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COMPILATION OF ENERGY BALANCES IN AFRICA: PRACTICES AND METHODS

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I. INTRODUCTION

1. Energy is a critical and irreplaceable element of life and of development: an adequate and sustainable supply is necessary to maintain and improve the quality of life, and economic grow is reliant to the efficient supply of energy in various forms in a sustainable manner. The awareness in Africa of these key roles that energy plays is outlined by the importance given to the development of the African energy sector on the agenda of all regional development programmes adopted by African policy makers, from the Lagos Plan of Action (LPA) to the Abuja Treaty. The recent high-level energy meetings in Cape Town (1994), Tunis (May 1995) and Accra (November 1995) reiterated that future prospects for growth of national economies are subject to provision of abundant and affordable energy supply, rational utilization of available energy resources, and energy conservation. From the developmental programmes and declarations adopted by the African energy ministers, it is clear that the African energy sector needs to be adjusted to the requirements of tomorrow.

2. An overall energy balance is a balance showing in a consistent accounting framework the complete picture of the flows of energy from their origins through conversion to final use in a country during a given period (usually annual). It constitutes a basic tool for development planning and a fundamental means of coordinating statistical activities in the energy sector. It also provides energy data in a form which facilitates clear understanding and sound analysis of the activities going on in the energy sector, as well as the interactions between its components.

3. The main purpose of compiling energy balances is to show in one table the overall picture of energy production (or imports), conversion and consumption for each fuel utilized in the country. Without such an overall comprehensive picture, the consequences of policy and investment decisions are unlikely to be as well understood, and the effects of past decisions on total energy provision will not be monitored as effectively.

4. The Lagos Plan of action adopted by the African Heads of State and Government in April 1980 constitutes the only platform on energy in Africa. It addressed the basic energy issues, identified the basic problems and recommended a number of solutions and approaches. The lack of control over the major variables to ensure success of the programme (political commitment of countries, clear programme identification and adequate financing) impeded its implementation.

5. This has resulted in problems to make energy statistics available and when they are available, reliable. This has also caused difficulties in compiling regional and sub-regional balance sheets which reflect the real situation of the continent and lead to the formulation of an appropriate programme, and the decision for its implementation at national and sub-regional levels.

6. Consequently, given the importance of energy in social and economic development, there is manifestly a great need to improve the energy sector in the countries and to know better and use more effectively and efficiently overall energy potential of the continent.

7. This paper is concerned essentially with overall energy balance. It does not discuss energy commodity balance which is the balance for an individual source of energy. After the introduction, the paper presents in chapter two, the main characteristics of the current energy situation in Africa. In chapter three, the essential features of this special accounting framework are outlined, and the important role of an overall energy balance is stressed. Chapter four critically assesses the practices and methods used to generate energy statistics and compile energy balances. In chapter five, a proposal on the development of a statistical energy system is presented, in view of the improvement of the energy situation in African countries. The paper concludes in chapter six with recommendations.

II. CHARACTERISTICS OF THE ENERGY SITUATION IN AFRICA

8. Africa energy resource base is rich and besides oil and gas, includes a wide range of new and renewable sources of energy: solar, hydropower potential, wind, geothermal, biomass and draught animal power.

9. North and West Africa hold almost all the oil and gas reserves, while Southern Africa alone hold most of coal deposits. To these resources may be added the vast hydro electrical potential located mainly in Central Africa. This potential is nearly five times African electricity consumption but of which 5% is being harnessed, 95% of this remains untapped. To appreciate the magnitude of such natural resources, it is worth recalling that the entire installed capacity of Africa is barely equivalent to the potential power capacity of the Zaïre river.

10. A large portion of the known resources have not yet been exploited. This is due mainly to the lack of suitably large

indigenous markets, distances, location, finance, and in some cases quality.

11. The performance of the energy sector in many African countries is inadequate due to inappropriate economic policies, weak energy institutions, over-control of the supply side, uneconomic pricing due to government intervention, and negative interference by governments in energy supply industries. While there is over-control of the commercial energy sectors, there is lack of control of the traditional energy sector leading to environmental unacceptable exploitation and the lack of sustainable supply.

12. The energy sector is also characterized by a large dependence on traditional fuels in the form of fuelwood. The reliance on fuelwood varies from country to country, ranging from 14% for South Africa to 90% for Tanzania. It is estimated that on average, Africa relies on fuelwood for 57% of its energy needs if South Africa is excluded, and 48% if it is included.

13. Most of the fuelwood is consumed by the domestic sector. Wood is also used for small-scale rural industries such as tea/coffee/tobacco processing, lime-making and brick-making. Traditional fuel on average accounts for 90% of energy consumed by the domestic sector (excluding South Africa).

14. The heavy reliance on traditional fuels can be attributed to the rural subsistence nature of a large proportion of the population of Africa, for whom commercial fuels are expensive and not easily accessible, together with the low level of economic development, and the extensive and rapidly growing squatter settlements in the peri-urban areas. The lack of suitable transport infrastructures also plays a significant role.

15. The commercial energy mix of African countries varies considerably and is, to a large extent, dependent on the composition of energy resources. This is an indication of the absence of meaningful trade in energy based on common indigenous resources.

