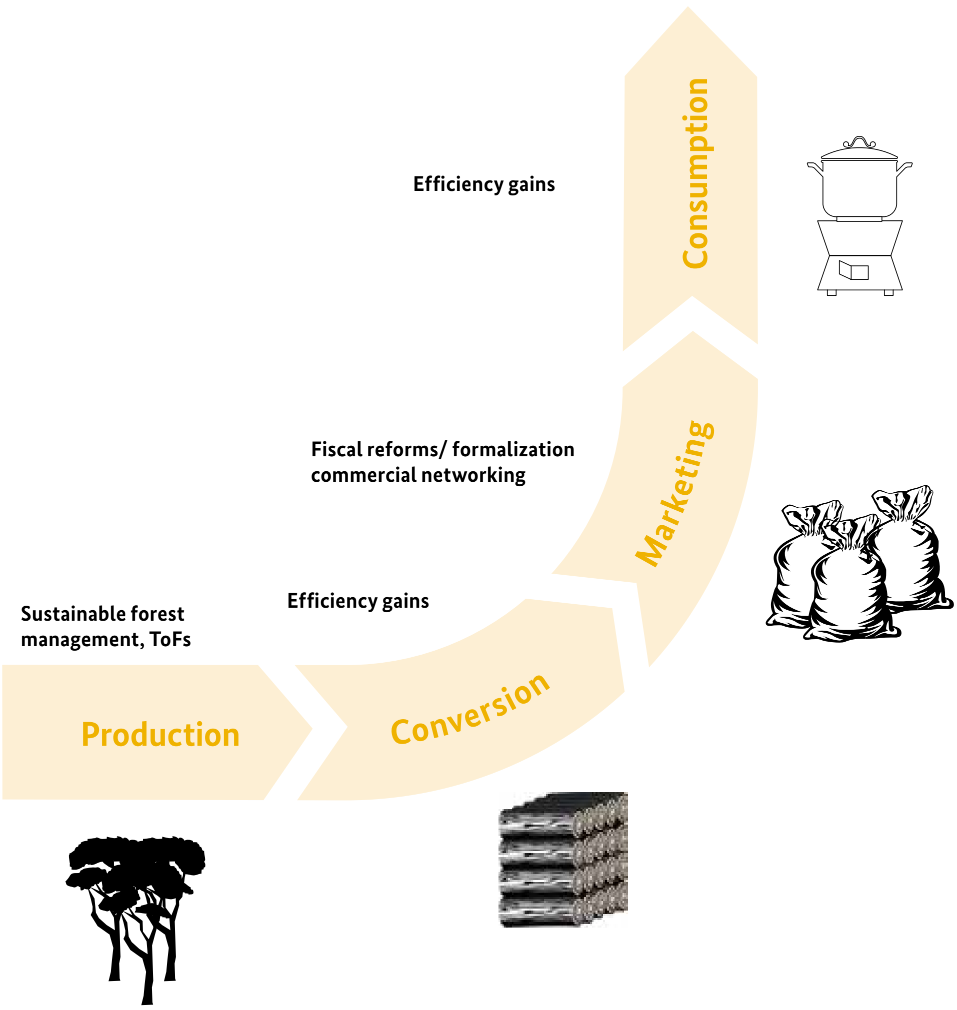
- Isolated interventions (reforestation, sustainable forest management, dissemination of improved stoves) fail to adequately exploit possible synergies that would foster sustainability if combined.

Action required

Targeted support for various stakeholder groups, acting as links in the entire value chain.

Impact

- Increased value added on a regional scale
- improved efficiency of the entire value chain
- sustainable provision of wood energy.



II. Improved leverage

Wood-fuel production

- Devolution of secure, long-term tenure to rural communities (e.g. Niger, Mali, Chad, Senegal, Madagascar)
- promotion of private plantations on marginal sites (e.g. Madagascar, Rwanda)
- energy contracting by small and medium-sized commercial consumers to private farmers (Brazil, Nicaragua).

Harvesting

- User-group organisation
- optimisation of logging technology
- streamlining of logging and transport
- harmonising harvesting with consumption patterns.

