interactive Wood Energy Statistics

i-WESTAT
Update 2004

Rudi Drigo

Wood Energy Planning – FAO Forestry Department under the supervision of Miguel Trossero, Senior Forestry Officer

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

Forestry Department

November 2005

Table of Contents

Acknowledgements

The revision of i-WESTAT and the drafting of the present document were carried out by Rudi Drigo, Forestry Consultant, FAO Forest Products and Economics Division, specialized in forest resources monitoring and wood energy, under the supervision of Miguel Trossero, Senior Forestry Officer, FAO Forest Products Service. With thanks to Mariana Manus for her comments and editorial support.

The review and compilation of this multi-source database would not have been possible without the collaboration of many institutions.

In particular, contributions from Adrian Whiteman, Felice Padovani and Carlos D'Ricco of FAO Forest Economics Service, Alex McCusker of UNECE/FAO Timber Branch, Jean-Yves Garnier and Riccardo Quercioli of IEA Energy Statistics Division, Karoly Kovacs and Liliana Carvajal of the Energy and Industrial Statistics Section of the UN Statistics Division are gratefully acknowledged.

Special thanks to Walter Antonio Marzoli, author of the original design of the i-WESTAT database, for his generous assistance on database matters.

Acronyms

ADB	African Development Bank
AFREPREN	African Energy Policy Research Network
AIT	Asian Institute of Technology
CEERD/AIT	Center for Energy-Environment Research and Development of the Asian Institute of Technology
CEN	Comité européen de normalisation
CUM	cubic meters; synonym of m^3 and m3 used in the database and text
EFC	European Forestry Commission
EFSOS	European Forest Sector Outlook Study
ENDA	Environment and Development Action (international NGO)
ESMAP	Energy Sector Management Assistance Programme (joint World Bank-UNDP Programme)
ETTS V	European Timber Trend Study V (outlook study by the Timber Section of the UNECE Trade Division and the forestry staff attached to the FAO Liaison Office in Geneva)
Eurostat	Statistical Office of the European Communities
FAO	Food and Agriculture Organization of the United Nations
FAOSTAT	FAO Statistical Database
FUNBAR	Fundación Bariloche
GFPOS	Global Forest Products Outlook Study (Forestry Policy and Planning Division of FAO Forestry Department)
IEA	International Energy Agency
IEPE	Institut d'Economie et de Politique de l'Energie (Grenoble, France) (Institute of Energy Economics and Politics)
INRENA	Instituto Nacional de Recursos Naturales (Perú) (Nacional Institute of Natural Resources)
IPCC	Intergovernmental Panel on Climate Change
ITTO	International Tropical Timber Organization
i-WESTAT	Interactive Wood Energy Statistics, Forest Products and Economic Division, FAO
LBL	Lawrence Berkeley Laboratory
LPG	Liquefied petroleum gas
MJ	Megajoule
MT	Metric ton
OECD	Organisation for Economic Co-operation and Development
OLADE	Organización Latinoamericana de Energía (Latin American Energy Organization)
PJ	Petajoule
RWEDP	Regional Word Energy Development Programme
SADC	South African Development Community
TC	Technical Cooperation
TE-CO2	Tonne of CO^2 equivalent
TJ	Terajoule
Toe	Tonne of oil equivalent
UN	United Nations
UNDP	United Nations Development Programme
UNECE	United Nations Economic Commission for Europe
UBET	Unified Bioenergy Terminology

WEIS	Wood Energy Information System, Forest Products and Economic Division
WES	Wood Energy System
WETT	Wood Energy Today for Tomorrow (Activity of FAO that analyzed wood energy statistics world-wide through regional studies [1] [2] [3] [4] [6])
WISDOM	Woodfuel Integrated Supply/Demand Overview Mapping (Methodology of analysis developed by FAO and UNAM, Mexico)
WRI	World Resources Institute
WF	Woodfuel
WE	Wood Energy

Foreword

Determining the consumption of fuelwood or charcoal in a given country by consulting and comparing different information sources has always been a trying experience. The definitions are rarely consistent, the measurement units are different and the discrepancies among the reported values are so wide, that one remains utterly confused.

In order to clarify the complex issue of wood energy statistics the Forest Products and Economics Division prepared and adopted the Unified Bioenergy Terminology (UBET) and developed the interactive Wood Energy Statistics (i-WESTAT), which assembles wood energy data collected from FAOSTAT as well as from international databases and other national sources.

i-WESTAT has now been updated (Version 2.0) and includes additional data from national sources, a thorough revision and update of data from international databases, with improved definitions and references. The database now contains over 115 000 records, with each value being defined by a primary source and a secondary source that helps to qualify it and to demonstrate its true value.

The aim of i-WESTAT is to support sector analysts and other interested users in reviewing the entire range of estimates, harmonized in terms of definitions and measurement units. This is done through an interactive user interface that allows for queries of information sources, periods, items, units and provides graphic or tabular displaying of results. While visualizing the range of estimates produced by all sources, the analyst can review the secondary sources or estimation procedures behind the individual figures and thus develop his/her own perception of the "weight" of the various figures and their reliability.

The review of primary and secondary data sources has shown that most wood energy statistics are estimated rather than measured, and their reliability varies from source to source and from country to country. It may be concluded that no single data source can be considered as fully authoritative and it is therefore important for the user, as well as for the database developer, to visualize this variance, rather than relying on a single data source, and to look for convergences and relations among the existing estimates. i-WESTAT thus illustrates how much needs to be done in order to achieve better wood energy statistics at national and international level.

In the last few years there has been a marked increase in the attention paid by international and national agencies to wood energy statistics. Moreover, woodfuels and other biomass fuels are acquiring new relevance in the context of the carbon and green house gas emission inventories required under the United Nations Framework Convention on Climate Change and its Kyoto Protocol.

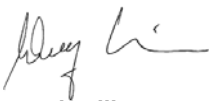
This increased attention has resulted in better structured databases, more comprehensive geographic coverage and more comparable statistics, the latter a result of the adoption of consistent terms and definitions as promoted by the Forestry Department of FAO. Such improved attention and recognition by national and international agencies however, has not yet induced a significant increase in field data collection and, consequently, data reliability is still poor.

Wood energy statistics are poor in both developed and developing countries because of insufficient institutional awareness about the importance of wood energy for local, national and regional economies. One of the biggest problems remains the different "forestry" or "energy" perspectives adopted by the estimating agencies. Forestry agencies rely primarily on forest production data, which often underestimate the entire flow of woodfuels while energy agencies rely primarily on estimation of sectoral energy requirements and fuel preferences.

Unreliable statistics are not a problem *per se* but rather they highlight a far more serious national incapacity to manage the sector, with inevitable negative consequences on sustainability of resources and services.

International and national institutions concerned with wood energy must continue on the path of data sharing and collaboration that has developed in recent years and strengthen joint efforts towards the collection of reliable information. It must be emphasized that improved data quality can only come from better country data.

To this end, in order to improve the reliability of wood energy data at national level and to support policy formulation and planning, FAO has developed and disseminated a practical guide for woodfuel energy surveys and the Woodfuel Integrated Supply/Demand Overview Mapping (WISDOM) methodology. The FAO experience with the implementation of WISDOM in some countries, such as Mexico, Slovenia and Senegal, shows that acceptable or even exhaustive wood energy statistics can be created using existing information, if the interest and the will to do it exist.



Wulf Killmann
Director
Forest Products and Economics Division
Forestry Department
FAO, Rome

Executive summary

The interactive Wood Energy Statistics (i-WESTAT) is a multi-source database that assembles worldwide wood fuel data, in comparable units, from international energy agencies, the Food and Agriculture Organization, other United Nations (UN) agencies, from national sources and thematic studies.

The i-WESTAT database has recently been updated (Version 2.0). The current version contains several improvements in the quantity and quality of woodfuel data; has more consistent definitions and a broader array of reference information. The database contains more than 115 000 records from 20 primary international and national sources and 400 reference categories. The graphic interface is designed to respond to specific queries and provides for information filters based on year, product, country, primary and secondary information source.

The database itself contains information for 213 countries from 1961 to 2003, and provides projections to 2030 from the Global Forest Products Outlook Study (GFPOS-FAO) source. The database includes information on production, import, export and consumption of woodfuel, fuelwood, charcoal and black liquor. Data on consumption by sector and by urban/rural areas was included where available.

A comparison of current and historical datasets shows marked differences in wood energy statistics. Over the past few years, almost all concerned international agencies have modified their estimation approaches, expanded the geographic coverage and improved on definitions. In addition, the cooperation between the main agencies has increased considerably, the result of an increasing institutional interest in wood energy.

That said, a reliable source for wood energy statistics cannot be identified. Meaning, the definition of “best estimates” would require a thorough review and cross-referencing of all data sources country by country and item by item. i-WESTAT is designed to facilitate this process.

i-WESTAT provides a comprehensive dataset with best-available information but its usefulness is limited by the quality of the statistics themselves. Wood energy statistics provided from most sources are generally poor. The problem is not lack of reliable data *per se* but rather the lack of consistent and uniform use of the available information from the forestry, energy and other agencies involved in wood energy. Woodfuel data has been a minor element in these agencies information systems and therefore, institutional capacity to manage wood energy systems is weak and often results in unsustainable resource use while limiting the ability of policy makers to understand the impacts of wood energy on development at local and national levels.

Key issues

Wood energy statistics are essential for: (i) understanding the dynamics of wood energy systems; (ii) evaluating the role played by woodfuels in the energy sector; (iii) assessing the share of forest products used for energy purposes (direct/indirect); (iv) assessing the role of woodfuels in climate change mitigation and sustainable development; and (v) formulating sound energy policies.

The complex nature of wood energy systems requires an inter-disciplinary approach. Wood energy plays a major role in both the forestry and energy sectors but receives limited attention from both, and neither takes full responsibility for developing the sector. Woodfuel statistics from these agencies often differ due to the fact that forestry agencies traditionally focus of wood removals from forests while energy agencies focus on energy balance statistics. These two perspectives cause major discrepancies in final estimates.

Beyond sectoral issues, other key limitations to wood energy statistics can be summarized as follows:

Terminology: Wood energy terms and definitions are not consistent and have often been simplified or generalized.

Data coverage: The coverage of woodfuel products and flows by the various sources is extremely heterogeneous. While some sources disaggregate fuelwood data by sector of consumption, others do not. More importantly, there is no information on supply sources for fuelwood and charcoal (i.e. natural forests, forest plantations, agricultural plantations, etc.).

Data generation: Accurate data generation is hindered by the current methods for data gathering and the lack of an inter-disciplinary approach to collection and interpretation. In some cases, international data sources use questionnaires to collect data. This approach is limited by the fact that there is little supporting documentation on references and procedures use—and sometimes, by the simple fact that the questionnaires are not filled out. FAOSTAT, for instance, was forced to estimate more than 50% of its woodfuel figures.

Conversion factors: The treatment and conversion of units (i.e. heat rates of specific woodfuels) often differ, causing inconsistencies between statistics derived from the same original data. At the same time, there is no agreement on efficiency rates of common conversion technologies and clarity on what rates are applied.

Progress

Over the past few years, FAO has undertaken several initiatives aimed at enhancing countries' capacities in wood energy planning and improvement of wood energy statistics. These initiatives include the development of normative actions such as the Unified Bioenergy Terminology (UBET)—that classifies and defines woodfuel terminology to ensure data is more consistent and comparable; the production of the Guide for Woodfuel Surveys; and the Wood Energy Supply/Demand Overview Mapping (WISDOM) methodology as a planning and policy development tool.

There is also a changing attitude towards wood energy in both developed and developing countries. Current concerns about global warming and initiatives such as the Kyoto Protocol have generated an increasing interest in the sustainable use of woodfuels. As a result, there has been a marked improvement in the quality of databases, geographic coverage and surveys on woodfuels, but much remains to be done.

Recommendations

Given the important role that woodfuels play in both forestry and energy planning, as well as their impacts on sustainable development and the environment, it is vital that reliable information be available. To this end, it is recommended that FAO, in cooperation with other agencies involved with forestry and energy, continue the process of information sharing and review; agree upon and adopt UBET as a common set of terms and definitions; combine the forestry and energy expertise to develop a specialized wood energy working group; and share responsibilities in data collection and analysis.

FAO itself has a major role to play in providing the tools and methodologies for data generation. In the short term, it is recommended that FAO: (i) provide i-WESTAT to national and international institutions (forestry and energy); (ii) continue its collection woodfuel data from local and national field surveys and through literature and bibliographic searches as was done for its Global Forest Products Outlook Study (GFPOS); (iii) convert GFPOS modeling into a flexible aid by selecting the most efficient models, updating independent variables and converting "adjustment functions"; and (iv) create standard approaches and procedures by reviewing conversion factors at national and international levels with special attention to the issue of efficiency loss.

In order to ensure continuity in data collection, medium- and long-term actions on the part of FAO should include: (i) further WISDOM analyses; (ii) the development and dissemination of tools such as the Guide for Woodfuel Surveys and the provision of technical assistance for the implementation of field surveys; and (iii) collecting (and promoting the collection of) woodfuel data disaggregated by type of woodfuel, by sectoral consumption, by geographic area and by supply source.

1. Introduction

FAO in close cooperation with other working groups is responsible for the implementation of activities related to wood energy planning and policy development. The overarching aim is to strengthen the national wood energy planning capabilities of forestry services and energy agencies through the development and dissemination of information, methodologies, tools and techniques for the adoption of enhanced national wood energy statistics that would support effective and sound wood energy policies and programs.

To meet its objectives, FAO is involved in the production and analysis of wood energy data on a scale ranging from local to global. The following list highlights the activities most relevant for this report:

- Conceptual definition of the Interactive Wood Energy Statistics (i-WESTAT).
- Conceptual design of the Unified Bioenergy Terminology (UBET) [5] and fostering interagency discussion on terms and definitions.
- Regional Studies on wood energy statistics produced in the series Wood Energy Today for Tomorrow (WETT). The studies were conducted in the period 1997 – 2000 and covered all regions of the world [1] [2][3] [4] [6].
- Commission and analysis of country studies thematically focused on wood energy statistics, an activity that was carried out in the framework of the FAO/EC Partnership Programme on Sustainable Forest Management (2000-2002).
- Field projects and pilot studies (Mexico, Cuba, Ghana, Slovenia, Benin, Senegal, just to mention few recent ones).
- Conceptual development and implementation of the Woodfuel Integrated Supply/ Demand Overview Mapping (WISDOM) methodology.
- Preparation and dissemination of Woodfuel Surveys Guidelines
- Version 1 of the interactive Wood Energy Statistics (i-WESTAT 1).

This last activity was undertaken to create a user-friendly interactive query system to provide up-to-date woodfuel and wood energy statistics by forestry, energy, environment and natural resource management professionals. It illustrated the fact that because most of the existing information on woodfuels was estimated rather than measured the accuracy and reliability of the information varied from country to country. The first version of i-WESTAT was developed by collating the statistics from the regional WETT studies. Since then, most international sources have reviewed their time series and several other sources became available, hence the need for an updated version of i-WESTAT.

The scope of the present activity (i-WESTAT Version 2) was to collect, harmonize and insert in i-WESTAT most up-to-date information on wood energy from international agencies, country reports and other accessible sources, with additional emphasis to original references, estimation methods, and any other information useful to the qualification of each individual value in the database.

2. i-WESTAT database

i-WESTAT is a multi source database containing more than 115 000 records from 20 primary international and national sources and defined by around 400 reference categories, with queries designed to filter information utilized as a user interface. Each record contains the information registered by product, country, primary and secondary information source and year.