16. The role of coal in the energy sector varies considerably within Africa. South Africa relies on coal for 81% of its primary energy requirements, while Ethiopia does not consume coal at all. Africa relies on gas for only a minor proportion of its energy needs although large gas resource exist.

17. With the exception of South Africa and Zimbabwe, petroleum products represent the largest source of commercial energy. Most sub-Saharan countries are importers of raw petroleum products, and increases in the price of oil have been an important factor in the weakening of commercial balances and the worsening of debt burden. More recently, the lack of the available capital has seriously compromised the performance of the African energy system.

18. Wood consumption in Africa is equivalent to its oil and gas consumption put together. The apparent self-sufficiency with 75% of commercial primary resources exported is only an illusion. It is the result of an economically reduced commercial demand. The 392 Mtoe (thousand tons of oil equivalent) of oil and gas produced in 1992 would hardly be sufficient to meet the continent's per capita consumption of 0.6 toe; a ratio still far from the standard of living and level of sustainable economic development.

19. The analysis of final energy consumption and income indicates that below $800 per capita, consumption per capita ranges between 0,1 toe; however, electricity consumption changes from $400 per capita even though that for biomass consumption does not drop significantly from $400. This implies that despite the penetration of electricity, energy requirements are still higher than the demand in the commercial market because electricity is not a substitute to biomass, especially in cooking.

20. Only electricity with a low cost can improve the energy consumption pattern. A specific study requested recently by African Development Bank (ADB) and carried out by a group of experts shows clearly that electricity prices are higher in Africa than in most of the countries in the world. These high tariffs are not specific to the electricity sub-sector only; but also to oil sub-sector.

21. Enormous progress has been made in increasing the number of people with advanced training. But in the various fields of energy resources, less emphasis so far has been placed on teaching students and workers planning skills. The implication is that Africa's capacity in the fields of energy planning, energy statistics as well as the acquisition and utilization of the relevant technologies is yet to be built.

22. In many African countries, the inadequacy of professionally and technically experienced personnel is the most binding constraint to development. There is a need to have a strong and well manned sector coordination mechanism for the implementation of energy programmes at the national level. There is also a need to increase the level of expertise in all sub-sectors related to

energy.

23. A frequently voiced concern almost everywhere in the region is that basic data on energy demand, production, trade, stock change, bunkers, apparent consumption, etc. is not available , or is not realistic. This is a stumbling block and all possible efforts must be made to correct this situation. This will facilitate the construction of national overall energy balances and therefore the formulation of efficient national, sub-regional and regional energy feasible programmes.

III. ESSENTIAL FEATURES OF ENERGY BALANCES

24. An overall energy balance shows in a coherent accounting framework the stocks and flows of all forms of energy used in a country during a year (or any time period) from their origins (production, imports, stockfall) through conversion (input for transformation into another energy source) to final uses (exports, stockrise, non-energy use, final energy consumption). It provides a basis for rigorous analysis and planning of the energy sector.

25. While not replacing detailed statistics on separate forms of primary and secondary sources of energy, compilation of an overall energy balance constitutes a key test of internal and external consistency within and between separate energy commodity balances. Such an overall balance is at the same time a key framework around which to undertake more elaborate analyses on supply and demand, where these are more detailed, than can conveniently be incorporated in the basic balance itself.

26. To be meaningful, such a balance must necessarily express the quantities of all forms of energy in terms of one single accounting unit for purposes of comparison and addition. To express the various original units in terms of a single accounting unit requires the use of conversion factors. It also shows the relationship between the inputs to and the outputs from the energy transformation industries.

27. An energy balance should be as complete as possible. All stocks and flows of existing forms of energy should be accounted for and known future sources of energy such as solar, wind, biomass, geothermal and draught animal power should be recorded.

28. The balance system should, in principle, be free from double-counting while showing all relevant types of supplies and uses of

energy. It should also be conceptually compatible with other economic analyses such as national accounts and more particularly input/output tables. An overall energy balance indeed helps to check the basic data and to test the consistency of the accounting system used.

29. An overall energy balance is established using many conventions and techniques. A knowledge of these is required for accurate interpretation and to avoid, for example, double counting.

30. The main purpose for which a country would find it valuable to compile energy balances is the planning and monitoring of the energy development programmes. Without such an overall comprehensive picture, the impact of policy and investment decisions are unlikely to be as well understood, and the effects of past decisions on total energy provision will not be monitored as effectively. Another very useful function of such balances is to gauge the potential for fuel substitution and formulate appropriate energy mix to meet the needs of all the population groups.