Conversion

- Dissemination of improved technologies (e.g kilns)
- further research and development (efficiency, environmentally sound processes)
- introduction of alternative wood energy products (e.g. wood-chips, briquettes or pellets).

Marketing

- Establishment of formalised local energy markets
- introduction and enforcement of a proof of origin for sustainably produced wood-fuel
- standardisation and improved product quality
- more equitable benefit sharing.

Consumption

- Dissemination of improved stoves
- research & development for cleaner and safer combustion
- streamlining wood-fuel products with consumption technologies
- kitchen management.

Success Stories

3.0

3.1 Biomass Energy Strategies (BEST)

The Biomass Energy Strategy (BEST) initiative is a joint effort of the EU Energy Initiative Partnership Dialogue Facility (EUEI PDF) along with GIZ's "Poverty-oriented Basic Energy Services" programme. The BEST initiative aims to strengthen awareness of biomass as Africa's main source of primary energy and to highlight its relevance to poverty allevations efforts, especially among decision-makers at the policy level. BEST development follows a six-stage systematic approach *[1]*:

1 Stakeholder analysis and team formation	What are the BEST vision and objectives? What is the political and policy environment? What are the roles and responsibilities of sector stakeholders? Who is in the BEST team and how will they work?
2 Baseline sector analysis	What is the curent energy supply and demand situation? What are the trends and their implications? What is the BEST scope, time horizon and process?
3 Development of scenarios	How is the energy situation likely to develop? What happens under different assumptions?
4 BEST strategy development	What are the options for intervention? Which of them should be implemented?
5 Action planning	What are the priority actions? Who will implement them? With what resources? Over what timeframe?
6 Adoption and implementation	Endorsement Launch Implementation

Biomass Energy Strategies have been developed in Lesotho, Botswana, Malawi, Rwanda, Mozambique and Ethiopia. *http://www.euei-pdf.org/country-studies*

3.2 Individual Reforestation Scheme – the example of Madagascar

Project design (duration: 2002–2014)

- Afforestation limited to marginal land (opportunity costs=0)
- voluntary decision of community members to participate
- allocation of responsibilities to all community actors
- individual ownership of plots and products (secured land/tenure rights)
- capacity building, creation of rural energy markets
- monitoring of plantation growth and quality.

Results (2010)

- Afforestation area: 6,500 ha in 57 villages
- involved households: 2,000
- share of the poorest: 34 %
- ownership of plots: 61 % men; 22 % women; 17 % couples
- average annual increase in income: 20 %
- value of the production/supply chain (5 rotations – 27 years): 9,900,000 EUR
- sustainable supply to more than 80,000 urban woodfuel consumers
- avoided deforestation of 49,000 ha of natural forests
- reduction in fire incidents (social control): 65 %.