The database contains information for 213 countries from year 1961 to 2003, with projections to 2030 for model data. The variables include woodfuel, fuelwood, charcoal and black liquor production, import, export and consumption. Data on consumption by sector and by urban/rural areas were also included where available.

The main features and functionalities of i-WESTAT are described in the User's guide (Version 2.0 October, 2004).

The structure of the main table of the i-WESTAT database is described in Table 1.

TABLE 1

Structure of "wf", the main table of i-WESTAT database

Fields	Description
contcode	Fields linked to Table "COUNTRYWEIS"
srcode	
CTYCODE	
Countryname	
Source1_ID	Primary sources, linked to table "Source_name"
Source2_ID	Secondary sources linked to table "Sec_sources" which include the variables "Ref_type" that qualify the references (see Table 10) and "Derived_item" that provide the formulae used for derived items.
Year	Year of observation
Item	Woodfuel type and flow. See below.
Unit	Measurement unit. '000 m3 for fuelwood; '000 tons for charcoal; PJ for woodfuels and black liquor
Sector	See below
Area_U_R	See below
Value	Numeric entry
PJ_Equiv	Correspondence of "Value" in energy units (PJ)
Kg_percapita	"Value" / total population. If fuelwood, the volume is converted in weight.
TJ_percapita	"PJ_Equiv" / population. Not available for black liquor and for import and export.

The categories under "Item" adopted in i-WESTAT, which identify the woodfuel type and flow, are listed in Table 2. These items reflect the conceptual scheme defined in UBET [5], shown in the figure in Appendix 2 and follow the definitions reported in the same Appendix.

TABLE 2

i-WESTAT variables

Item code	Item name	Item code	Item name
FwCons	Fuelwood consumption	WfCons	Woodfuel consumption
FwProd	Fuelwood production	WfProd	Woodfuel production
FwImp	Fuelwood import	WfImp	Woodfuel import
FwExp	Fuelwood export	WfExp	Woodfuel export
ChCons	Charcoal consumption	BlkLiq	Black liquor
ChProd	Charcoal production	TraLoss	Transformation losses (charcoal)
ChImp	Charcoal import		
ChExp	Charcoal export	PsbCons	Primary solid biomass consumption (IEA)

Sector	Description	
All	Including all sectors	
Household	Limited to household sector	
Non-household	All non-household sectors combined. Calculated by deduction in cases where the source provides only figures at total and household level, without further subdivisions	
Commercial	Limited to the commercial sector	Details rarely available
Industries	Limited to the industrial sector	
Services	Limited to the services sector	
Transformation	Limited to the transformation sector	

Area_U_R	Description	
All	Including rural and urban areas	
R	Limited to rural areas	Details rarely available
U	Limited to urban areas	

2.1 Population statistics

National population statistics are released annually by the UN Population Division and used by all UN agencies. The annual revisions of population statistics do not simply add one year to the previous time series but are complete re-estimations of the entire time series, adjusted on the basis of new census data and other inputs. The most recent data series includes 2002 statistics.

In i-WESTAT, population data are used to produce per capita values of fuelwood and charcoal production and consumption. These per capita values are useful when comparing several countries' production and consumption.

2.2 Conversion factors

The aim of converting original values in common units is to allow the comparison of different data sources and the aggregation of specific fuel data in terms of estimated energy contribution. The standard conversion factors applied in converting volume and weight units into energy units and vice versa are reported in Appendix 3.

True conversion factors may vary widely from the standard ones applied in i-WESTAT, as a result of local factors, such as specific wood characteristics and conversion technologies, which are generally unknown. Consequently, the values resulting from the application of standard factors should be considered as tentative, providing orders of magnitude rather than actual values.

Accurate measurements are further complicated by the fact that the original measurement units are not consistent. Each institution collecting country data faces the need to harmonize the original values to common units therefore, in some cases, measurements might be converted back from a derived unit to the original unit using different factors and finally creating a new value significantly different from the originally measured one.

Another aspect related to unit conversions which strongly affects data consistency is the application, or otherwise, of efficiency losses related to conversion technologies. Energy units are considered sometimes as total fuel energy content and sometimes as actual energy production, the latter depending largely on the conversion technologies used.

The highest risk of inconsistency resulting from conversion processes is when a value determined with efficiency loss consideration is re-converted without efficiency consideration, artificially inflating the resulting value[1].

This problem can only be resolved with a coordinated effort by all concerned agencies in truly developing metadata on original sources and estimation procedures.

[1] An example of this risk is given by the Slovenia case. The household fuelwood consumption was determined in energy units at 8.7 PJ (derived from census data on dwelling size of fuelwood users and energy requirements for house heating and cooking) and converted into cubic meters of fuelwood, i.e. 1.3 million m^3, using average energy content of common fuelwood species and efficiency loss related to common conversion technologies, which was defined as 35 percent of wood energy content. Obviously, if the fuelwood volume is converted into energy units using the standard factor the result in energy units will be 35 percent larger than the original estimate.

3. Primary data sources

The 20 primary sources reported in i-WESTAT represent the state of the art of current woodfuel statistics as well as historical references that help to understand the relation among sources and the evolution of woodfuel statistics in the last decade. In this respect the primary sources may be classified as “historical” and “updated” as follows.

Historical sources	Updated sources
UNECE/ETTS	Country report
ENDA/IEPE	FAOSTAT (2003)
ESMAP	GFPOS 1970–2030
Eurostat 89–94	IEA (2002)
FAOSTAT (1998)	OLADE 90–02
FUNBAR	Other national [includes also old references]
IEA non OECD 99	UN energy statistics (2002)
IEA OECD Wf 80–94	
LBL	
OLADE 80-97	
RWEDP	
UN energy statistics 1995	
WETT99 best estimate	

A summary description of the primary sources is given in Table 3. The statistics provided by the various sources are heterogeneous in terms of geographic, thematic and temporal coverage. Appendixes 5 to 10 provide detailed statistics on primary sources data concerning the following aspects:

- Temporal coverage
- Number of records by item
- Sector subdivision
- Rural-urban area subdivision
- Geographic coverage
- Typology of secondary reference data

TABLE 3

Summary description of primary sources included in i-WESTAT grouped as "updated sources" and "historical sources".

	Updated sources	
Code	**Primary Source**	**Description**
3	**Country report**	Thematic country studies on wood energy statistics carried out in the framework of the FAO/EC Partnership Programme on Sustainable Forest Management (2000–2002), supervised by FAO. The country studies are based on national information from national and local surveys and other supporting material. Usually providing short time series based on observed data rather than pure modeling. *Strong points*. In general, the studies represent the best "blend" of forestry, energy statistics and of scattered and fragmented data that are not available outside the countries. *Weak points*. The quality of these studies varies considerably depending on the authors' capacity to integrate inter-sectoral information and on the quality of reference. Covering 39 countries only.
25	**FAOSTAT (2003)**	This primary source includes all data extracted from FAOSTAT forest products statistics and includes data up to 2003 (release September 2004). Original FAOSTAT data include official statistics (provided via questionnaire) or, if official data are not available, unofficial statistics and FAO's own estimates (approx. 60 percent). Since 1998, FAO, UNECE, Eurostat and ITTO share a joint forest sector questionnaire. FAOSTAT estimates are since 2001 based on GFPOS models. In i-WESTAT the values are reported directly as can be found in FAOSTAT (e.g. charcoal statistics), or derived from original FAOSTAT items (see below for detailed explanation). *Strong points.* The original FAOSTAT wood products statistics allowed definition of the widest range of woodfuel items. Practically all the countries of the world are included. Longest temporal coverage (1961 to 2003). FAO's own estimates (based on GFPOS models) are objectively documented. *Weak points.* There is no information on the sources and estimation procedures of official statistics, which prevents their reliability from being assessed (a condition common to most sources). National correspondents are mainly from the forestry sector, which may induce an underestimation of fuelwood production and consumption. No sector and area subdivision in consumption statistics.
30	**GFPOS 1970-2030**	Set of models for the prediction of fuelwood and charcoal consumption in all countries of the world. As many as eight charcoal models and nine fuelwood models were developed in the framework of the Global Forest Products Outlook Study. The aim of these models was that of providing best possible estimates to fill data gaps in FAOSTAT forestry statistics. *Strong points.* Except "FAOSTAT" models, all other models were based on well documented field survey data (mostly sub national surveys) distributed all over the world. Apart from their use as gap filling, the models can serve as adjustment functions to project in time single-point data of known reliability. *Weak points.* The "FAOSTAT" models, which were based on official statistics (of unknown reliability) for the countries with over ten official entries, are not necessarily providing realistic trends.
34	**IEA (2002)**	Apart from FAO sources, IEA maintains the most comprehensive set of wood energy statistics. Since 1999 the Energy Statistics Working Group (IEA, the UN, UNECE, Eurostat and their respective member governments, has decided to develop a common, specific questionnaire on renewables and wastes. IEA publishes statistics on charcoal and on primary solid biomass, which includes wood and non-wood biomass. IEA also keeps disaggregated statistics on wood and black liquor, which were provided and included in the database. *Strong points.* Directly linked to national energy statistics that produce more realistic consumption estimates. Consumption data are subdivided by sector. Increased efforts, in recent years, for producing better statistics on renewable energy sources (including biomass) and for disaggregating the statistics. *Weak points.* Available for "only" 127 countries. Published IEA statistics are still limited to primary solid biomass. Estimation as well as disaggregating procedures are not known.

31	**OLADE 90–02**	OLADE collects and harmonizes national energy statistics from 24 American countries. This source is used as main reference by IEA and by WETT99. OLADE's main references are national energy balances produced by energy agencies. *Strong points.* Directly linked to national energy statistics that produce more realistic consumption estimates. *Weak points.* Estimation procedures are not known.
7	**Other national**	Miscellaneous documents addressing energy issues, including woodfuels, which were assembled mainly, but not exclusively, during the WETT Africa and Asia studies. In the majority of cases this source refers to energy statistics and thematic country studies. *Strong points.* National-level data. *Weak points.* Very heterogeneous in terms of original items, unit and coverage. Very wide temporal distribution, mostly out of date, especially those for Africa.
27	**UN energy statistics (2002)**	UN energy statistics on fuelwood and charcoal refer almost exclusively to FAOSTAT, especially since 1996. Charcoal statistics for a few countries are estimated directly by the UN Energy Statistics Division. *Strong points.* Wood energy is incorporated within energy statistics. *Weak points:* Practically a copy of FAOSTAT values, except that FAOSTAT's "wood fuel, including wood for charcoal" is presented as "fuelwood", which is not entirely consistent. The estimation procedures of non-FAOSTAT values are not known.
	Historical sources	
18	**UNECE/ ETTS**	Dataset extracted from the UNECE European Timber Trend Study V, which was used as one of the references in WETT99. Now only useful as a historical dataset to understand the relation between data sources in past estimates. *Strong points:* historical reference. *Weak points:* Out of date: data include only 1980 and 1990.
15	**ENDA/IEPE**	Jointly with the IEPE (Grenoble, France), ENDA (Senegal) issued a synoptic study on the energy situation in French speaking African countries in 1995. The study did not produce time series but collected national-level data. These country data were sometimes used for WETT99 best estimates for African countries. *Strong points.* Reports original national data. *Weak points.* Covering 28 countries in Africa. Rather out of date (late 1980s, early 1990s).
6	**ESMAP**	ESMAP conducted numerous projects in various African countries. Although it never produced aggregated statistics, the numerous project documents contained information on woodfuels that was compiled during the WETT Africa study and sometimes used as reference for WETT99 best estimates. *Strong points.* Reports original field project data. *Weak points.* Covering 39 countries in Africa. Out of date (1970s and 1980s).
19	**Eurostat 89–94**	Dataset extracted from Eurostat Renewable Energy Resources Statistics (1996), used as one of the references in WETT99 for Europe and OECD. Now only useful as historical dataset to understand the relation among data sources in past estimates. *Strong points.* Historical reference. *Weak points.* Out of date: data are only for1989 to 1994.
10	**FAOSTAT (1998)**	Dataset extracted from FAOSTAT 1998 statistics and used as one of the references in WETT99 and in the analysis of the country reports done in the framework of the FAO/EC Partnership Programme on Sustainable Forest Management (2000-2002). Now only useful as a historical dataset to understand the relation between data sources in past estimates. *Strong points.* Historical reference. *Weak points.* Out of date. Data replaced by new statistics reported under 25: FAOSTAT (2003).
16	**FUNBAR**	Dataset extracted from FUNBAR 1990 statistics and used as one of the references in WETT99. Now only useful as a historical dataset to understand the relation between data sources in past estimates. *Strong points.* Historical reference. *Weak points.* Out of date: data include only 1980, 1985 and 1990.

8	**IEA non-OECD 99**	Dataset on charcoal consumption extracted from IEA 1999 statistics and used as one of the references in the analysis of the country reports done in the framework of the FAO/EC Partnership Programme on Sustainable Forest Management (2000–2002). Now only useful as a historical dataset to understand the relation between data sources in past estimates. *Strong points.* historical reference. *Weak points.* Out of date. Data replaced by new statistics reported under 34: IEA (2002).
20	**IEA OECD Wf 80–94**	Dataset extracted from IEA 1996 statistics, which was used as one of the references in WETT99 for Europe and OECD. Now only useful as a historical dataset to understand the relation between data sources in past estimates. *Strong points.* Historical reference. *Weak points.* Out of date. Data replaced by new statistics reported under 34: IEA (2002).
21	**LBL**	Dataset extracted from Lawrence Berkeley Laboratory Energy Statistics, which was used as one of the references in WETT99 for Europe and OECD. Now only useful as historical dataset to understand the relation between data sources in past estimates. *Strong points.* Historical reference. *Weak points.* Covers only nine countries. Out of date. Data limited to the period 1980–1992.
17	**OLADE 80-97**	Dataset extracted from OLADE 1997 statistics and used as one of the references in WETT99. Now only useful as a historical dataset to understand the relation between data sources in past estimates. *Strong points.* historical reference. (Includes estimates probably obsolete, for the period 1970–1989 which are not included in new OLADE set data). *Weak points.* Out of date: Data replaced by new statistics reported under 31: OLADE 90-02.
13	**RWEDP**	Estimates identified as best reliable in the framework of RWEDP. Mostly referring to figures reported under primary sources (3) and (7). *Strong points.* National-level data. *Weak points.* Limited to 16 (RWEDP) countries and to 1997. Selection procedure not documented. More comprehensive regional comparison was conducted by the WETT Asia study.
11	**UN energy statistics 1995**	Dataset extracted from UN energy statistics 1995 and used as one of the references in WETT99 and in the analysis of the country reports done in the framework of the FAO/EC Partnership Programme on Sustainable Forest Management (2000-2002). Now only useful as historical dataset to understand the relation between data sources in past estimates. *Strong points.* Historical reference. *Weak points.* Out of date. Data replaced by new statistics reported under 27: UN energy statistics (2002).
1	**WETT99 Best estimate**	"Best estimates" produced in the regional studies of the WETT series. The studies were conducted in 1999–2000 and reviewed all national and international information available at that moment. The studies concluded by selecting the most reliable data sources (the data was then labeled as "best estimates") or produced new time series based on reliable point data, projected thereafter based on per capita values and population growth statistics. *Strong points.* Based on expert critical review of all available sources. Perfectly reflecting the Unified Wood Energy Terminology, the estimates produced cover all items. Including almost all countries of the world. *Weak points.* Reference data are rapidly outdated. National statistics and country reports often referred to the 1980s. International databases identified as best references, such as FAOSTAT, have changed their time series on account, it is to be hoped, of new evidence.