31. When analyzing the past, it is logical to start with the supplies of different energy sources and then to relate each to how it has been used or stocked or lost prematurely as waste heat. This sequence results in what is called a "top down" energy balance; it generalized form is:

  Domestic Production
+ Imports
- Exports
+ Stockfall
- Stockrise
= Consumption

32. When assessing the future, on the other hand, it is sometimes convenient to project demand (or consumption) on the basis that it is in some way related to the level of gross domestic product, its structure and distribution, the stock of energy-using equipment and likely developments in the technology of energy use , and to deduce the level of energy supplies that would be needed if the projected level and mix of energy demand is to be met. This equally logical analytical sequence leads to what is called a "bottom up" energy balance, with the generalized form:

Domestic Consumption
+ Exports
- Stockfall
+ Stockrise
- Stockrise
= Imports

33. An energy account framework should be suitable for meeting both types of need but there are important differences in the two requirements. Much more data is ordinarily available about the past than needed when trying to assess the future. The analysis needed when looking forward five years or more should be conceptually consistent with the fuller analysis that is possible for past years. This computability is not a mere matter of statistical purity but is a very practical necessity.

34. As aforementioned, the construction of an overall energy balance, as opposed to one relating to a single fuel, requires conversion of the different units in which the fuels are expressed to a common unit of measurement for a number of reasons. It is only by converting figures for different fuels compiled in the units normally associated with that fuels, into a single energy unit that overall energy statements may be obtained. Also, since one of the most useful functions of such balances is to gauge the potential for fuel substitution, it is only in converting different fuels units into a common energy unit that comparison between fuels and rational decisions for fuel substitution can be possible. The common energy unit recommended by the United Nations for general application is the joule, usually expressed in terms of multiple of one thousand. It is also the only basic energy unit of measurement recommended in the International System of Units.

35. In African countries, where a major portion of energy needs are met by consumption of traditional fuels (biomass), it is essential that an overall energy balance includes as much relevant and reliable data as possible on these type of fuels: the compilation of energy balances which exclude biomass fuels in such circumstances can be highly misleading, both for providing a picture of national energy characteristics and for planning future developments.

IV. PRACTICES AND METHODS USED IN THE COMPILATION OF ENERGY BALANCES IN AFRICAN COUNTRIES

36. It is clear from the definition of energy balances and the method of compilation described in the previous chapter that,

before constructing an overall supply and use account, all the necessary data on supplies and uses of each type of primary and secondary energy sources must be available (in original units of measurements).

1. ENERGY STATISTICS IN AFRICA

37. A very important step of the energy planning process is to improve the availability and quality of the energy data. This involves energy resource surveys and energy consumption surveys. The data collected should be stored in a computerized database, and appropriate software used to process and compile them.

38. The primary sources of energy data on African countries may be grouped into three categories:

- The energy supply industries (including local producers and importers);
- other industries and organizations producing energy
- other producers of energy (e.g.traditional energy producers);
- energy consumers.

39. Within the first category come governments owned and other centrally controlled industries engaged in the production and import of coal, oil and gas, in oil refining and electricity generation, and in the import and distribution of some or all of the products produced from these fuels for final consumption.

40. The initial task which consists of collecting data from the energy industries (mines, refineries, electrical power stations, etc.) may fall to a number of ministries or other organizations. The success with which these data can be collected and compiled into the statistics that users wish to have, depends to a large extent on the inter-relationships among all those involved.

41. Most energy institutions are State controlled. The degree of central control varies from country to country. The degree to which central Government is directly involved in industries will have a significant effect on both the ease with which data may be collected, and the range of data that will be considered reasonable to collect.

42. The secondary and other sources of energy data of African countries are:

- Ministries (with responsibility for the production or distribution of fuels);
- national statistical offices;
- official national publications;
- United Nations Statistical Division;
- World Bank;
- FAO;
- publications by various other international agencies.

43. Renewable energy resources as defined by the United Nations conference in Nairobi in 1981 comprise more than 13 different types. However, only six of such resources are available in Africa: Solar, wind, hydro, geothermal, biomass and draught animal power.

44. Most of the available renewable energy resource data in Africa, are based on the meteorological documentation, FAO statistics, and the results of various studies undertaken by some national experts or institutions.

45. End-use analysis is an important part of the compilation of overall energy balances. However, all the information required on energy end-use (that is the purpose for which the fuel is used e.g. : lighting, cooking, appliances), point and time of application of energy etc., should be captured. In most rural communities in Africa, no such information is being gathered. End-use needs in rural areas differ considerably by type of application; by period of use, by variations in location, etc. The lack of such specific knowledge of energy data needs has, in fact, tended to understate and thus suppress the opportunities that could arise for energy supply markets. A specification of per capita end-use needs for sustainable development is a fundamental pre-requisite for comprehensive energy programmes at the national level.

46. The majority of the population, rural and urban depend on traditional energy, also called biomass fuels[1] to an overwhelming extent. As most forms of this energy is used in the informal sector and outside the commercial channel, biomass supply figures are poor

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1. **Biomass fuels comprise**: fuelwood, charcoal, twigs, leaves and sticks, husk and shells, dung and other agricultural wastes, and animal residues.

or non-existent, and accurate and reliable biomass demand data are rarely available, if at all.

47. Indeed, few African governments in Africa have sought to play more than a nominal role, if any, in the supply of any form of biomass fuel; as a consequence, there is no centralized institution responsible for the collection and processing of data on biomass fuels on a regular basis. The most untractable of these fuels are animal residues and agricultural wastes which, while not commercially traded, are at least amenable to quantification in thermal equivalents, given rudimentary surveys.