3.3 Community Forest Management – the example of Senegal

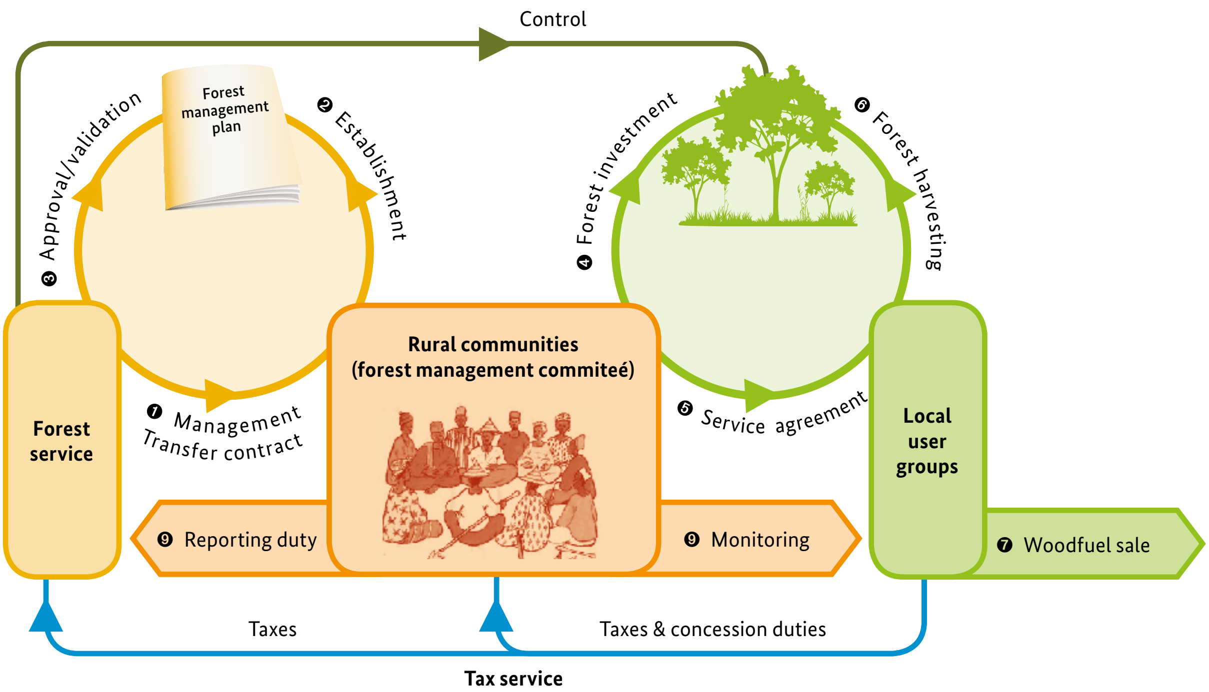
Project design (duration: 2003–2013)

- Creation of favorable political and economic pre-conditions
- supporting the delegation of powers for forest management to regions and rural communities
- enhancing the development of value chains for woodfuel and non-wood forest products
- capacity building for local communities, regional councils and the forest service
- awareness creation and lobbying for the importance of woodfuel.

Results (2013)

- Technical and organisational standards for sustainable management of state and community forests have been developed.
- Four regional plans for the sustainable management of forests have been expanded in a participatory way.
- 60,000 ha forests under management.
- 5 regions, 30 communties and 255 villages are involved in sustainable forest management.
- 350 men and 250 women are employed in the formalised wood energy value chain.

Partnership between rural communities and forest service *[5]*



3.4 Sustainable Management of Natural Resources – the example of Paraguay

Project design (duration: 2004–2010)

- Promotion of conservation agriculture, reforestation, natural forest management, agro-forestry and nurseries
- organisation of farmer committees
- business approach and technical support
- provision of financial incentives to farmer committees
- initiating public-private-partnership projects.

Results (2010) (forest component)

- Support for 9,000 families in five departments
- 8,000 ha of sustainable forest management including 3,500 ha of reforested land
- production potential of fast-growing plantations up to $20m^3$/ha/year
- 90 % of the families became self-sufficient in wood energy (annual consumption of 21 m^3 of wood/houshold)
- additional family income of about 500 EUR/year.

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4.0

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Imprint

Published by the
Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH

Programme
Poverty-oriented Basic Energy Services (HERA)

Dag-Hammarskjöld-Weg 1-5
65760 Eschborn
Germany
Tel. +49 (0) 61 96 79 6179
Fax +49 (0) 61 96 79 80 6179

E hera@giz.de
I www.giz.de/hera

Author
Steve Sepp, ECO Consulting Group

Edited by
Heike Volkmer

Design, Infographics, Illustrations
creative republic, Frankfurt / Germany

Printed by
Metzgerdruck, Obrigheim / Germany
Printed on FSC-certified paper

As at
February 2014

GIZ is responsible for the content of this publication.

On behalf of
Federal Ministry for Economic Cooperation and Development (BMZ)

Addresses of the BMZ offices

BMZ Bonn
Dahlmannstraße 4
53113 Bonn
Germany
Tel. + 49 (0) 228 99 535 - 0
Fax + 49 (0) 228 99 535 - 3500

BMZ Berlin
Stresemannstraße 94
10963 Berlin
Germany
Tel. +49 (0) 30 18 535 - 0
Fax +49 (0) 30 18 535 - 2501

poststelle@bmz.bund.de
www.bmz.de