3.1 Relation between primary sources and information flow

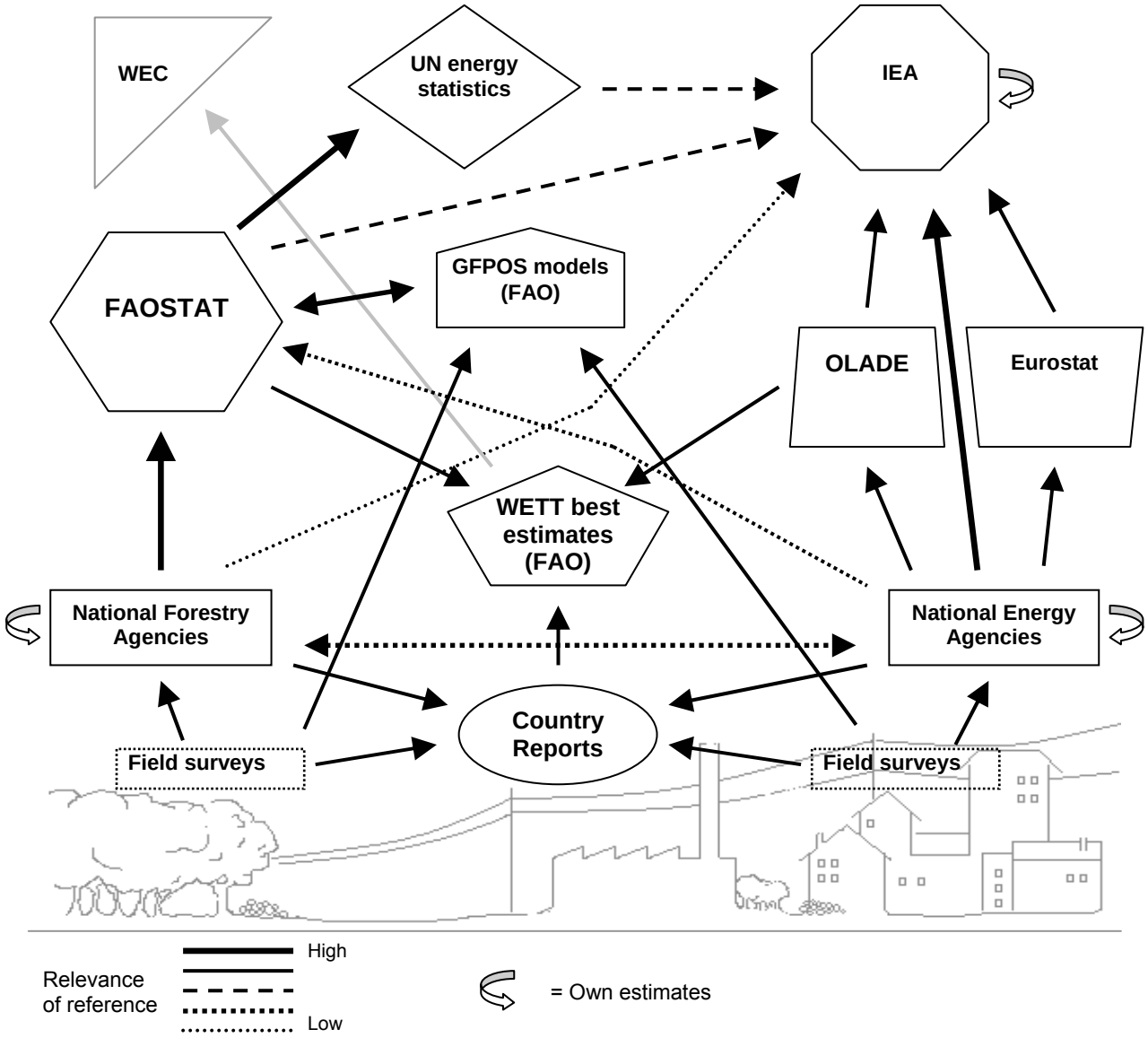
The flow of information that feeds the primary sources is extremely complex, as is shown, tentatively, in Figure 1. Wood energy statistics originate from two sectors: the forestry sector, shown on the left side of the figure; and the energy sector, shown on the right. The level of integration between the perspectives of these two different sectors is still quite low, which explains some of the main discrepancies between data sources.

The first critical aspect is that there are very limited field data. Second, and to some extent as a consequence, the information produced by primary sources is based on a great number of estimates, extrapolations, modeling and cross-referencing. Third, the original field reference data are not known or not reported and the descriptions of estimation procedures are extremely rare. In practice, it is impossible to rate the reliability of database entries. Nonetheless, in order to qualify the data with the best possible approximation, each record has been ranked by "reference type" according to the data sources or estimation approaches described in metadata and other available documentation (see Table 10 in Chapter 4). The results of this typology are summarized in Appendix 10. In addition, Appendix 10 provides a *tentative* reliability ranking, established with

the assumption that field survey data are most reliable and that the further from the “field survey” level, the lower the reliability.

FIGURE 1

References of main sources



3.2 Description of main sources

FAOSTAT data

FAO forest products statistics report forestry data provided by member countries, with some license to fill data gaps with estimates. The concept of forest and forest functions continued to evolve in the past decades to include elements such as “trees outside forest”, “other wooded lands”, “urban forestry”, “agro forestry”, “carbon sink” and “wood as fossil fuel substitute”, which required, and still requires, re-defining the information to be collected and reported on. The process of adaptation to this moving target poses considerable stress on national (and international) forestry agencies.

Practically every forestry institution is involved in this process of adaptation and their capacity to provide consistent data varies considerably. This condition strongly affects wood energy statistics, which concern

forestry and energy aspects, including forest and non-forest wood resources whose flow is almost entirely informal. [2]

Some national agencies provide only official and formally recorded statistics of fuelwood and charcoal produced in state forests (capturing as little as 10 percent of the true production), while other national agencies provide less official (but more realistic) production statistics derived from consumption surveys conducted usually by energy agencies.

FAOSTAT data collection

In 1998 FAO UNECE established a working group with Eurostat and ITTO for the joint collection and compilation of data on forest products. For this purpose a joint questionnaire was created. Each member of the group is responsible for the collection of information from a defined group of countries. The statistics are then collated and published by FAOSTAT.

In cases where questionnaire data (official figures) are not available, FAO can quote authoritative national sources (unofficial figures) or can produce its own estimates (FAO estimates). The latter case was traditionally resolved by using the best per capita consumption estimates and population statistics to estimate total consumption. This approach has been criticized as too simplistic and therefore, since 2001, FAO estimates are based on GFPOS models (see below).

Definition of i-WESTAT items from FAOSTAT data

FAO forestry statistics include the world's most comprehensive data series on wood products and as such they provide the most coherent and consistent input to the quantification of woodfuel flows. However, except for charcoal, which is treated in FAOSTAT as a separate commodity, all other i-WESTAT items were arithmetically deducted from the original FAOSTAT statistics. Tables 4 and 5 describe the relevant FAOSTAT items and their re-elaboration to generate the i-WESTAT items included in the database.

[2] The difficulty of identifying forest and non-forest supply sources and assessing their sustainability should also be considered but will not be discussed here because it is beyond the scope of the present activity. However, it should always be remembered that sustainable resource management remains the main aim when working with international statistics. It is a fact that adequate knowledge is an essential requisite to sustainable resource management and to the formulation of sound policies.

TABLE 4

FAOSTAT parameters and temporary codes

FAOSTAT items	Units	Production	Imports	Exports
Woodfuel, including wood for Charcoal	'000 m^3	FAOWfProd	FAOWfImp	FAOWfExp
Wood charcoal	'000 tonnes	FAOChProd	FAOChImp	FAOChExp
Wood residues	'000 m^3	FAOWResProd	FAOWResImp	FAOWResExp
Chemical pulp	'000 tonnes	FAOCPulpProd	FAOCPulpImp	FAOCPulpExp
Semi-chemical pulp	'000 tonnes	FAOSCPulpProd	FAOSCPulpImp	FAOSCPulpExp

Fuelwood items were calculated by deducting from FAOSTAT's wood fuel the equivalent of charcoal production (import, export) and adding a fraction of wood residues. The fraction of residues from wood industries actually used as fuel (usually in the industries themselves) is not known. As an approximation, 50 percent of residues were included in the calculation of fuelwood items, as indicated by the WETT Latin America study [6]. As regards black liquor, it was assumed that the entire amount produced is used as fuel directly by pulp industries.

Conversion factors are provided in Appendix 3.

TABLE 5

Generation of i-WESTAT items for FAOSTAT (2003)

Fuelwood items

FwProd ('000 m^3)	= FAOWfProd (000m3) – FAOChProd (000 tonnes)/0.165 + FAOWResProd/2 (limited to FAOWfProd >0)
FwImp ('000 m^3)	= FAOWfImp + FAOWResImp/2
FwExp ('000 m^3)	= FAOWfExp + FAOWResExp/2
FwCons ('000 m^3)	= FwProd + FwImp – FwExp

Charcoal items

ChProd (000 tonnes)	= FAOChProd
ChImp (000 tonnes)	= FAOChImp
ChExp (000 tonnes)	= FAOChExp
ChCons (000 tonnes)	= FAOChProd + FAOChImp – FAOChExp

Transformation loss

TraLoss (PJ)	= ChProd ('000 tonnes)/0.165*0.01005 – ChProd (PJ)

Black liquor

BlkLiq (PJ)	= FAOSCPulpProd (semi-chemical, '000 tonnes) * 2.27 * 0.01005 + FAOCPulpProd (chemical, '000 tonnes) * 2.27 * 0.01005

Aggregated woodfuels

WfProd (PJ)	= FwProd (PJ) + ChProd (PJ) + BlkLiq (PJ)
WfCons (PJ)	= FwCons (PJ) + ChCons (PJ) + BlkLiq (PJ)
WfImp (PJ)	= FwImp (PJ) + ChImp (PJ)
WfExp (PJ)	= FwExp (PJ) + ChExp (PJ)

FAOSTAT sources

Original FAOSTAT figures are defined according to their sources, as reported in Table 6. This information was reported as source 2 for all FAOSTAT (2002) data. In the case of derived figures, source 2 reports the source of the main component of the aggregation. In the case of fuelwood production and consumption (FwProd and FwCons) the source information refers to FAOSTAT wood fuel production. In case of charcoal consumption (ChCons), the source information refers to charcoal production (ChProd).

TABLE 6

FAOSTAT source categories

FAOSTAT code	Description	i-WESTAT source 2 code
No code	Official figure (government figures in questionnaire)	97
*	Unofficial figure (authoritative non-governmental source)	109
T	Trend: repetition of last official figure	250
F	FAO estimate	18
M	Missing value	Not included

GFPOS 1970-2030

Modeling of fuelwood and charcoal consumption

The modeling exercise carried out in the framework of the Global Forest Products Outlook Study [11] had the goal of supplying best possible estimates of fuelwood and charcoal consumption to fill FAOSTAT information gaps. It responded to the concern over previous FAO estimation procedures, basically projecting woodfuel consumption on population growth, which was considered over simplistic.

GFPOS models were based on a range of independent explanatory variables encompassing income, forest area, the urban population proportion and a range of dummy variables.

A total of 17 models were developed (Table 7), belonging to two sets:

- Set of models based only on the FAOSTAT dataset, limited to the countries that supplied at least ten valid questionnaires, used to estimate and project total fuelwood and charcoal consumption;
- Set of models based on all available information, including a relatively rich data set of national and subnational field surveys assembled for the purpose from “grey” literature[3] and FAOSTAT entries, used to estimate household and non-household fuelwood consumption and total charcoal consumption.

[3] Reports which are not published through conventional publishing channels –or in bood, which are not usually included in the classic citation analysis tools

TABLE 7

GFPOS model types and countries of application

Model type		Countries
Fuelwood consumption models		
FAOSTAT 1	FAOSTAT model relating the log of total national fuelwood consumption to the log of GDP PPP in 1997 (US$)	14
FAOSTAT 2	FAOSTAT model relating the log of total national fuelwood consumption to the log of population	12
FAOSTAT 3	FAOSTAT model relating the log of per capita fuelwood consumption to the log of per capita GDP PPP in 1997 US$	20
FAOSTAT linear	F Linear- FAOSTAT model relating total national fuelwood consumption to GDP PPP in 1997 (US$)	2
FAOSTAT constant	F constant - Constant total national fuelwood assumption	1
National household model + National non-household model		2
National household model + Continental non-household model		11
Regional household model + Continental non-household model		142
Regional household model + National non-household model		1
Charcoal consumption models		
F1 FAOSTAT	FAOSTAT model relating the log of total national charcoal consumption to the log of GDP PPP in 1997 (US$)	3
F2 FAOSTAT	FAOSTAT model relating the log of total national charcoal consumption to the log of population	1
F3 FAOSTAT	FAOSTAT model relating the log of per capita charcoal consumption to the log of per capita GDP PPP in 1997 US$	1
F4 FAOSTAT	FAOSTAT model relating the log of per capita charcoal consumption to the urban proportion of the population	2
FAOSTAT linear	FAOSTAT model relating total national charcoal consumption to the urban proportion of the population	6
FAOSTAT constant	Constant total national charcoal assumption	1
Global model of total consumption model		180
National model of total consumption model		11

The FAOSTAT fuelwood consumption models were based on the fuelwood fraction of the broader FAOSTAT category “wood fuel including wood for charcoal”.

Beyond providing “gap filling” estimates, a promising additional application of GFPOS modeling is to serve as an adjustment function for short- and long-term consumption projections based on new reference data.

The dataset collected and harmonized for model development includes data from over 160 countries on woodfuel consumption at national and sub-national level, by sector and by area over the period 1960-1999. The dataset is extremely heterogeneous in terms of representation and reliability but nonetheless it represents a valuable effort that deserves to be pursued.

IEA (2002)

IEA energy statistics for non-OECD countries present historical series for the aggregated item primary solid biomass (PSB) and for charcoal over the period 1971–2002.

The statistics for OECD countries present historical series for the aggregated biomass PSB and for charcoal over the period 1960–2002. Charcoal data seem to be incomplete. (In Europe, charcoal statistics are available only for Italy).

IEA metadata do not provide specific information on the sources of charcoal and PSB data. However, since the sources cited for "renewables and waste" are probably relevant also for charcoal and PSB, these were quoted as secondary sources.

In addition to Web-published data, the IEA Statistical Division provided disaggregated primary solid biomass data, which included the categories wood and black liquor. Table 8 lists the most relevant parameters and the correspondence with i-WESTAT items.

TABLE 8

i-WESTAT items from IEA statistics

IEA item	Flow		WEIS item	Sector	Area_U_R
WOOD					
FINCONS	Final consumption	=	FwCons	All	All
RESIDENT	Residential	=	FwCons	Household	All
FINCONS less RESIDENT	Consumption in all other sectors	=	FwCons	Non-household	All
BLACK LIQUOR					
INDPROD	Indigenous production	=	BlkLiq	All	All

UN energy statistics (2002)

Except for a few own estimates, UN statistics on fuelwood (and, to a lesser extent, on charcoal) are taken from FAOSTAT, at least since 1996.

UN Fuelwood Production data directly use the FAOSTAT values for production of "wood fuel including wood for charcoal". Therefore, for the user of UN statistics the values refer to fuelwood only. Accordingly, in i-WESTAT the item for the UN values is FwProd, although this is not entirely correct. In order to explain the relation with FAOSTAT, the secondary source for all these UN values states: "FAO forestry statistics (FAOSTAT) ref. FAOSTAT item: production of 'wood fuel, including wood for Charcoal'".

UN charcoal production data are partly estimated by the UN Statistical Division, partly taken from FAOSTAT values and partly from other sources (not specified).