48. As a result, biomass fuels pose serious problems of acquisition of data necessary for the compilation of energy balances. All existing assessment methods are based on incomplete surveys, and the use of ratios as estimation method, although not satisfactory, cannot be abandoned, pending a more reliable approach.

49. Much more difficult statistical energy challenges are animal and human energy which are important components of the energy sector in many African countries. Clearly, the innumerable number of oxen, donkeys and other animals employed in many countries of the region to cultivate the lands or carry various kind of loads, and the countless rickshaws operating in almost all African countries using human energy in place of fuel in farms, markets, industries, car and railway stations, etc. for which official energy data are seldom available in Africa, should not be neglected in the compilation of overall energy balances as it is currently the practice in most countries in the continent.

2. ENERGY BALANCES: THE CURRENT SITUATION IN AFRICA

50. To get a full picture of the current practices and methods used in the compilation of energy balances in African countries, a questionnaire was sent to all countries to be completed by the national statistical authorities. The outcome of the questionnaires returned was not high enough to allow an aggregate or comparative description of the practices and methods used in the compilation of energy balances in the region and sub-regions on the subject.

51. With the exception of only two, the countries which filled and returned the questionnaire do not compile energy balances for various reasons namely:

- Not programmed;

- non availability of energy data needed to construct overall energy balances;

- Lack of qualified staff in order to set up a system for the compilation of energy balances;

- Not ready: started only recently building the various basic data needed for the compilation of energy balances.

52. Nevertheless, the information collected was supplemented by the results of investigations and studies undertaken recently under the initiative of the African Development Bank within the framework of the implementation of an African Energy Programme (AEP) that ECA, OAU and ADB presented at the First Pan African Energy Ministers' Conference held in Tunis, (Tunisia) in May 1995, and the report of the First Pan-African Energy Ministers' Conference.

53. Numerous shortcomings appear in the process of generating energy statistics in African countries; these deficiencies have considerable negative impact on the compilation of overall energy balances. The initial task in the compilation of an overall energy balance consists of collecting data; this responsibility, as mentioned earlier, generally falls to a number of ministries or other institutions. The success with which these data can be collected and compiled into the desired statistics depends to a large extent on the inter-relationships among all those involved. Unfortunately, coordination and communication among the different energy sub-sectors is almost never put in concrete form. As a consequence, even when they exist, the energy statistics needed to compile overall energy balances are not always available because of the scattered nature of the data collection centres and the poor management of these data collection centres in the countries.

54. Most energy institutions in African countries being State controlled, the range of data that are considered reasonable to collect do not always include data essential to the construction of an overall energy balance.

55. Although the majority of the population (rural and urban) depends on biomass (traditional energy) to an overwhelming extent in Africa, biomass supply figures are poor or non-existent, and accurate and reliable biomass demand statistics are rarely available. Thus, overall energy balances which exclude biomass fuels in countries where these fuels are of considerable use can be useless or even misleading, both in providing a picture of national energy features and for planning future developments.

56. In many African countries, the use of human and animal energy is so important that the exclusion of either of these forms of energy may adversely affect the usefulness of overall energy balances in the countries concerned. Yet the generation of such statistics is still posing a number of conceptual and practical problems and represents a serious challenge to energy statisticians and other energy planners.

57. In most African countries, the compilation of energy balances is the responsibility of the Ministry in charge of energy; this is the case in South Africa, Ethiopia, Lesotho, Zimbabwe, Burundi, Rwanda and Zaïre. For illustration purpose, the 1989-1990 overall energy balances of Ethiopia is given in Annex of this report; one uses terajoule as accounting unit, and the other, tons of oil equivalent. These balances represent a typical overall balance in the context of Africa.

58. Although more countries in the region are now using a single accounting unit to express the quantities of all forms of energy, many are still not. Also, since the adoption of an agreed international standardized energy statistics system published in 1982 by the Statistical Division of the United Nations, African countries have not been using the concepts and conventions adopted in the compilation of their national energy data, and no other norms exist that all African countries comply to in the compilation of energy statistics and energy balances. For example, in the compilation of the national energy balance, the accounting unit used is ton coal equivalents (tce) in Lesotho, ton oil equivalents (toe) in Tunisia and Burundi; and terajoule in Ethiopia. Consequently, international comparison of national overall energy balances is now not possible. A benefit of considerable importance for sub-regional and regional energy planning and development would result from all African countries agreeing on the use of same accounting units, conversion factors, classifications and conventions in the compilation of their energy balances.

V. THE NEED FOR THE DEVELOPMENT OF A STATISTICAL ENERGY INFORMATION SYSTEM

59. It is crucial to develop and maintain in each country, an energy statistical information system which is centralized and has a clearly defined set of standards. All energy sub-sectors of the country should comply to these standards to enable the compilation of overall energy balances and meaningful comparisons.

60. The compilation of overall energy balances is reliant on adequate, relevant and reliable energy data. The collection,

processing and analysis of energy data is therefore an integral part of this compilation process and is vital to overall energy balances. The data collected should be such as to help the policy-makers in making decisions based on the realities of the situation.

61. The most important limitation to the compilation of an overall energy balance effort is the non-availability of the data needed, and the quality and detail of data used in its construction. Many energy planning projects in Africa failed (as witnessed by electricity, gas and other fuels shortages in most of Africa large cities), because of lack of relevant and reliable data, or because the data used was totally inadequate. Also, some energy projects failed to meet their original aims, primarily because of a lack of sufficiently detailed data.

62. Given that the compilation of energy balances require the quantification (in thermal equivalents) of all forms of energy used in a country within the period considered, the current state of energy data is of prime importance. Unfortunately, the quality of energy data in African countries is far from adequate. Although some progress has been made towards improving the situation, data gaps and other deficiencies are very considerable and there is still much to be done.

63. Some proposals regarding the compilation of energy statistics are presented here. They are limited to a broad sketch of the steps which should be followed in developing an energy information system at the national level.

64. As the Government is responsible for formulating national energy policies, it is obvious that it should also be responsible for creating and supporting the infrastructure necessary for collecting energy data. There is a logical sequence which should be followed in developing an energy statistical system.

65. The first step must be for the Government to take a positive decision regarding the importance of adequate energy database to underpin the energy planning and the economic development process. While this may be perceived to be obvious, in reality this is not necessarily so. When the Government fails to launch a program to collect and compile energy data, it is likely that any data collection programme will have a low priority. Outside parties are likely to develop unofficial databases to compensate for a lack of State leadership. Also, a number of organizations may each develop their own databases to satisfy their specific energy statistics requirements.

66. Duplication of effort, lack of uniformity and co-ordination contribute to confusion and problems (e.g. : questions concerning the legitimacy of the information generated, different parties using different concepts and methods for collecting and processing energy data and consequently, having different figures for the same indicator). The creation of an energy information agency that should make provision for the confidentiality of company sensitive information and also provide penalties for non-compliance could be very necessary.

67. The country should make use of existing expertise and system, where they are available. The United Nations (1991) noted the importance of using trained and experienced staff in the compilation of energy data. Ongoing staff training, and a provision for continuity, should be a feature of the organization compiling the national energy data.

68. The next stage is to conduct a study of the energy utilization. Energy flows should be developed for each energy carrier, from the primary source through to the consumer. This will permit an understanding of the energy economy which will ensure that energy suppliers and major consumer groupings can be properly identified.

69. A comprehensive classification system must be developed and applied to ensure that all data received from different sources is compatible. If the country has a national or central statistical office, use should be made of whatever system is used by this institution. This will facilitate the inclusion of auxiliary information into the energy database to make social and economic comparisons possible. The use of the International Standard Industrial Classification System (ISIC), or its local adaptation, is recommended for classifying economic sectors.

70. Once these basics are in place, the actual collection of data can begin. It is suggested that energy suppliers identified from the energy flows be required to provide annual (or more frequent) energy sales data. To ensure that all data is compatible, it is suggested that the institution responsible for collecting and analyzing the data should assist each supplier to classify customers by geographic position and economic activity. This will ensure that data from all energy suppliers will meet the same standard classification system. Comparisons of energy data from the Central Statistical Office will then be facilitated.

71. The computerization of the whole process is a necessary and valuable undertaking: a computer system need to be in place to

store, process and compile the data. It would be wise to design the system in a such a way that later upgrading is easy, and expansion possible without having to redesign the database structure. Thus careful though as well as sufficient financial resources need to be invested in this aspect of the entire process.

72. The final stage is the generation of information for users. The outputs need to be in a format which will be both useful and utilizable to the users. Outputs can be in hard copy, electronic format, or accessible on an on-line basis. Sight should not be lost of the statistics requirements of international organizations and the output should be compatible with the requirements of international bodies such as the United Nations (UN).

73. For many less developed countries in the region, the desegregation required by the UN may be more than adequate. Other relatively more developed countries in the region may want to collect data in more detail, since it is easy to aggregate information while the reverse is impossible.

V. CONCLUSION AND RECOMMENDATIONS

74. From the analysis and discussions carried out in this report, it appears that one of the key tenets for sustained economic development in the African countries is sound energy planning. The negative impact of the energy crisis on African economies and the persistent poor performance of the national energy sectors result more from structural weakness than from inadequate energy resource (Africa's energy resource base is rich). Many African governments still lack a detailed energy plan, and most do not compile overall energy balances. An overall energy balance should be the first tool to consider in any analysis of energy issues. Problems of data, skilled manpower, preponderance of non-commercial fuels and institutional arrangements are presently hampering the development and utilization of this very important planning tool. Energy statisticians face many practical problems; the information about the size or the cost of exploitation of an energy resource is more likely to be inadequate than not; data on energy technology are very sketchy; almost no information is gathered on energy end-use; the use of human and animal energy is quite considerable in many countries in Africa; however, it is rarely taken into account because its measurement in thermal equivalents is difficult.