Eurostat

Eurostat statistics do not include specific fuelwood and charcoal data. In the yearly statistics data 2002 by country, under the renewable energy source "biomass", the category "wood and wood waste" is reported separately from "municipal solid waste" and "biogas". However, despite this definition, the "wood and wood waste" category includes lignocellulosic biomass from agro residues and corresponds practically to the IEA category primary solid biomass (PSB, see definition under IEA section). In fact, for European countries, Eurostat statistics on "wood and wood waste" *are* the IEA main reference for PSB. In view of this, Eurostat data were not included in i-WESTAT.

WETT 99 best estimates

The woodfuel data reported under "WETT99 best estimates" represent the result of the regional analyses of wood energy statistics carried out by FAO in the years 1997–2000. They assemble what were considered the best references available at the time of the regional studies. They reported existing time series (i.e. FAOSTAT 98 and OLADE 80–97), or were built upon single-year figures from "reliable" sources (i.e. ENDA/IEPE, ESMAP, other national) using per capita consumption estimates and population statistics. Table 9 shows the sources used as best references.

TABLE 9

Information sources of WETT99 best estimates: percentage of fuelwood and charcoal consumption estimates

	FAOSTAT 98	ENDA/IEPE and ESMAP	OLADE 80-97	Other national	Undefined	
FwCons	32	8	10	14	36	100
ChCons	32	8	10	17	34	100
	32	8	10	15	35	100

The WETT99 best estimates should be considered as historical reference. In fact, most of FAOSTAT 98 figures were replaced in recent years as a result of new official figures or of improved estimation procedures. Similarly, the time series of OLADE 80–97 show considerable differences in respect of the new OLADE 90–02 time series. ENDA/IEPE and ESMAP figures have not changed, since they refer to specific country studies or surveys, but they are all quite old, referring mainly to the 1970s and 1980s or early 1990s at the latest. The source "other national" is more heterogeneous and in several countries recent statistics provided more up-to-date information, compared with the ones used for WETT99. In addition, many country studies have produced new estimates.

Consequently, new "best estimates" would differ significantly from WETT99 data.

Country reports

The primary source "country reports" includes all data contained in the thematic studies on wood energy statistics carried out by national experts in the framework of the FAO/EC Partnership Programme on Sustainable Forest Management or in FAO field projects on wood energy. As a result of the studies completed from 2000 to 2004, new estimates of fuelwood and charcoal production and consumption were produced for 39 countries. In general, these reports provide new estimates or, more frequently, the best and more recent "blend" of existing national and sub-national level data. The important contribution of these studies is the possibility to review critically and integrate forestry and energy information that is rarely accessible from outside the countries. In view of these features, country reports' statistics have considerable weight in the evaluation of statistics from other sources.

4. Wood energy statistics

Fuelwood and charcoal production are rarely quantified and, because of their local and informal character, are only partially and inadequately accounted for in national forestry and energy statistics. This has several causes. In spite of their true importance in both forestry and energy, woodfuels are often considered “minor” forest products by foresters and “traditional” fuels (i.e. obsolete) by energy agencies, especially in developing countries. Forestry as well as energy management considers that the comparatively low commercial value of woodfuels does not guarantee adequate returns on investments in data collection.

Thus, most of the figures reported in national and international databases are the result of various estimation processes rather than field surveys.

In most cases the production of woodfuels is derived from consumption data, considering that fuelwood production is demand-driven and not independent, and that in a general national context woodfuel production is equal to woodfuel consumption (minus export plus import), since large accumulations and storage beyond the annual consumption are uncommon.

In other cases the production of woodfuels is derived from forest products statistics. These statistics should be checked extremely carefully since there are risks of systematic underestimation as a result of two main factors:

- Consistent amounts of woodfuels, especially fuelwood, are produced outside forest areas (wood from farmlands, homestead vegetation, residues from wood industries, etc.). They are not considered forest products and not accounted for in forestry statistics.
- Fuelwood and charcoal production from forest areas is largely informal and sometimes illegal and therefore is not recorded as accurately as other forest products.

Detailed metadata on the original data sources, estimation methods, confidence intervals, etc. are never available. Reasonable information, useful for estimating data reliability, is sometimes provided by country studies. Regional and international databases provide only an approximate indication of data sources or very generic labels such as “official data” or “estimated value”.

In order to qualify i-WESTAT figures as well as possible, the secondary sources associated which each entry were ranked by “reference type” according to their original data sources and/or estimation approaches, as derived from available metadata or other documentation. A total of 15 reference types were defined, as described in Table 10.

The distribution of primary source data by reference types is summarized in Appendix 10.

In addition, the table in Appendix 10 provides a *tentative* reliability ranking, established with the assumption that field survey data are the most reliable and that the further from the “field survey” level, the lower the reliability. The results of this very tentative assessment of data reliability are summarized in Table 11.

TABLE 10

Common reference types

Type	Reference type	Remarks
1	National-level field surveys of fuelwood and charcoal consumption	Most consistent and reliable estimates of consumption and, indirectly, production. Usually point data referring to single years, disaggregated by sector and by urban/rural areas. Weak definition of supply sources and sustainability (e.g. selected country reports)
2	Country studies based on national information from national and local surveys and other supporting material	The quality of these studies varies considerably. In general, they represent the best "blend" of scattered and fragmented data that are not available outside the countries. Usually providing short time series based on observed data rather than pure modeling. (e.g. country reports EC-FAO partnership program).
3	National forestry statistics on fuelwood and charcoal production/consumption (forestry perspective)	Forestry statistics based on concession data and timber control measures tend to underestimate woodfuel production because of informal unrecorded practices and the fraction of non-forest sources (e.g. Slovenia Statistical Office, forest products statistics) In other cases forestry agencies combine forestry and energy data and provide more comprehensive estimates.
4	National energy statistics on fuelwood and charcoal consumption (energy perspective)	These include energy data from national statistical offices as well as from regional databases directly linked to them (i.e. Eurostat, OLADE SIEE) (e.g. Slovenia Statistical Office, energy statistics).
5	Projection of woodfuel consumption based on per capita values and population statistics	Reliability depends on the quality and representation of reference consumption values. Valid approach for short projections since rarely account for saturation dynamics (e.g. WETT projections).
6	Modeling of fuelwood and charcoal consumption based on socio-economic variables	Estimation reliability depends on the quality and representation of reference consumption data. Suitable for longer projections since saturation dynamics are accounted for. Suitable for filling data gaps (e.g. GFPOS)
6.1	National model	Model valid for a specific country based on data exclusively from that country. National models can only be made in the presence of rich country data and are usually the most reliable (e.g. GFPOS national models).
6.2	Subregional/continental model	Model valid for all countries of a region, based on data from that region. Regional models are less reliable than national ones because the dataset used to develop them is rarely representative of all country conditions (e.g. GFPOS regional and continental models).
6.3	Global model	Model valid for all countries of the world, based on data from any country. Global models are less reliable than national and regional ones (e.g. GFPOS).
7.1	Questionnaires filled in by national forestry authorities (official statistics) or authoritative sources (unofficial statistics)	Reliability is extremely variable depending on the reference data used by government officials. Reliability of woodfuel data in forestry questionnaires is low when they refer exclusively to official forestry statistics. The reliability increases when forestry and energy statistics are integrated. Estimation processes are not documented (e.g. FAOSTAT, UN energy statistics).
7.2	Questionnaires filled in by national energy authorities	Reliability is extremely variable depending on the reference data used by government officials. Estimation processes are not documented (e.g. UNECE Questionnaire on Renewables; IEA/AFREPREN Questionnaire on Biomass Energy Statistics).
8	Modeling/processing of questionnaire data	Same as 7.1 and 7.2; reliability depends directly on the questionnaire data used as input data (e.g. GFPOS "FAOSTAT" models).
9	Derived from aggregation of official and estimated data (types 6 to 8)	Reliability of aggregated values depends on the quality and consistency of composing elements (e.g. aggregation of original FAOSTAT data on wood products to form WEIS parameters).
10	Quoting international databases, international and regional thematic studies and reviews	Based on miscellaneous sources (country reports, national and international statistics, etc.). Reliability is extremely variable. Considering the frequent revision of time series, these references are only valid for a few years.
11	Undefined	

TABLE 11

Very tentative reliability ranking of fuelwood consumption statistics from primary sources based on reference types

Tentative reliability ranking (fuelwood consumption data)	High	Mid-high	Medium	Mid-low	Low	Undefined
WETT99 best estimate	8	14			42	36
Country report	89	10	1			
ENDA/IEPE						100
ESMAP						100
Other national	21	32	4		29	13
IEA non-OECD 99						100
FAOSTAT (1998)						100
UN energy statistics 1995						100
RWEDP	3					97
FUNBAR						100
OLADE 80–97						100
FAOSTAT (2003)			100			
GFPOS 1970–2030		6	24	70		
OLADE 90–02		100				
IEA (2002)		55	5		28	13

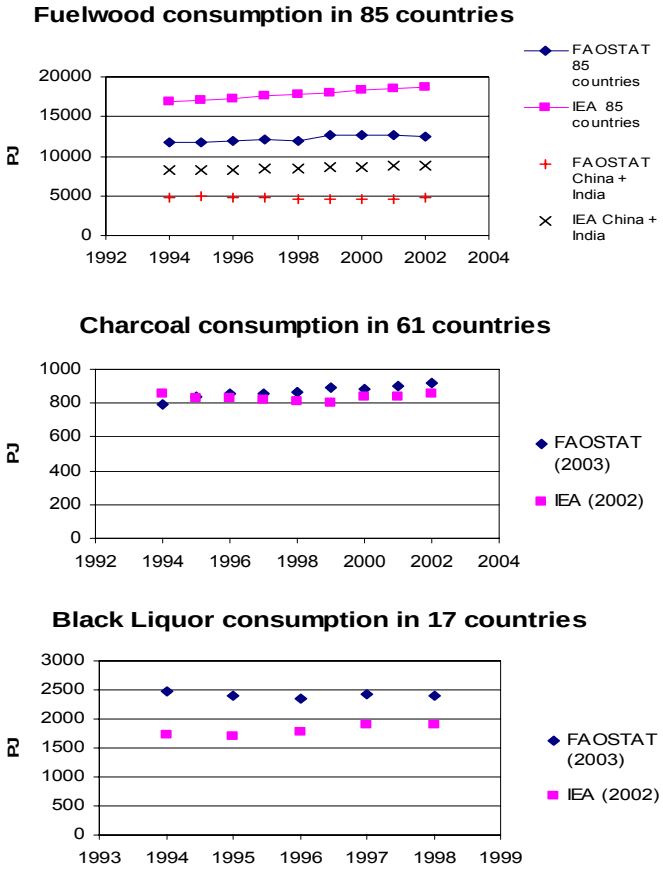
5. Comparison of primary sources

The characteristics of the primary sources included in i-WESTAT differ considerably from one another in terms of parameters, geographic coverage, temporal coverage and reference sources, aspects that are described in detail in Appendixes 5 to 10. Given these peculiarities, it is difficult to compare the various sources over a large number of countries.

Sources that provide relatively large comparable datasets are FAOSTAT (2003) and IEA (2002). Figure 2 shows the summary of fuelwood, charcoal and black liquor for the countries covered by both sources (85, 61 and 17, respectively). According to the global FAOSTAT data the common areas include some 81 percent of the entire fuelwood consumption, 73 percent of that of charcoal and 86 percent of that of black liquor.

FIGURE 2

Consumption of fuelwood, charcoal and black liquor according to IEA and FAO statistics



The differences between FAOSTAT (2003) and IEA (2002) are considerable for fuelwood, where IEA estimates are higher, and for black liquor, where they are lower, while for charcoal consumption they are in reasonable agreement.

The differences for fuelwood are probably a result of the distinct character of the respective data sources. FAOSTAT relies prevalently on forestry statistics, which often underestimate the amount of fuelwood produced (and consumed) in the countries while IEA relies mainly on energy statistics, which may, according to some analysts, be slightly overestimated. Most of the discrepancy between FAOSTAT and IEA estimates of fuelwood consumption originates from the respective estimates for China and India, as shown in the figure 3. Resolving the huge discrepancies for these two countries should be of the highest priority for FAOSTAT and IEA.

With regards black liquor, the difference may depend primarily on the conversion factors applied in deriving the amount of black liquor from paper pulp statistics. This particular aspect requires further investigation and could possibly be resolved by defining and adopting standard conversion factors.

5.1 Definition of best references

As discussed in the section on WETT99 best estimates, most of the references that were identified only a few years ago (1997–2000) as most reliable are no longer valid.

This is a positive sign since it shows improvements in wood energy statistics. In only a few years almost all concerned international agencies have modified their estimation approaches, expanded the geographic coverage and improved on item definitions.

On the other hand, no single reliable source can be identified, which means that the definition of new “best estimates” requires thorough review and cross-referencing of all data sources country by country and item by item. This is a process in which i-WESTAT can demonstrate very clearly its power and usefulness as an analytical tool.

5.2 Contrasting forestry and energy perspectives

The diverging perspectives from the forestry and energy agencies with respect to wood energy, aggravated by the fact that it is considered marginal by both, are often responsible for the critical discrepancies in estimates and the associated confusion.

This contrast can only be resolved by integrating the two perspectives into a uniform analytical context in order to cross-reference and reconcile forestry and energy information and develop a consistent inter-sectoral perspective.

Significant cases are those of Slovenia and Peru, are briefly discussed below.

Slovenia

The Statistical Office of Slovenia produced statistics on fuelwood production (source of FAOSTAT), and on the country’s energy balance (source of IEA) that contrast with each other, as shown in Figure 3. The primary sources and respective references are listed in Table 12.

The FAO/Government of Slovenia Project TCP/SVN/2901 "Supply and Utilization of Bioenergy to Promote Sustainable Forest Management" analyzed all relevant information, including the rich forestry and new census data, applying the Woodfuel Integrated Supply/Demand Overview Mapping (WISDOM) methodology. This process enabled a more realistic level of fuelwood consumption to be estimated in the country, which seems to be better represented by energy data and rather grossly underestimated by forest product data.

FIGURE 3

Estimation of fuelwood consumption in Slovenia from various sources

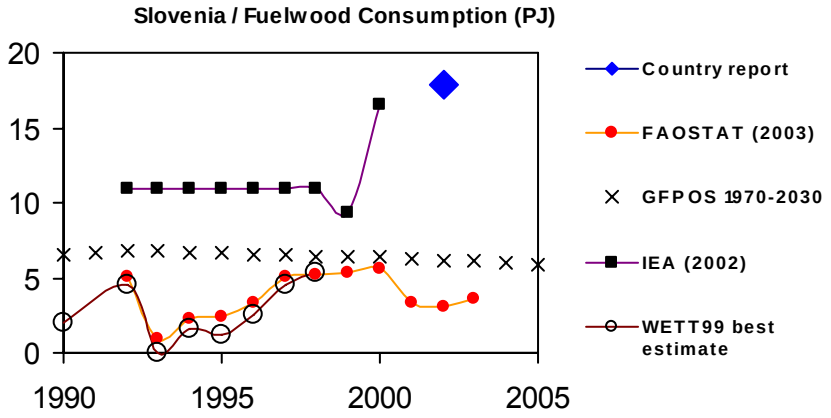


TABLE 12

I-WESTAT sources of fuelwood consumption estimates in Slovenia

Source name	Reference
Country report	Slovenia Wood Energy Statistics (SWSTAT), 2004. Output of FAO/Government of Slovenia Project TCP/SVN/2901 "Supply and Utilization of Bioenergy to Promote Sustainable Forest Management"
FAOSTAT (2003)	Official figure. Statistical Office of Slovenia; forest products statistics
GFPOS 1970–2030	Household Fuelwood model: regional; non-hh Fw model: continental
IEA (2002)	UNECE Energy questionnaires 1993 to 2002. (Correspond to the values reported by the Statistical Office of Slovenia (energy balance) and by Eurostat)
WETT99 best estimate	Refer to Faostat figures available in 1999

Peru

The Peru dataset provides another clear example of the diverse forestry and energy estimation perspectives. In his country report (FAO Project GCP/RLA 133/EC), Rocío Malleux highlighted the different consumption scenarios provided by the forestry and energy information sources:

- forestry statistics and projections from INRENA;
- energy statistics from the Ministry of Energy and Mines.

In presenting both datasets, Malleux commented:

“in the case of INRENA, the recording of fuelwood consumption is carried out on a minimal part of the wood actually commercialized for this purpose …” (that may induce an underestimation of fuelwood consumption); and

“the Ministry of Energy and Mines has a permanent monitoring program of energy consumption, by source and by sector of utilization, based on surveys of industries and households especially in urban areas, a factor that might determine an overestimation of fuelwood consumption.”

The Peru dataset is extremely complex, with each source, listed in Table 13, giving different estimations at different times and all totally distinct, as can be seen from the grey data sets in Figure 4. As a result, in spite of so many statistics, no one can accurately estimate the consumption of fuelwood and charcoal in the country. The recommendations by Malleux to improve and standardize data collection methods and to coordinate institutional efforts in this field are highly justified.

Figure 4: **Estimation of fuelwood consumption in Peru from various sources.**

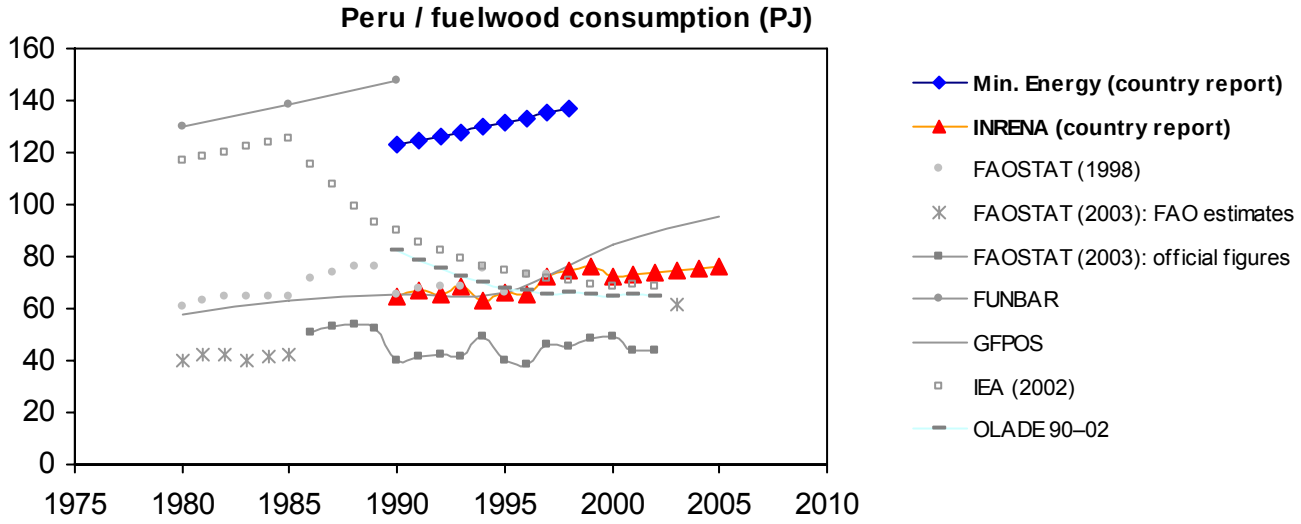


TABLE 13

I-WESTAT sources of fuelwood consumption estimates in Peru

	Primary source	Reference
3	Country Report	Country report by Rocío Malleux. Estimates based on forestry statistics and projections (after 1999) from Instituto Nacional de Recursos Naturales – INRENA – Perú Forestal en Números, 1990-1999
3	Country report	Country report by Rocío Malleux. Estimates based on energy statistics from Ministerio de Energía y Minas (MEM) Balance Nacional de Energía 1998
22	FAOSTAT (2003)	Official figure (source not known)
10	FAOSTAT (1998)	Data from INRENA
22	FAOSTAT (2003)	FAO estimate (apparently GFPOS FAOSTAT model results forced along the official figures series)
16	FUNBAR	Estimates from Fundación Bariloche 1980,1985,1990
30	GFPOS 1970-2030	GFPOS "Faostat 3 " model based on Faostat 1999 figures (whose reference source was INRENA)
34	IEA (2002)	Balance Nacional de Energía 1971–2002 communicated to the Secretariat from MEM.
31	OLADE 90–02	n/a

6. Conclusions and recommendations

6.1. Conclusions

General issues

Role of wood energy statistics

Wood energy statistics are essential for:

- understanding the dynamics of wood energy systems;
- evaluating the role played by woodfuels in the energy sector;
- assessing the share of forest products used (directly and indirectly) for energy purposes;
- assessing the role of woodfuels in climate change mitigation and sustainable development; and
- formulating sound forestry and energy policies and, more specifically, wood energy policies.

In this perspective it is essential to understand the value of existing statistics and pave the way for their improvement.

Wood energy statistics today

Several international (UN New York, FAO, EC/FAO, IEA, WEC, etc.), regional (Eurostat, UNECE/FAO Timber Branch; Olade, Enda, AIT) and national organizations have provided wood energy statistics and information that are now included in i-WESTAT. Comparison with previous versions showed that most databases were recently reviewed, highlighting a revived interest of international agencies in wood energy statistics.

In general, wood energy statistics receive marginal attention from both the forestry and energy sectors and consequently they are scarce, of low reliability, poorly defined and have wide discrepancies among different sources.

Particularly serious is the lack of data on supply sources, which prevents addressing the sustainability issue with objectivity.

It is worth emphasizing that unreliable statistics are not a problem *per se* but rather they are a symptom of a more serious national incapacity in managing the sector, with inevitable negative consequences on the sustainability of resources and services.

In conclusion, despite a tangible improvement in the last few years, existing woodfuel data is still not adequate for understanding the dynamics of wood energy systems; for evaluating the role of wood energy in the energy sector; for assessing energy use of forest products; for assessing the role of woodfuels in climate change mitigation and sustainable development; or for formulating forestry, energy and wood energy policies.

BOX 1

Abstract from the resolutions of the Timber Committee - European Forestry Commission from the JOINT FAO/UNECE WORKING PARTY ON FOREST ECONOMICS AND STATISTICS. Twenty-sixth Session, 15–17 March 2004

Guidance of work area 1, markets and statistics (item 3 of the agenda)

….

Wood energy

18. The Working Party raised the issue of the quality of wood energy statistics, and suggested that the secretariat assess the sources and quality of information available via the national statistics correspondents. Acknowledging the desirability of follow-up to the 2003 policy forum on "Forests, Wood and Energy" and the associated market discussions, future work in this field will be decided by the forthcoming Strategic Review of the Integrated Programme of Work of the TC and EFC, using, among other things, inputs established during an informal meeting on this subject during the Working Party session.

Guidance of work area 3: forest sector outlook studies, focus on review of major draft outcomes of EFSOS

….

32. The Working Party agreed on the following topics emerging from the EFSOS analysis as meriting further, more detailed, consideration by UNECE/FAO over forthcoming years, and suggested the strategic review process took them into consideration:

- wood energy policy (policy for renewable energy) and information gaps as regards unrecorded harvests;
- promoting the sound use of wood;

Recently, the issue of the quality of wood energy statistics was raised at the 26th Session of the Joint FAO/UNECE Working Party on Forest Economics and Statistics (see Box 1).

I-WESTAT, with its user-friendly consultation frame, allows comparison of all statistics and cross-referencing of all primary and secondary sources, thus assessing, country by country and item by item, convergences and contradictions. With these functions i-WESTAT helps in the evaluation of existing data, offers an opportunity to identify the main limitations, problems and drawbacks faced by major wood energy statistics sources and assists in paving the way to overcoming them.

FAOSTAT and other FAO initiatives

FAO forestry statistics provide the most consistent input to the quantification of woodfuel flows but their information content needs to be understood in order to produce consistent wood energy statistics. Key aspects are as described below.

In accordance with their original aim, FAO forest products statistics report forestry data supplied by member countries, usually by the ministries responsible for forestry. FAO also has the license to produce its own estimates for filling data gaps when needed.

National forestry agencies have a very low capacity for providing consistent wood energy data, and this factor strongly affects the reliability and completeness of wood energy statistics. Unlike other conventional forestry products, woodfuel production and consumption concern both the forestry and energy sectors while forest and non-forest wood resources and their flow are almost entirely informal.

Since the adoption of the new questionnaire and the change in definition from “fuelwood” to “wood fuel, including wood for charcoal” in the roundwood removal category, the role and contribution of FAOSTAT forestry statistics in the creation of consistent wood energy statistics has become clearer. Some contradiction still remains, however, where data gaps are filled in with GFPOS fuelwood model estimates that refer to total consumption inclusive of all supply sources and not only to roundwood removals.

Considering the structure and mandate of FAOSTAT forestry statistics, whose main balance is in total removals, it is unlikely that in the near future they will develop to cover the entire range of wood energy items and aspects. In fact, many of these items are created downstream, from sources that have been put in the production statistics under other categories (such as pulp- or sawnwood) or are produced in farmlands and other non-forest domains.

In synthesis, according to the UBET definition of woodfuels, FAOSTAT provides statistics on *charcoal* only.

Specific *fuelwood* and *black liquor* statistics are not provided by FAOSTAT forestry statistics but these include other items that can be used in their estimation. Such items are: “wood fuel, including wood for charcoal” (a sub item of roundwood removals), “wood residues” and “chemical/semi-chemical pulp”.

In fact, as discussed earlier, the fuelwood and charcoal data included in the i-WESTAT database as “FAOSTAT (2003)” are not true FAOSTAT data but were derived by combining the original FAOSTAT data mentioned above following, as closely as possible, the woodfuel balance scheme of WEIS and UBET (Appendix 2).

FAOSTAT data has been available for all countries over a 42 year period (1961–2003) but there is no disaggregation by sector or by area of consumption.

In addition to FAOSTAT data, FAO has contributed to the development of consistent wood energy statistics at national, regional and global level through many initiatives. The most relevant actions undertaken in the last few years are listed in Box 2.

Complexity of wood energy systems

The patterns of woodfuel production and consumption, and their associated social, economic and environmental impacts, are quite complex and very site- and situation- specific.

The disciplines that regulate wood energy are extremely heterogeneous, encompassing forestry, physics, economy, social sciences, etc., which make the technical capacity to manage this sector a very rare item.

Broad generalizations of woodfuel situations at regional, national and even at sub national level, based on a poor understanding of area-based wood energy systems, still commonly lead to biased assumptions [10] and, consequently, to poor statistics.

To date, woodfuel data have been “minor elements” of forestry and energy information systems, in which they receive a level of attention that is clearly not adequate for the inter-sectoral and inter disciplinary complexity of wood energy systems. As a result, there is a problem of inadequate capacities by national institutions in coping with wood energy statistics (and hence in supplying statistics to international agencies).

Diverging forestry and energy perspectives

The frequent and wide discrepancies among information sources result from the lack of solid reference data and inconsistent estimation methods, reflecting the different perspectives of forestry and energy agencies on this sector.

This is the case of FAOSTAT (2003) and IEA (2002), which hold the two most important databases. The main references of the first are national forestry agencies, with a traditional focus on wood removals from the forests (although this perspective is rapidly evolving), with the risk of a systematic underestimation of woodfuel quantities. On the other hand, the references of the second are mainly energy agencies and energy balance statistics. These two perspectives cause major discrepancies in the final estimates (as discussed in section 5.2 and in several country cases summarized in Appendix 11).

Lack of clear responsibility

Wood energy is strongly inter-sectoral, considering the important forestry, energy, rural development and agricultural aspects that characterize it. This is a characteristic that produces a fragmentation of competencies among institutions and services, each of which holds a piece of the information puzzle that concerns the wood energy sector. In spite of the important role of wood energy in both forestry and energy none of them takes full responsibility for developing wood energy policies and for making them a priority issue.

It is becoming more and more evident that the wood energy issue cannot be dealt with from a single perspective and that a sound approach must integrate all sectors and disciplines concerned.

Specific issues

Terminology

Unambiguous wood energy terms and clear definitions are essential for the comparison and combination of statistics from different sources and, most importantly, they are instrumental in the processes of estimation. Wood energy terms have always suffered from simplifications and generalizations.

Fuelwood, according to UBET, includes wood residues and recovered wood but this is often overlooked. In FAOSTAT, for instance, the category “Wood Fuel, including wood for charcoal”, which refers to roundwood removals, clearly does not include wood residues. However, the results of GFPOS models, which are used to fill gaps in the above category of FAOSTAT, are based on consumption data that do include them. Quantitatively this is not very relevant but it represents a conceptual contradiction.

The promotion of UBET by FAO has brought significant improvement in this context but the process of agreement and adoption is still informal and needs to be pursued further.

Data coverage

The coverage of woodfuel products and flows by the various sources is extremely heterogeneous (see Appendixes 5 to 9). Only the statistics based on FAOSTAT (2003) cover the entire range of items (combination of products and flows), while most other sources report only on selected items. The most common items are fuelwood and charcoal consumption.

Additional information on the sector of consumption (i.e. household, industrial and commercial) is provided by nine out of 20 primary sources, IEA being the most relevant, and for selected countries only (Appendix 8). Information on area of consumption, i.e. urban and rural, can be found only in two primary data sources: country reports and other national (Appendix 7). Unfortunately, FAOSTAT (2003) does not provide disaggregated data by sector and/or area.

The temporal and geographic coverage by various sources are also extremely heterogeneous (Appendixes 5 and 9). FAOSTAT (2003) and GFPOS modeling show the more comprehensive coverage, including all countries of the world with time series from 1961 to 2003 (FAOSTAT) and from 1970 to 2030 (GFPOS).

BOX 2
Relevant FAO actions (other than FAOSTAT)

- Wood energy group of Forest Products and Economics Division Development and promotion of UBET
- Conceptual design of Wood Energy Statistics Systems (WESTAT) built on a clear system of definitions (UBET)
- Regional studies on wood energy covering the entire world, field projects, pilot studies, country reports.
- Development of planning tools (A Guide for Woodfuel Surveys, WISDOM)
- Forests Products and Economics Division initiative for the harmonization and review of all available national and international information sources through i- WEIS (version 2002 and 2004)
- Informal collaboration with international (IEA, UN, IEPF, WEC) , regional (UNECE, OLADE, ENDA, AIT, etc.) and national partners (Mexico, Senegal, Slovenia)

Forestry Policy and Information Division:
Development, in the framework of the Global Forest Products Study (GFPOS), of fuelwood and charcoal consumption models to improve country estimates and to fill FAOSTAT data gaps

Because of these inconsistencies the comparison between primary sources is limited mainly to fuelwood and charcoal consumption. The best level of comparison can be achieved at the level of individual countries, where i-WESTAT carries out its most important function. Direct comparison at global or regional level is impossible, except for FAO datasets (FAOSTAT 2003, WETT99 best estimates and GFPOS). A more interesting comparison between FAOSTAT (2003) and IEA (2002) on a subset of countries covered by both sources shows that IEA figures are significantly higher than FAOSTAT's for fuelwood consumption but in reasonable agreement concerning charcoal consumption (see Chapter 5). The values of black liquor based on FAOSTAT's paper pulp statistics are higher than IEA's but this is probably on the result of conversion factor inconsistencies that can be easily resolved.