75. In the African region, governments do not only assume direct management of energy institutions; they also provide guidelines for activities in the energy sector . National practices and methods used in the compilation of energy statistics and balances, in many

countries, are not adequate due to economic policies; government intervention and interference in energy supply industries; the spitting of functions between several ministries or agencies resulting in communication and co-ordination problems; the lack of collaboration among the scattered energy sub-sectors and the non-existence of appropriate norms, standards and a well defined methodology to guide the collection of energy data and the compilation of energy statistics and energy balances exercises. Important changes and innovations must take place before the current situation can improve. To that end, the following recommendations are proposed.

RECOMMENDATIONS

76. In order to build capacity for accelerated social and economic growth, African energy planners must be sensitized on the important role that energy balances could play.

77. Strengthening of energy security through identification of economic possibilities of the utilization of local resources in the substitution of the imported and costly energy products.

78. In order to harmonize work on energy statistics in the continent, an African Energy Commission should be created to set norms and standards appropriate to the needs of African countries, and all countries in the regions should comply to them. This is necessary for international comparisons of statistical information and the formulation of feasible sub-regional and regional energy programmes.

79. In view of the critical current situation of energy statistics in general and in particular statistics on biomass fuels whose consumption is overwhelming in most African countries, African governments are urged to construct and implement strategies to improve the availability and quality of the data in their respective countries.

80. Likewise, in view of the scattered nature of energy sub-sectors in the countries and the lack of co-ordination and communication among them, African governments are urged to create a centralized and computerized energy statistical information system office that would ensure the availability of comprehensive, reliable and timely energy statistical information, and compile energy balances. In countries where such an office already exists, whenever the

need is felt, its capacity must be strengthened.

81. in view of the actual lack in skilled manpower in energy planning, it is recommended that specialized training in energy statistics and planning be offered in training institutions (schools, universities, etc.) and a mechanism be set up for continuous upgrading of the skills of staff inside or outside the country, not only in these fields, but also to the utilization of the relevant and related changing technologies.

ANNEX

ETHIOPIAN NATIONAL ENERGY BALANCES

METHODOLOGY

1.1 Sector Definitions

Total energy consumption in 1989-1990 fiscal year (FY) was analyzed to determine its distribution among economic sectors, categorized here as: households, agriculture, transport, industry, and services and other. In some cases, it is a matter of choice whether the energy consumption is regarded as more appropriately allocated to one sector rather than another. For example, energy used by private cars was allocated to the transport rather than household sector, because this is most appropriate for planning and policy analyses. Within each of the major sectors, energy use was further desegregated among different numbers of sub-sectors, determined in part by the categorizations of the available data and in part by the desire to achieve greater specificity of energy use, by mode of transport, for example.

Household energy consumption was defined as energy used for non commercial domestic and closely related activities; such consumption is neither for providing services nor for generating income. The more energy intensive of these household activities are cooking, fuel collection, water collection, lighting and ironing. Energy used for some productive activities, such as human labour and animal power for the collection of fuel to sell, and human energy and electricity for small cottage industries and commercial activities, that cannot be estimated separately is included in the household sector. Energy used for private cars and motor cycles was included in the transport sector.

The agricultural sector encompasses crop production and livestock raising activities such as land clearing, irrigation water pumping, aerial crop fumigation, harvesting and post-harvest activities such as threshing. Agricultural use of diesel does not include fuel used for transportation to and from farms (which is included in the transportation sector.)

The transport sector was defined to include fuel used for personal transport and physical displacement of materials, excluding fuel used to move materials and products around factories and warehouses (which is included in industrial and service and other sectors). Use of fuel within the sector was desegregated by transport mode: road, rail, water and air. In addition, approximate estimates of fuel use for different types of transport were made for public passenger (buses and taxis), private passenger (private cars and motor cycles), freight transport (trucks), and commercial (small trucks and cars).

The industrial sector consists of cottage industries, grain milling, small, medium and large scale industries, mining and construction.

The services and other sector includes commercial and governmental sub-sectors and street lighting. The commercial sub-sector was defined to include food catering and beverage producers and other commercial activities. The government sub-sector consists of all public services and government bodies such as ministries, water resources, military and EELPA (not including power generation). The services and other sector also includes energy consumption by diplomatic missions and international organizations for uses other than transportation.

1.2 Sectoral Consumption of Energy

1.2.1 Traditional Energy Resources

Use of biomass and animate energy in 1989-1990 was estimated on the basis of results from CESEN's sectoral energy demand forecasting model.[1] This model is a system of econometric relationships which attempt to capture a wide range of economic interactions. Population and economic growth are major forces driving energy use in the model. In addition, the model includes such factors as energy prices, biomass availability, urbanization, access to market (distance to road) and end use efficiencies. The model is based on surveys in 81 urban areas and rural settlements.

The current estimate of population growth since 1991-1992 GC (3% per year) is the same as forecast by CESEN. Current estimates of GNP in 1989-1990 FY indicate it to be lower than forecast by CESEN. Lower economic growth involves lower direct demand for biomass but less substitution by modern fuels, so that the net effect of the higher forecast on biomass demand may not be significant.[2]

CESEN, Main Report, 1986

2. It was not possible to run the CESEN model for this study.

Specific sectoral biomass energy demand was based on CESEN estimates of consumption in 1991-1992 GC and projected using corresponding demand growth rates for the different biomass fuels: fuelwood, charcoal and crop and animal residues (Table 2.1).[3]

Crop and animal residues, in addition to being used as fuel, are used for construction purposes, as animal feed (crop residue) and for soil conditioning or fertilizer. The CESEN study estimated residues use for each of these purposes.[4] Demand in 1989-1990 for crop and animal residues for construction was based on the CESEN estimates for 1991-1992 GC and projected using the population growth rate. Crop residue for animal feed was determined from the CESEN estimates of feed in 1991-1992 and an estimate of the number of cattle in 1989-1990 FY. The difference between gross supplies of crop and animal residues and the sum of consumption for fuel, construction and feed was assumed to be used as soil conditioner and fertilizer. The gross supply of agricultural residue in 1989-1990 FY was estimated from crop production and livestock population statistics.

Human labour and animal energy use for agriculture, transport and household activities was based on corresponding CESEN estimates for 19991-1992 GC. The 19991-1992 figures were adjusted to 1989-1990 FY using changes in various factors between 1991-1992 and 1989-1990 FY. For example, animal energy input for cultivation was calculated on the basis of the CESEN estimate for 1991-1992 and projected to 1989-1990 using changes in the number of cattle. CESEN calculated this animate energy use from their survey results for hours spent in different activities and their estimates of energy expended per hour in these activities.[5] Population growth rates were used to update estimates of human energy use for household activities and transport of goods. The amount of energy used for collecting and transporting fuel was determined on the basis of total demand for biomass fuel. For this report, additional calculations were made to estimate the amount of human energy used in collecting water. Animal energy used for transport was estimated on the basis of the change in the number of donkeys between 1983-1985 and 1989-1990 FY.

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3. See household sector fuelwood and charcoal consumption for adjustments based on substitution by kerosene.

4. CESEN, <u>Main Report</u>, Chapter 4, Figure 1

5. CESEN, <u>Technical Report</u> 13, 1986, Appendix G

1.2.1 Modern Fuels

Production and consumption of petroleum products and electricity were determined from EPC and EELPA statistics for 1989-1990 fiscal year.

EPC data on the supply of petroleum products include wholesale sales to large consumers (such as industry, construction, transport, agriculture, government and other sub-sectors) and retail sales. Retail sales of petroleum products, which include LPG, kerosene, gasoline and diesel, are consumed in households, for commercial activities, by industry, government and for transportation. Retail sales of cooking and lighting fuels (LPG and kerosene) are assumed to be used only in households and the commercial sub-sector. While retail sales of gasoline are virtually all used for transportation, diesel is used by agriculture, industry, service and other sectors as well as for transportation. Consumption of gasoline and diesel by different modes of transport was determined on the basis of numbers of vehicles, specific fuel consumption and data and estimates of average distance travelled in 1989-1990 FY. Lubricants are all imported (about 18,000 tons in 1989-1990); thus, they do not effect the refinery balance and relatively small quantities of waste oil are used as fuel.[6]

LPG and kerosene use by households were both estimated, on the basis of CESEN's figures for 1991-192 GC, to be 95% of EPC retail sales. Kerosene use by cottage industries was based on CESEN estimates for 1991-1992 GC and projected using their corresponding growth rates.

Diesel consumption by cottage industries was based on CESEN estimates for 1991-1992 GC and projected using their corresponding growth rates. Consumption of diesel for grain milling was computed from estimates of the amount of grain milled in rural and urban areas[7].

Diesel used for generation of electricity sold by non-EELPA producers, including excess autogenerated electricity sold to EELPA for resale, was estimated on the basis of EELPA data.

Electricity supply was considered to be that generated for sale. Hence, in-house production and consumption of electricity does not appear on the supply side. Electricity consumption was allocated to different sectors using EELPA definitions and tariff

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6. EEA investigations in Addis Ababa revealed fuel use of waste oil by only one factory.

7. EEA, Energy Balances and Forecasts course Report, January 1990, p.62

rate information.

2. Data Issues for Future Work

There are a number of issues that on-going data collection and analysis should address in order to refine energy balance work. Some of these overlapping issues are: the sub-sectoral breakdown of energy use, traditional fuel use, household energy use and end-use analysis. As noted in various parts of this report, the sectoral and sub-sectoral detail for energy consumption is often approximated and for energy planning purposes requires improvement. One of the most obvious areas concerns household energy use in urban and rural areas; significant changes since the CESEN effort make new information important.

End-use analysis is an important area for future work both for energy balances and the more critical area of energy demand analysis and forecasting. This analysis would focus on the efficiency of energy use and the types of end use. End uses include heat or thermal energy, shaft or mechanical power, lighting and electricity (auto- and co-generation).