It is important to highlight that there is no information at all on fuelwood and charcoal supply sources (natural forests, forest plantations, agricultural plantations, orchards, etc.) or on sustainability aspects. Except for wood residues and by-products of industrial processes, which represent fairly closed production/consumption cycles, the supply sources of fuelwood and of charcoal are undefined, leaving ample room for speculation about the real impact on natural forest resources and meaning that the sustainability issue cannot be addressed with objectivity.

Data generation

Questionnaires. The questionnaire approach, which is followed by international data sources, has several weaknesses, such as the lack of documentation on the references and estimation procedures used, or the simple fact that questionnaires are often not filled out. In these cases the agencies issuing the questionnaires are forced to seek alternative sources or to make their own estimates. FAOSTAT, for instance, was forced to estimate more than 50 percent of its woodfuel figures reported so far and the situation does not seem to improve (in 2000, the estimated values were over 60 percent).

Moreover, experiences at FAO and IEA have shown that including wood energy within huge questionnaires on other items may lead to neglecting this item. It is evident that energy from wood has complicated interdisciplinary and inter sectoral aspects and therefore requires a high degree of attention. If a questionnaire approach cannot be avoided, then a specific one should be designed focused on wood energy aspects, including that of woodfuel supply sources.

The adoption of joint questionnaires, resulting from international collaboration and coordination, such as the Joint Forest Sector Questionnaire and the Joint Questionnaire on Renewables and Wastes mentioned below, is an important step that improves the consistency of supplied data with reduced stress on national correspondents but does not resolve the problem of data reliability.

In several instances the questionnaire approach has been abandoned in favor of more reliable data collection systems. A clear case is the FAO Forest Resources Assessment Programme, which abandoned such an approach in the 1970s in favor of documented references, expert judgments, survey approaches, etc. wood energy questionnaires should therefore be complemented by exhaustive metadata or replaced by well documented expert judgments.

GFPOS modeling. GFPOS modeling of fuelwood and charcoal consumption provided time series for all countries of the world and is currently used to fill data gaps in FAOSTAT forestry statistics. If the effect of the GFPOS study is limited to this application and to the series of estimates already produced, its impact is likely to fade away in a short time. On the contrary, the GFPOS study could provide a continued benefit if the most efficient models were to be converted into flexible 'adjustment functions' to be used with new reference data. Another important product of GFPOS is the dataset on woodfuel consumption that was derived from selected field surveys and used for the development of the various models. If properly structured and updated with recent reliable observations this dataset will represent a solid asset for future studies and model refinements.

The complexity of wood energy calls for a thematically focused and multidisciplinary approach. The development of a reliable data collection system should benefit from the collaboration of international and national forestry and energy agencies, the integration of relative competences, and the transparent sharing of data and competencies. The guidelines for the execution of national woodfuel surveys produced and disseminated by FAO [8] may play an important role in this context.

Conversion factors

The treatment and conversion of units are important aspects, sometimes responsible for inconsistencies between statistics derived from the same original data.

The way in which primary data are converted should be the same at all agencies. Conversion from volume to energy units needs some basic assumptions, to be agreed upon by all relevant statistical institutes. These specifically refer to the average dry matter density of the wood used and its average moisture content. On the basis of these assumptions, conversion factors can be calculated. In addition, agreement on efficiency rates of common conversion technologies and clarity on whether such rates are applied or not are essential.

It seems that at present there is no clear idea as to what kinds of assumptions are appropriate. It should be realized that this can provide huge distortions. It may be necessary not to have overall conversion factors, but to differentiate for regions according to prevailing regional conditions. In this case assumptions may be different for different regions, but the method for conversion should remain the same.

The conversion method to express black liquor into wood volume equivalents should receive special attention.

Overall conclusions

The poor state of wood energy statistics are a result of the lack of a sectoral policy focus at national as well as international level rather than the quality of existing data. The problem is not lack of reliable data *per se* but rather the lack of a uniform and consistent analytical perspective, which prevents proper use of the information that exists in the forestry and energy agencies of most countries.

What are the chances of improvement?

The poor condition of wood energy statistics are a result of many problems of a varying nature. Some of these are deeply-rooted, requiring long-term plans of action such as the re-directing of institutional responsibilities at national and international levels and the deployment of additional human and financial resources.

But this should not be discouraging. Other problems are of a more technical nature and can be approached with significant benefits in a comparatively short time frame and with minor financial investment. It is just a matter of spacing out actions.

Beneficial short-term actions could include the distribution of I-WESTAT to international agencies and national correspondents. This would play an important catalytic role. The possibility of visualizing the various estimates will indicate the benefits of a collaborative approach for the definition of common procedures and standards. As discussed in Chapter 5, for example, a major part of the discrepancy between FAOSTAT and IEA fuelwood consumption statistics could be resolved by reconciling the estimates for China and India alone.

At the same time, the harmonization of definitions and conversion factors and the joint review of references, for instance, can considerably reduce the discrepancies among international data sources and enhance the general sense of confidence about this “complicated issue”.

Another action could be the integration of existing knowledge. It is argued that the discrepancies and inconsistencies of wood energy statistics depend on the lack of integration of existing information as much as on the availability of data. The review and integration of existing information (from forestry, energy, industry, demography, etc.) cost far less than the collection of new data and allow the definition of critical data gaps, thus reducing the need for expensive surveys. A great deal of information exists in the countries that can be analyzed and integrated through methods such as WISDOM, which has high benefits and relatively low costs.

Changing attitude

A changing attitude towards wood energy is becoming more and more evident in developed and, to a lesser extent, developing countries. As a result, wood energy is receiving higher recognition than ever before.

- Current concerns about global warming and initiatives such as the Kyoto Protocol generate an increasingly widespread interest in the sustainable use of woodfuels as a viable substitute for fossil fuels for power generation and other energy purposes. This new dimension presents a great opportunity for the development of this sector, but the demand for sound information to guide policies and project designs is equally great and certainly unmatched by the current state of knowledge.
- As an effect of this new interest, in the last few years there has been a marked improvement in the attention paid by international and national agencies to woodfuel statistics. The increased attention by statistical divisions of energy and, at a lower level, forestry agencies has produced better-structured databases, more comprehensive geographic coverage and more comparable statistics. The latter is the result of the adoption of the consistent terms and definitions strongly and successfully promoted by FAO.
- Inter institutional collaboration and data sharing have also improved considerably lately. Most relevant are the adoption of joint questionnaires and the inherent adoption of common definitions, such as:
    - the Joint Forest Sector Questionnaire (1999), shared by FAO Forestry Department, the Economic Commission for Europe (ECE), the Statistical Office of the European Communities (Eurostat) and the International Tropical Timber Organization (ITTO);

- o the Joint Questionnaire on Renewables and Wastes adopted by the Energy Statistics Working Group (1999), made up of IEA, the United Nations, the United Nations Economic Commission for Europe, Eurostat and their respective member governments.

Notwithstanding the concern about questionnaires expressed under “Data generation” above, the adoption of shared questionnaires and definitions has the beneficial effects of reducing the pressure on national correspondents (often afflicted by look-alike forms from international agencies asking for the same information) and reducing the confusion created by similar but largely inconsistent datasets.

To date there have been just weak and not always effective actions but there are clear signs of an increased interest in wood energy by international and national agencies and of a more active and positive attitude towards a process of upgrading wood energy statistics.

Wood energy tools

The tools developed by FAO can play an important proactive and normative role in promoting and upgrading wood energy statistics.

UBET and i-WESTAT represent useful tools in the task of improving wood energy statistics.

- The process of clarifying concepts, terms and definitions launched by UBET provides a solid base for inter-institutional collaboration and coordination and the development of consistent wood energy statistics;
- The i-WESTAT database offers an unprecedented opportunity to consult the knowledge provided so far and compare statistics from the most relevant sources of wood energy data. With these functions, i-WESTAT assists in the identification of main limitations, problems and drawbacks of current wood energy statistics and helps to pave the way to overcome them.

In addition, the Guide for Woodfuel Surveys and WISDOM methodology developed and disseminated by FAO represent well-focused tools for building national capacities of collecting and analyzing wood energy statistics.

In synthesis, the elements listed above justify some optimism. There is reasonable hope of improving the quality of wood energy statistics and the understanding of the dynamics of wood energy systems dynamics.

6.2. Recommendations

In order to support the development of a uniform and comprehensive wood energy outlook, and hence to build up consistent statistics, it is recommended that the dialogue between forestry and energy institutions be improved along with the integration of existing knowledge and espertese within these two sectors. To this end, the following actions are recommended:

Institutional Collaboration

Short term

At the bilateral level it is recommended that FAO (wood energy group and FAOSTAT) liase with the Energy Statistics Division of IEA as a privileged partner on wood energy statistics and undertake a joint review of respective woodfuel statistics. It is envisaged that minimal consultations can resolve the major discrepancies between the data of the two agencies and for the basis for a coordinated initiative.

The aim of these consultations will be to review terms and definitions, cross-reference the respective data sources (from questionnaires, national statistics, country correspondents, etc.), to determine the pest estimation procedures and to define common conversion and transformation factors and efficiency rates. This process will be greatly facilitated by the i-WESTAT database.

Medium term

At the multilateral level, it is recommended that international and regional agencies concerned with wood energy statistics:

- continue in the process of sharing information and deepen the level of integration;

- agree upon standard methods and standard conversion factors (global, regional);
- conclude the UBET process by agreeing upon and adopting a common set of terms and definitions; and
- combine their forestry and energy axpertise and develop a specialized “wood energy” program and a joint wood energy questionnaire

Long term

- make more efficient use of the limited resources by sharing responsibilities and avoiding redundancies in data collection and analysis
- increase consistency among all wood energy databases

FAO action on wood energy statistics

Short term

- Within the framework of data collection for international databases, and in order to support the transparency and critical review of existing estimates, it is recommended that i-WESTAT be provided to national and international institutions dealing with forestry and energy and involved with data and planning;
- In order to establish a reliable and documented information base on woodfuels, it is recommended that woodfuel data from local and national field surveys continue to be collected from “grey”literature through a bibliographic search, as was done for the GFPOS study on woodfuels;
- It is recommended that GFPOS modeling of fuelwood and charcoal consumption be further developed in order to to convert it into a flexible aid to the estimation process. This will include the selection of most efficient models, the updating of independent explanatory variables (GDP, forest area, urbanization, etc.) and the conversion in “adjustment functions to be used in combination with new reference data;
- In order to propose standard approaches and procedures, it is recommended that a review of conversion factors currently adopted at both national and international levels be undertaken, with special attention given to efficiency losses.

Medium Term

- In order to improve the reliability of wood energy statistics at the national level (and, indirectly at the international level) it is strongly recommended that the integrated analysis of existing information from forestry and energy sectors be improved. To this end, it is recommended that international agencies promote and support the implementation of integrated studies such as WISDOM [10]. These studies will provide the most comprehensive portrayal of national wood energy systems based on existing knowledge and will pinpoint critical information gaps. This will allow the concentration of actions on circumscribed targets and thus optimize the use of available resources (human, institutional, financial, etc.)
- In order to increase the efficiency of data collection and analysis at the national level, it is recommended that FAO continue in the development and dissemination of methodological tools such as the Guide for Woodfuel Surveys and increment its technical assistance to member countries in order for them to carry out field surveys.
- In order to improve upon the understanding of data reliability, it is recommended that the use of questionnaires in the estimation process be minimized and the critical and documented review of data sources be encouraged (as has been done in other branches of forestry statistics).

Long term

- In order to enhance national wood energy planning capacities, it is recommended that the collection of disaggregated data be promoted by type of woodfuel, by sector of consumption and by area of consumption. Of particular relevance for the forestry sector, by supply sources. The latter information, together with sustainable production levels, is largely undefined but remains crucial for the implementation of planned woodfuel production schemes and the development of sustainable forest management plans and programs.

References

[1] The role of wood energy in Asia. Working Paper FOPW/97/2. FAO 1997.
http://www.fao.org/docrep/w7519e/w7519e00.htm

[2] The role of wood energy in Europe and OECD. Working Paper FOPW/97/1. FAO 1997.
http://www.fao.org/docrep/w7407e/w7407e00.htm

[3] The role of wood energy in Africa. Working Paper FOPW/99/3. FAO 1999.
http://www.fao.org/docrep/x2740e/x2740e00.htm

[4] The role of wood energy in the Near East. Working Paper FOPW/00/2. FAO 2000.
http://www.fao.org/docrep/003/X9085E/X9085E00.htm

[5] UBET–Unified Bioenergy Terminology. FAO 2001.
http://www.fao.org/forestry/FOP/FOPH/ENERGY/doc/UBET/eng/UBET-e00.htm

[6] El rol de la energía de la madera en Latinoamérica y el Caribe. Santiago de Chile. April 2001
http://www.fao.org/forestry/FOP/FOPH/ENERGY/doc/lc_e.pdf

[7] Wood energy information in Africa. Review of TCDC wood energy country reports and comparison with the regional WETT study. FAO 2001.
http://www.fao.org/forestry/FOP/FOPH/ENERGY/doc/InfoinAfrica.pdf

(Available also in French)
[8] A guide for woodfuel surveys. FAO 2002.
http://www.fao.org/docrep/005/Y3779E/Y3779E00.htm

(Available also in French and Spanish)
[9] Wood energy information analysis in Asia. FAO 2003.

[10] Woodfuels Integrated Supply/Demand Overview Mapping – WISDOM. FAO 2003.
http://www.fao.org/docrep/005/Y4719E/Y4719E00.htm

[11] Past trends and future prospects for the utilization of wood for energy. (Annex 1 and Annex 2). By J. Broadhead, J. Bahdon and A. Whiteman. Global Forest Products Outlook Study (GFPOS). FAO 2001.

[12] Unified Bioenergy Terminology. FAO 2004 (in press)

Appendixes

1. UBET meeting statement and considerations on statistical databases

FAO IEA IEPF OLADE ENDA AIT-CEERD

EXPERT CONSULTATION
Unified Wood Energy Terminology – UBET
Rome, 3 – 4 October 2001
MEETING STATEMENT

Twenty-five experts from Latin America, Europe, Asia and Africa, belonging to leading international, regional and national organizations in the topic of wood energy met at FAO in Rome, from 3 to 4 October 2001.

The participants

recognized that:

- wood energy is, and will remain in the future, an important source of energy;
- properly harnessed, wood energy provides the opportunity to foster sustainable development, particularly at the local level;
- the discussion on climate change opens new opportunities for the development of bioenergy;
- data and information on woodfuels (and other biofuels) are crucial for the evaluation of the current situation, the assessment of environmental issues and constitute the basis for wood energy planning and sound forestry and bioenergy policies.

on the other hand,

- the importance of wood energy is not yet properly recognized by energy and forestry planners and policy-makers;
- the national and international capabilities for the systematic collection, analysis and presentation of woodfuel statistics are often dramatically insufficient and focused mainly on the demand side leaving unattended most issues related to supply and its sustainability;
- the terminology used for collection, analysis and presentation of woodfuel statistics is not properly defined and standardized;
- most countries lack appropriate tools, methodologies and human resources for data collection, interpretation, planning; and
- there is insufficient coordination and collaboration among national, regional and international organizations (forestry, energy and agriculture).

prepared:

- a revised list of the terms with their definitions which will be described in a publication called “A Unified Wood Energy Terminology (UBET), Definitions and Descriptions” to be edited by FAO.

discussed:

- various methodologies needed for bioenergy information and planning, including:
  - an approach to be followed for the identification and classification of main biofuels, and
  - tools for the development of improved national wood energy statistics as well as the implementation of wood energy planning exercises.

agreed:

- to be actively involved in the adoption, application and dissemination of UBET;
- to increase cooperation at regional/international levels for the development of improved woodfuel statistics and planning systems; and
- to help in launching and to support an initiative directed to improve the understanding and quantification of bioenergy supply sources.

Abstract from Unified Bioenergy Terminology (UBET)

Statistical databases

Data from national administrations are, in most cases, inadequate both in quantity and quality. Energy statistics are frequently restricted to the commercial (and thus more easily measurable) component of the energy picture. In developing countries, there is often a lack of expertise as well as financial and human resources for adequate data collection and estimation, a task rendered more difficult by the decentralized, mostly rural, and largely non-marketed nature of bioenergy use. The variety of sources, the lack of uniform definitions and methodologies, and the use of different units and conversion factors, make comparison between countries and assessment of time trends a difficult task Even where the figures and values presented or estimated by national and international statistics are well established, the structure of the bioenergy database is affected by the following problems.

- *Coverage.* Different international agencies produce periodic statistical data (i.e. FAOSTAT, UNECE, IEA, OLADE, Eurostat) on products related to bioenergy but with very heterogeneous approaches and without truly covering bioenergy. Those statistics are based on a few and selected biofuels only (e.g. FAO covers charcoal and "wood fuel, including wood for charcoal" as a subcategory of roundwood removals; Eurostat covers biomass as a renewable energy source with a subcategory called "wood and wood waste" that includes, in spite of the definition, also lingo cellulosic biomass from agroresidues; IEA publishes data on primary solid biomass inclusive of wood and non-wood biomass but keeps estimates of subcomponents such as wood, black liquor and agricultural residues. The data on biofuels, and woodfuels in particular, have also to fit into the structure of the energy and forestry statistics which are the main basis for modeling and forecasting work that is undertaken in the technical organizations involved. For instance, data on black liquor (the most important form of wood energy in many developed countries) are omitted in FAO statistics. In addition, key agrofuels are not considered at all in most of the statistics.
- *Disaggregation.* Most existing information on *biofuels* and *woodfuels* is focused on *biomass* consumption and does not pay sufficient attention to other related aspects such as production and supply sources. Regardless of the importance of non-forest supply sources of *wood energy* and the large use of recycled products, the supply side is not disaggregated in the FAO wood energy database. On the other hand, although there is a clear shift of *wood energy* demand from traditional to modern uses, with considerable repercussions for the whole wood energy systems, information on demand is absent in the current FAO database. One important requirement seen here is a need to assess consumption in rural and urban areas separately.
- *Definition incompatibility.* The main terminology currently used by the above agencies is not adequate for the proper collection, collation, exchange and presentation of biofuel data yet. The absence of a comprehensive framework and clear sets of definitions limits the possibility of comparison and exchange with other data sources on *bioenergy*.
- *Uncertainty of conversion factors. Bioenergy* accounting covers primary data from various sources. Energy sources and commodities may be measured by their *mass* or weight or even *volume*, but the essential factor is the *energy content* related to these sources and commodities. The uncertainty of conversion factors limits the possibility of comparison and exchange with other data sources.

Therefore there is a strong need for a unified terminology which will improve data collection and exchange in order to enable assessments and policy analysis at a national and international level. To develop an adequate database for *bioenergy*, the following aspects need to be taken into consideration.

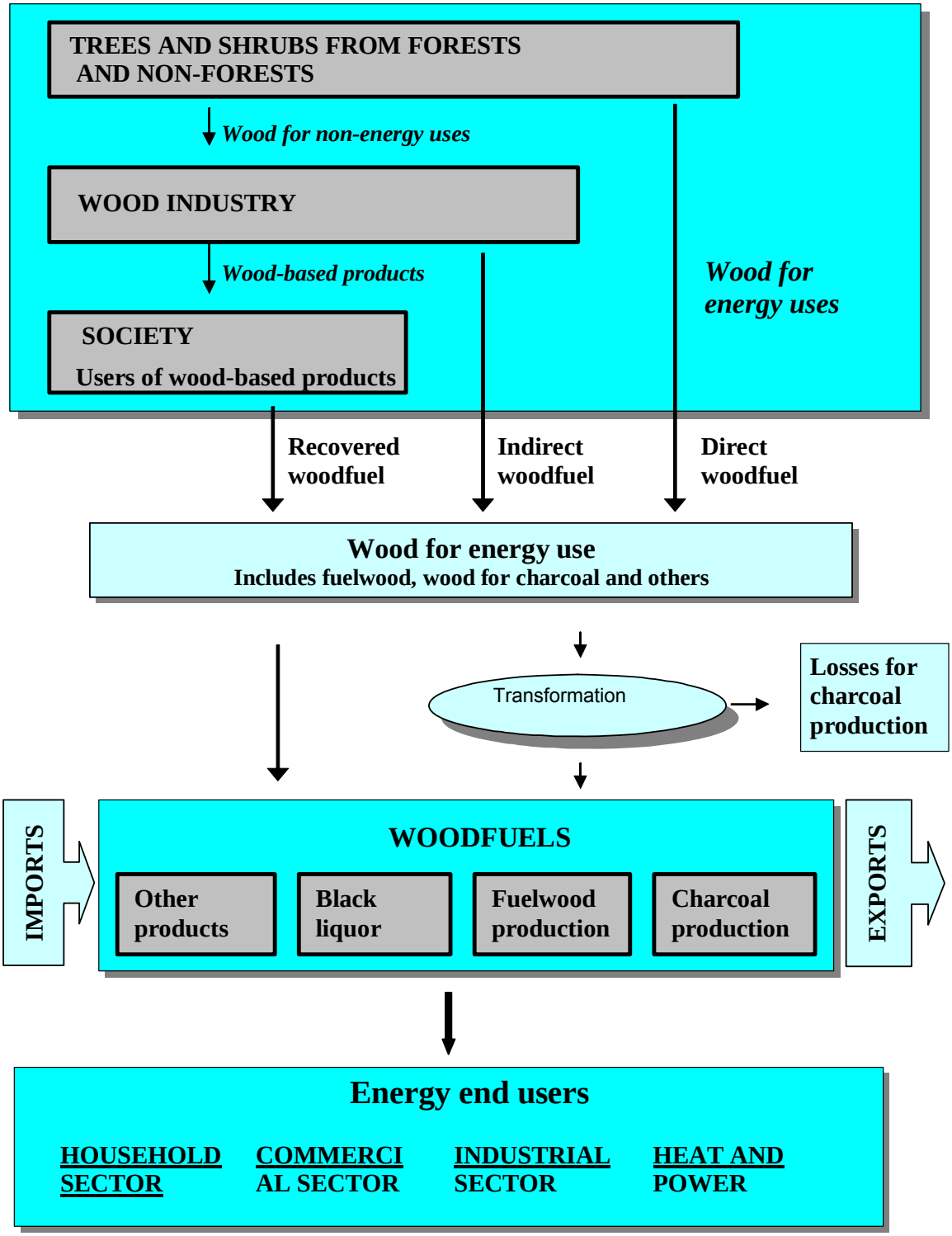
- *Supply sources:* including forestry and agriculture, *biomass* processing industries (wood industry and agroindustry) and end-use products of the society as well as biofuel preparation activities (i.e. charcoal production).
- *Demand (users' side):* including the main demand sectors (residential, commercial, industrial sectors and heat and power generation) as well as the distinction between urban and rural areas.
- *Biofuel trade:* including import and export of *biofuels.*

The basic idea behind such a terminology is to create a suitable framework for the identification of the amount and type of *bioenergy* flowing from different supply sources to meet end users needs. Thus the fuel or product used to transport energy is the basic parameter to be accounted and properly classified. Whether in commercial or non-commercial terms, these fuels should always be considered goods or commodities that are valuable and capable of meeting demand effectively.

2. Definition of i-WESTAT items and conversion factors

The woodfuel types and flows that compose the "items" of the i-WESTAT database refer to the definitions formulated in the Unified Bioenergy Terminology and summarized in the following figure.

Woodfuel balance scheme, from supply source to end user



Definition of relevant terms

The following is a selection of the more relevant terms from the Unified Bioenergy Terminology.

black liquor
alkaline spent liquor obtained from digesters in the production of sulphate or soda pulp during the process of paper production, in which the energy content mainly originates from the content of lignin removed from the wood in the pulping process

charcoal
solid residue derived from carbonization distillation, pyrolysis and torrefaction of *fuelwood*

energy density
ratio of net energy content and *bulk volume*

NOTE The energy density is calculated using the *net calorific value* determined and the *bulk density*

firewood
cut and split oven-ready *fuelwood* used in household wood-burning appliances such as stoves, fireplaces and central heating systems. Firewood usually has a uniform length, typically in the range 150 to 500 mm.

fuel
energy carrier intended for energy conversion

fuelwood
woodfuel where the original composition of the wood is preserved

gross calorific value (q_{gr})
absolute value of the specific energy of combustion, in joules, for unit mass of a solid fuel burned in oxygen in a calorimetric bomb under the conditions specified. The results of combustion are assumed to consist of gaseous oxygen, nitrogen, carbon dioxide and sulphur dioxide, of liquid water (in equilibrium with its vapour) saturated with carbon dioxide under conditions of the bomb reaction, and of solid ash, all at the reference temperature and at constant volume. The old term is higher heating value

NOTE Adopted by ISO1928:1995

net calorific value (q_{net})
under such conditions that all the water of the reaction products remains as water vapour (at 0.1 MPa), the other products being as for the *gross calorific value*, all at the reference temperature. The net calorific value can be determined at constant pressure or at constant volume. The old term is lower heating value. Net calorific value as received ($q_{net,ar}$) is calculated by the net calorific value from dry matter ($q_{net,d}$) and the *total moisture* as received

oven-dry wood
wood free of *moisture,* produced by drying to constant weight under specific conditions

recovered construction wood
used wood arising from construction of buildings or from civil engineering works

sawdust
fine particles created when sawing wood

NOTE Most of the material has a typical particle length of 1 to 5 mm

slabs
parts of *woody biomass* created when cuts are made into the edges of logs and whereby one side shows the original rounded surface of the tree, either completely or partially, with or without *bark*

stacked volume
volume of stacked wood including the space between the wood pieces

used wood
wood substances or objects which have performed their intended purpose

NOTE 1 See also recovered construction wood and demolition wood
NOTE 2 Proposal within the Draft CEN Report Solid Recovered Fuels [11]

wood chips
chipped *woody biomass* in the form of pieces with a defined *particle size* produced by mechanical treatment with sharp tools such as knives. Wood chips have a sub-rectangular shape with a typical length 5 to 50 mm and a low thickness compared with other dimensions

NOTE See also *cutter chips, forest chips, green chips, stemwood chips*, and *whole-tree chips.*

wood energy, forest energy
energy derived from *woodfuels* corresponding to *the net calorific value* of the *fuel*

wood energy systems
All the (steps and/or) unit processes and operations involved for the production, preparation, transportation, marketing, trade and conversion of woodfuels into energy

woodfuels, wood based fuels, wood-derived biofuels
all types of *biofuels* originating directly or indirectly from *woody biomass*

NOTE See also *fuelwood, forest fuels,* and *black liquor.*

wood processing industry by-products, wood processing industry residues
woody biomass by-products originating from the wood processing as well as the pulp and paper industry

NOTE See also *bark, cork by-products, cross-cut ends, edgings, fibre board by-products, grinding dust, particle board by-products, plywood by-products, sawdust, slabs* and *wood shavings*

wood shavings; cutter shavings
shavings from *woody biomass* created when planning wood

woody biomass
biomass from trees, bushes and shrubs

NOTE See also *forest wood*, *wood processing industry by-products, fibre board by-products, particle board by-products, plywood by-products* and *used wood*

3. Basic parameters and conversion factors

Basic parameters and conversion factors		
Wood – net calorific value (30% mc, dry basis)	13.8	MJ/kg
Charcoal – net calorific value (5% mc, dry basis)	30.8	MJ/kg
Charcoal/fuelwood	165	Kg charcoal/CUM
Wood density	725	Kg/ CUM
Black liquor availability*	2.27	CUM/ tonne chemical pulp
Chemical pulp (in form of black liquor)	22 711	MJ/ tonne chemical pulp
* for black liquor accounting as woodfuel, it can be assumed that from one tonne of chemical cellulosic pulp production, an amount of liquor equal to 2.27 m^3 of woodfuel, in energy terms, results (FAO, 1997).		
Auxiliary assumptions		
Fraction of wood residues used as fuel	50 %	
Fraction of black liquor used as fuel	100 %	

Energy Conversion Factors						
		MJ	**PJ**	**Toe**	**Ktoe**	**Boe**
Megajoules	**MJ**	1	1.00E-09	2.388E-05	2.388E-08	0.000164
Petajoules	**PJ**	1.00E+09	1	23 884.6	23.8846	1.64E+05
Tonne of oil equivalent	**Toe**	41 868	4.19E-05	1	0.001	6.849315
'000 Toe	**Ktoe**	41 868 000	0.041868	1 000	1	0.006849
Barrel of oil equivalent	**Boe**	6 112.73	6.11E-06	0.146	0.000146	1

SI prefixes

Prefix	Symbol	Factor
Peta	P	10^{15}
Tera	T	10^{12}
Giga	G	10^{9}
Mega	M	10^{6}
Kilo	K	10^{3}

4. Specification of relevant IEA energy statistics

Notes on combustible renewables and waste from OECD metadata [IEA Web site]

in 1996 and 1997, the Secretariat extensively revised data on combustible renewables and waste (i.e. solid biomass, biogas, liquid biomass, industrial waste and municipal solid waste) based on data from Eurostat (for the 15 EU member countries) and on other national sources for other OECD member countries. As consumption data for combustible renewables and waste from Eurostat are generally available from 1989, there may be breaks in series between 1988 and 1989 for some EU member countries. Generally data on combustible renewables and waste are reported in non-specified prior to 1989 for EU member countries.

In December 1999, the Energy Statistics Working Group, made up of the IEA, the United Nations, the United Nations Economic Commission for Europe, Eurostat and their respective member governments, decided to develop a separate annual questionnaire on renewables and wastes in the hope that this would improve the quality of reporting by national administrations. As a result of this new questionnaire, it is possible that there will be breaks in renewables and waste time series between 1997 and 1998 until national statistical offices are able to revise their series. In order to improve the quality of renewables and waste statistics and to ensure data compatibility, the IEA initiated a project in 2002 with the objective to compare and harmonize historical IEA data with those of national administrations and/or Eurostat for EU member countries, where applicable. As a result, the renewables and waste time series of many countries were revised back to the year 1990."

IEA definitions of parameters

SBIOMASS	Primary solid biomass (TJ – net)	The figures are expressed in terajoules based on net calorific values. Biomass is defined as any plant matter used directly as fuel or converted into other forms before combustion. Included are wood, vegetal waste (including wood waste and crops used for energy production), animal materials/wastes, sulphite lyes, also known as "black liquor" (an alkaline spent liquor from the digesters in the production of sulphate or soda pulp during the manufacture of paper where the energy content derives from the lignin removed from the wood pulp) and other solid biomass. This category contains only primary solid biomass. This includes inputs to charcoal production but not the actual production of charcoal (this would be double counting since charcoal is a secondary product).
CHARCOAL	Charcoal (1 000 t)	Charcoal covers the solid residue of the destructive distillation and pyrolysis of wood and other vegetal material.

IEA GEOGRAPHIC COVERAGE

Africa includes Algeria, Angola, Benin, Cameroon, Congo, Democratic Republic of Congo, Côte d'Ivoire, Egypt, Eritrea, Ethiopia, Gabon, Ghana, Kenya, Libya, Morocco, Mozambique, Namibia, Nigeria, Senegal, South Africa, Sudan, United Republic of Tanzania, Togo, Tunisia, Zambia, Zimbabwe and *Other Africa*.