Table 1.A NATIONAL ENERGY BALANCE SUMMARY, 1989/90 [Terajoules]

	PRIMARY ENERGY					SECONDARY ENERGY								
	Wood	Agri-residue	Process residue	Hydro	Crude Oil	Briquette & Biogas	Char-coal	Electri-city	Petroleum Fuels	Asphalt & Lubes	Animate Energy	Sub-total	Fertilizer	TOTAL
GROSS SUPPLY	501,779	512,365	7,410	4,608	32,641	0	0	0	15,481	747	62,443	1,137,475	2,033	1,139,508
Production	501,779	512,365	7,410	4,608					0		62,443	1,088,606		1,088,606
Imports					32,838				14,554	758		48,150	2,033	50,183
Stock Changes					197				-927	11		-720		-720
INPUTS TO CONVERSION	28,449	14	10	4,608	32,641				2,125			67,847		67,847
REFINERY FUEL									1,917			1,917		1,917
OUTPUTS FROM CONVERSION		3				20	6,543	4,519	31,435	425		42,944		42,944
LOSSES FROM CONVERSION	21,906	1		691	782				1,523			24,903		24,903
TRANSMISSION & DISTR. LOSS								817	0			817		817
EXPORTS									9,963			9,963		9,963
FERTILIZER		280,331							0			280,331	282,364	282,364
OTHER AND NON-ENERGY USES		131,720	2,753						0	1,171		135,644		135,644
NET ENERGY SUPPLY	473,330	100,304	4,647	0	0	20	6,543	3,702	32,911	0	62,443	683,899	282,364	966,263
Statistical Difference *	0	0	0	0	0	0	0	0	-584	0	0	-584	0	-584
FINAL ENERGY CONSUMPTION	473,330	100,304	4,647	0	0	20	6,543	3,702	33,494	0	62,443	684,483	282,364	966,847
Household	441,898	96,048	0	0	0	1	6,370	1,160	3,384		12,699	561,560		561,560
Urban	25,272	5,532				0	4,186	1,160	3,226			39,377		39,377
Rural	416,626	90,516				1	2,183	0	157		12,699	522,183		522,183
Agriculture	0	0	0	0	0	0	0	0	1,288		30,005	31,293	282,364	313,657
Transport	0	0	0	0	0	0	0	0	21,355		19,739	41,094		41,094
Industry	13,630	2,449	4,647	0	0	0	91	2,003	3,788		0	26,608		26,608
Services and Other	17,802	1,806	0	0	0	19	83	539	3,679		0	23,927		23,927

Totals etc. may appear inconsistent due to rounding of the figures shown
* Includes the difference between petroleum product distributors' purchases and sales, i.e. stock changes
Source: Ethiopian Energy Authority

1.B NATIONAL ENERGY BALANCE SUMMARY, 1989/90 [Tons of Oil Equivalent]

	PRIMARY ENERGY					SECONDARY ENERGY								
	Wood	Agri-residue	Process residue	Hydro	Crude Oil	Briquette & Biogas	Char-coal	Electri-city	Petroleum Fuels	Asphalt & Lubes	Animate Energy	Sub-total	Fertilizer	TOTAL
SUPPLY	11,975,632	12,228,282	176,858	109,985	779,032	0	0	0	369,476	17,826	1,490,286	27,147,377	48,520	27,195,898
oduction	11,975,632	12,228,282	176,858	109,985					0		1,490,286	25,981,043		25,981,043
orts					783,725				347,344	18,088		1,149,157	48,520	1,197,677
ock Changes					4,693				-22,132	262		-17,177		-17,177
S TO CONVERSION	678,982	329	235	109,985	779,032				50,708			1,619,271		1,619,271
ERY FUEL									45,751			45,751		45,751
TS FROM CONVERSION		67				473	156,166	107,849	750,227	10,133		1,024,915		1,024,915
S FROM CONVERSION	522,816	12		16,498	18,672				36,346			594,345		594,345
MISSION & DISTR. LOSS								19,497	0			19,497		19,497
TS									237,789			237,789		237,789
LIZER		6,690,475							0			6,690,475	6,738,995	6,738,995
AND NON-ENERGY USES		3,143,665	65,711						0	27,959		3,237,335		3,237,335
NERGY SUPPLY	11,296,650	2,393,879	110,912	0	0	473	156,166	88,352	785,455	0	1,490,286	16,322,174	6,738,995	23,061,169
stical Difference *	0	0	0	0	0	0	0	0	-13,929	0	0	-13,929	0	-13,929
ENERGY CONSUMPTION	11,296,651	2,393,879	110,912	0	0	473	156,166	88,352	799,384	0	1,490,286	16,336,103	6,738,995	23,075,098
hold	10,546,494	2,292,326	0	0	0	27	152,021	27,686	80,753		303,079	13,402,386		13,402,386
ban	603,144	132,035				5	99,915	27,686	77,003			939,787		939,787
ral	9,943,350	2,160,291				21	52,106	0	3,751		303,079	12,462,599		12,462,599
ulture	0	0	0	0	0	0	0	0	30,750		716,110	746,860	6,738,995	7,485,855
port	0	0	0	0	0	0	0	0	509,663		471,098	980,761		980,761
try	325,290	58,455	110,912	0	0	0	2,165	47,809	90,412		0	635,043		635,043
ces and Other	424,866	43,099	0	0	0	446	1,980	12,857	87,806		0	571,054		571,054

s etc. may appear inconsistent due to rounding of the figures shown
ludes the difference between petroleum product distributors' purchases and sales, i.e. stock changes
e: Ethiopian Energy Authority

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