Other Africa includes Botswana, Burkina Faso, Burundi, Cape Verde, Central African Republic, Chad, Comoros, Djibouti, Equatorial Guinea, Gambia, Guinea, Guinea-Bissau, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Niger, Reunion, Rwanda, Sao Tome and Principe, Seychelles, Sierra Leone, Somalia, Swaziland and Uganda.

Middle East includes Bahrain, Islamic Republic of Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syria, United Arab Emirates and Yemen.

Non-OECD Europe includes Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Gibraltar, Former Yugoslav Republic of Macedonia (FYROM), Malta, Romania, Serbia and Montenegro, and Slovenia.

Former USSR includes Armenia, Azerbaijan, Belarus, Estonia, Georgia, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Republic of Moldova, Russia, Tajikistan, Turkmenistan, Ukraine and Uzbekistan.

Latin America includes Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, Guatemala, Haiti, Honduras, Jamaica, Netherlands Antilles, Nicaragua, Panama, Paraguay, Peru, Trinidad and Tobago, Uruguay, Venezuela and *Other Latin America*.

Other Latin America includes Antigua and Barbuda, Bahamas, Barbados, Belize, Bermuda, Dominica, French Guiana, Grenada, Guadeloupe, Guyana, Martinique, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines and Suriname.

China includes the People's Republic of China and Hong Kong (China).

Asia includes Bangladesh, Brunei, Chinese Taipei, India, Indonesia, DPR of Korea, Malaysia, Myanmar, Nepal, Pakistan, Philippines, Singapore, Sri Lanka, Thailand, Vietnam and Other Asia.

Other Asia and *Other Oceania* includes Afghanistan, Cambodia, Bhutan, Fiji, French Polynesia, Kiribati, Laos, Macao, Maldives, Mongolia, New Caledonia, Papua New Guinea, Samoa, Solomon Islands, Tonga and Vanuatu.

The Organisation for Economic Co-Operation and Development (OECD) includes Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States.

5. Temporal coverage by item and primary source

			Last year of the series														
			Black - liquor	Charcoal				Fuelwood				Primary solid biomass*	Transf. - loss	Woodfuels			
		First - year		Cons.	Export	Import	Produc.	Cons.	Export	Import	Produc.			Cons.	Export	Import	Produc.
code	Primary Source		BlkLiq	ChCons	ChExp	ChImp	ChProd	FwCons	FwExp	FwImp	FwProd	PsbCons	TraLoss	WfCons	WfExp	WfImp	WfProd
1	WETT99 best estimate	1980	1998	1998	1998	1998	1998	1998	1998	1998	1998		1998	1998			1998
3	Country report	1980	2002	2010		2002	2002	2010	2002	2002	2002			2010			
5	ENDA/IEPE	1985		1994				1994									
6	ESMAP	1970		1988				1990									
7	Other National	1973		2002	2002	2002		2002		2002							
8	IEA non- OECD 99	1980		1999				1997									
10	FAOSTAT (1998)	1980		1998				1998									
11	UN Energy Statistics 1995	1982		1995				1995									
13	RWEDP	1985		1997				1997									
16	FUNBAR	1980		1990				1990									
17	OLADE 80-97	1980		1997				1997									
18	ECE/ETTS	1980												1990			
19	Eurostat 89-94	1989												1994			
20	IEA OECD Wf 80-94	1980												1994			
21	LBL	1980												1993			
25	FAOSTAT (2003)	1961	2003	2003	2003	2003	2003	2003	2003	2003	2003		2003	2003	2003	2003	2003
27	UN energy statistics (2002)	1980			2001	2001	2002				2002						
30	GFPOS 1970-2030	1970		2030				2030									
31	OLADE 90-02	1990		2002				2002									
34	IEA (2002)	1960	2002	2002		2002	2002	2002				2002					

6. Items by Primary Source

				Charcoal				Fuelwood				Prim. solid biomass*	Transf.	Woodfuels			
			Black liquor	Cons.	Export	Import	Produc.	Cons.	Export	Import	Produc.		loss	Cons.	Export	Import	Produc.
code	Primary Source	Total	BlkLiq	ChCons	ChExp	ChImp	ChProd	FwCons	FwExp	FwImp	FwProd	PsbCons	TraLoss	WfCons	WfExp	WfImp	WfProd
1	WETT99 best estimate	16 280	819	2 244	707	922	1 117	2 739	553	550	1 737		1 112	2 012			1 768
3	Country report	1 515	18	439		8	8	888	6	6	9			133			
5	ENDA/IEPE	57		24				33									
6	ESMAP	218		92				126									
7	Other national	897		334	9	10		538		6							
8	IEA non-OECD 99	391		371				20									
10	FAOSTAT (1998)	2 062		915				1 147									
11	UN Energy Statistics 1995	167		48				119									
13	RWEDP	381		106				275									
16	FUNBAR	102		47				55									
17	OLADE 80-97	641		263				378									
18	ECE/ETTS	130												130			
19	Eurostat 89–94	123												123			
20	IEA OECD Wf 80-94	297												297			
21	LBL	167												167			
25	FAOSTAT (2003)	54 585	2 205	5 298	1 708	2 192	4 401	6 475	1 690	2 203	6 103		4 401	6 687	2 259	2 779	6 184
27	UN energy statistics 2002	5 023			194	197	1 260				3 372						
30	GFPOS 1970-2030	16 786		8 385				8 401									
31	OLADE 90–02	573		264				309									
34	IEA (2002)	15 022	339	3 189		3	27	4 602				6,862					
	(Total values >0)	115 417															

7. Items by area and primary source

				Black - Liquor	Charcoal				Fuelwood				Prim. solid biom.*	Transf. loss	Woodfuels			
					Cons.	Export	Import	Produc.	Cons.	Export	Import	Produc.			Cons.	Export	Import	Produc.
code	Primary source		Total	BlkLiq	ChCons	ChExp	ChImp	ChProd	FwCons	FwExp	FwImp	FwProd	PsbCons	TraLoss	WfCons	WfExp	WfImp	WfProd
1	WETT99 Best estimate	All	16 280	819	2 244	707	922	1 117	2 739	553	550	1 737		1 112	2 012			1 768
2	GFPOS 5-yearly	All	2 529		1 181				1 348									
3	Country report	All	1 140	18	372		8	8	594	6	6	9			119			
3	Country report	Rural	181		27				147						7			
3	Country report	Urban	194		40				147						7			
5	ENDA/IEPE	All	57		24				33									
6	ESMAP	All	218		92				126									
7	Other national	All	889		330	9	10		534		6							
7	Other national	Rural	4		2				2									
7	Other national	Urban	4		2				2									
8	IEA non-OECD 99	All	391		371				20									
10	FAOSTAT (1998)	All	2 062		915				1 147									
11	UN energy statistics 1995	All	167		48				119									
13	RWEDP	All	381		106				275									
16	FUNBAR	All	102		47				55									
17	OLADE 80–97	All	641		263				378									
18	ECE/ETTS	All	130												130			
19	Eurostat 89–94	All	123												123			
20	IEA OECD Wf 80–94	All	297												297			
21	LBL	All	167												167			
25	FAOSTAT (2003)	All	54 585	2 205	5 298	1 708	2 192	4 401	6 475	1 690	2 203	6 103		4 401	6 687	2 259	2 779	6 184
27	UN energy statistics (2002)	All	5 023			194	197	1 260				3 372						
30	GFPOS 1970–2030	All	16 786		8 385				8 401									
31	OLADE 90-02	All	573		264				309									
34	IEA (2002)	All	15 022	339	3 189		3	27	4 602				6 862					

8. Items by sector and primary source

ID		Sector	Total	BlkLiq	ChCons	ChExp	ChImp	ChProd	FwCons	FwExp	FwImp	FwProd	PsbCons	TraLoss	WfCons	WfExp	WfImp	WfProd
1	WETT99 Best estimate	All	16 280	819	2244	707	922	1 117	2 739	553	550	1 737		1 112	2 012			1 768
2	GFPOS 5-yearly	All	2 529		1181				1 348									
3	Country Report	All	821	18	285		8	8	416	6	6	1			73			
3	Country Report	All non-hh sectors	211		55				149						7			
3	Country Report	Commercial	55		12				36						7			
3	Country Report	Households	369		69				268						32			
3	Country Report	Industries	50		15				16			8			11			
3	Country Report	Services	9		3				3						3			
5	ENDA/IEPE	All	57		24				33									
6	ESMAP	All	88		39				49									
6	ESMAP	All non-hh sectors	45		16				29									
6	ESMAP	Households	85		37				48									
7	Other National	All	490		175	9	10		290		6							
7	Other National	All non-hh sectors	125		51				74									
7	Other National	Households	282		108				174									
8	IEA nonOECD_99	All	195		175				20									
8	IEA nonOECD_99	All non-hh sectors	32		32													
8	IEA nonOECD_99	Households	164		164													
10	FAOSTAT (1998)	All	2 062		915				1 147									
11	UN Energy Statistics 1995	All	167		48				119									
13	RWEDP	All	138		46				92									
13	RWEDP	Households	129		46				83									
13	RWEDP	Industries	65		6				59									
13	RWEDP	Services	49		8				41									

Cont./

ID		Sector	Total	BlkLiq	ChCons	ChExp	ChImp	ChProd	FwCons	FwExp	FwImp	FwProd	PsbCons	TraLoss	WfCons	WfExp	WfImp	WfProd
16	FUNBAR	All	102		47				55									
17	OLADE 80-97	All	641		263				378									
18	ECE/ETTS	All	69												69			
18	ECE/ETTS	Households	23												23			
18	ECE/ETTS	Industries	18												18			
18	ECE/ETTS	Transformation	20												20			
19	Eurostat 89–94	All	90												90			
19	Eurostat 89–94	Households	13												13			
19	Eurostat 89–94	Industries	12												12			
19	Eurostat 89–94	Transformation	8												8			
20	IEA OECD Wf 80-94	All	297												297			
21	LBL	All	114												1 14			
21	LBL	Households	24												24			
21	LBL	Industries	23												23			
21	LBL	Services	6												6			
25	FAOSTAT (2003)	All	54 585	2 205	5 298	1 708	2 192	4 401	6 475	1 690	2 203	6 103		4 401	6 687	2 259	2 779	6 184
27	UN energy statistics 2002	All	5 023			194	197	1 260				3 372						
30	GFPOS 1970-2030	All	16 786		8 385				8 401									
31	OLADE 90-02	All	573		264				309									
34	IEA (2002)	All	6 619	339	1 464		3	27	2 025				2 761					
34	IEA (2002)	All non-hh sectors	3 297		632				897				1 768					
34	IEA (2002)	Households	5 106		1 093				1 680				2 333					
	(Total values >0)		115 417															

9. Country coverage by primary sources

	Regions	Africa	Asia	Oceania	Europe	North and Central America	South America	World
code	**No. of countries primary sources**	57	51	16	44	34	13	215
1	WETT99 best estimate	54	48	15	39	22	13	191
3	Country report	21	9		1	3	5	39
5	ENDA/IEPE	28						28
6	ESMAP	39						39
7	Other national	39	15			1	1	56
8	IEA non-OECD 99	19	11					30
10	FAOSTAT (1998)		41			15	13	69
11	UN energy statistics 1995		16					16
13	RWEDP		16					16
16	FUNBAR					9	10	19
17	OLADE 80–97					11	11	22
18	ECE/ETTS		3		31	1		35
19	Eurostat 89–94				15			15
20	IEA OECD Wf 80-94		3	2	27	2		34
21	LBL		1		7	1		9
25	FAOSTAT (2003)	53	49	15	43	27	13	200
27	UN energy statistics (2002)	49	44	7	38	18	13	169
30	GFPOS 1970–2030	56	49	15	38	34	13	205
31	OLADE 90–-02					12	12	24
34	IEA (2002)	26	38	2	38	13	10	127

10. Typology of reference data

Percentage of primary source entries. **All items**

	Tentative reliability ranking	High		Mid-high			Medium						Mid-low		Low / undefined	
		1	1	2	2	2	3	3	3	3	3	3	4	4	5	5
	Main reference types	Field surveys	Country studies	Energy statistics	Projections (per capita cons. x population)	National models	Forestry statistics	Modeling of socio-economic variables	Question-naires (forestry)	Question-naires (energy)	Modeling of Question-naire data	Derived values (6 to 8)	Regional models	Global models	Quoting regional/global databases	Undefined
ID	Primary sources	1	2	4	5	6.1	3	6	7.1	7.2	8	9	6.2	6.3	10	11
1	WETT99 best estimate		2	5											13	80
3	Country report	9	79	7	3		2									
5	ENDA/IEPE															100
6	ESMAP															100
7	Other national	2	17	37	0		2			2					26	13
8	IEA non-OECD 99															100
10	FAOSTAT (1998)															100
11	UN energy statistics 1995															100
13	RWEDP		4													96
16	FUNBAR															100
17	OLADE 80-97															100
18	ECE/ETTS															100
19	Eurostat 89–94															100
20	IEA OECD Wf 80–94															100
21	LBL															100
25	**FAOSTAT (2003)**							29	15		4	52				
27	UN energy statistics 2002														21	79
30	GFPOS 1970–2030					6					15		35	44		
31	OLADE 90–02			100												
34	**IEA (2002)**			45	2					3	1				29	19

Percentage of primary source entries on **Fuelwood consumption** (FwCons)

		High		Mid-high			Medium						Mid-low		Low / undefined	
	Tentative reliability ranking	**1**	**1**	**2**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**4**	**4**	**5**	**5**
	Main reference types	Field surveys	Country studies	Energy statistics	Projections (percapita cons. x population)	National models	Forestry statistics	Modeling of socio-economic variables	Question-naires (forestry)	Question-naires (energy)	Modeling of questionnaire data	Derived values (6 to 8)	Regional models	Global models	Quoting regional/global databases	Undefined
ID	Primary sources	1	2	4	5	6.1	3	6	7.1	7.2	8	9	6.2	6.3	10	11
1	WETT99 best estimate		8	14											42	36
3	Country report	6	83	6	4		1									
5	ENDA/IEPE															100
6	ESMAP															100
7	Other national	2	19	32	0.4		2			2					29	13
8	IEA non-OECD 99															100
10	FAOSTAT (1998)															100
11	UN energy statistics 1995															100
13	RWEDP		3													97
16	FUNBAR															100
17	OLADE 80–97															100
25	FAOSTAT (2003)							58	29		7	6				
30	GFPOS 1970–2030					6					24		70			
31	OLADE 90–-02			100												
34	IEA (2002)			52	3					5					28	13

Percentage of primary source entries on **Charcoal consumption** (ChCons)

		High		Mid-high			Medium						Mid-low		Low / undefined	
	Tentative reliability ranking	1	1	2	2	2	3	3	3	3	3	3	4	4	5	5
	Main reference types	Field surveys	Country studies	Energy statistics	Projections (percapita cons. x population)	National models	Forestry statistics	Modeling of socio-economic variables	Question-naires (forestry)	Question-naires (energy)	Modeling of Question-naire data	Derived values (6 to 8)	Regional models	Global models	Quoting regional / global databases	Undefined
ID	Primary sources	1	2	4	5	6.1	3	6	7.1	7.2	8	9	6.2	6.3	10	11
1	WETT99 best estimate		8	17											41	34
3	Country report	8	73	11	3		5									
5	ENDA/IEPE															100
6	ESMAP															100
7	Other national	3	14	41			1			3					24	14
8	IEA non-OECD 99															100
10	FAOSTAT (1998)															100
11	UN energy statistics 1995															100
13	RWEDP		8													92
16	FUNBAR															100
17	OLADE 80-97															100
25	FAOSTAT (2003)							73	21		5	0.2				
30	GFPOS 1970–2030					5					7			88		
31	OLADE 90–02			100												
34	IEA (2002)			53	4					4	2				28	9