

**INFORMATION SYSTEM FOR THE ETHIOPIAN RURAL
ENERGY DEVELOPMENT AND PROMOTION CENTRE**

By
Yeshiwork Bizualem

*A thesis submitted to the School of Graduate Studies of Addis Ababa
University in partial fulfillment of the requirements for the Degree of
Master of Science in Information Science*

JUNE 2000

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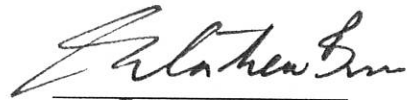
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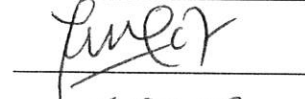
BY
YESHWORQ BIZUALEM

Name and Signature of Members of the Examining Board

Ato Getachew Birru, Chairman, Examining Board



Dr. Gezahegn Yirga, Advisor



Ato Workshet Lameneu, Advisor



Prof. I.K. Ravichandra Rao, External Examiner



DEDICATION

To the Almighty God for His Precious

and

Uncountable Gift

ACKNOWLEDGEMENT

I am indebted to many people in the process of preparing this thesis. First of all I would like to acknowledge my advisors Dr. Gezahegn Yirgu and Ato Workshet Lamenu for their unreserved guidance and invaluable comments. In fact, without their constructive suggestions and assistance the success of this thesis would have been doubtful.

I acknowledge with grateful thanks my indebtedness to Ato Getnet Tesfaye, head of the Information and Documentation Service, and staff of EREDPC for their kind co-operation in providing me all the necessary information for the thesis.

My appreciation goes to the officials in Ethiopian Science and Technology Commission for giving me the opportunity to participate in the graduate programme and permitted to stay away from my office work for two years. I am also grateful to Ato Getachew Birru, Dean of SISA and the staff of SISA for their support and encouragement during my stay at SISA.

Last but not least, my thanks goes to Dessie Messelu, my sister Tigist Nega, and my friends Haria W/Gabriel, Enchalew Yifru, Million Meshesha, Tesfaye Tafere, Temtim Assefa and Girma G/Tsadik who extended their co-operation in the preparation of this thesis.

TABLE OF CONTENTS

DEDICATION.....	II
ACKNOWLEDGEMENT	III
TABLE OF CONTENTS	IV
LIST OF TABLES	IX
LIST OF ACRONYMS AND ABBREVIATIONS	X
CHAPTER ONE: INTRODUCTION.....	2
1.1 Background	2
1.2 Statement of the Problem.....	3
1.3 Justification of the Study.....	6
1.4 Objectives of the Study.....	7
1.4.1 General Objective.....	7
1.4.2 Specific Objectives.....	7
1.5 Methodology	8
1.5.1 Literature review.....	8
1.5.2 Data collection.....	8
1.5.2.1 Questionnaire.....	8
1.5.2.2 Document Searching.....	9
1.5.2.3 Interview.....	9
1.5.3 <i>System Development Methodology</i>	10

1.5.4 Sampling Technique.....	10
1.6 Scope and Limitation of the Study	11
1.7 Significance of the Study	11
1.8 Organisation of the Study.....	12
CHAPTER TWO: LITERATURE REVIEW.....	14
2.1 Introduction	14
2.2 Categories of Energy.....	14
2.2.1 Energy Categories by Source.....	14
2.2.2 Energy Category by Form and Market Coverage.....	15
2.3 Energy Consumption as an Economic Indicator	16
2.3.1 Energy Consumption in the Developed Countries	16
2.3.2 Energy Consumption in the Developing Countries.....	17
2.3.3 Energy Consumption in Ethiopia.....	18
2.4 Energy Demand Forecast of Ethiopia	20
2.5 Energy Resources Potential of Ethiopia	20
2.6 Energy Institutional Settings in Ethiopia: Ministry of Mines & Energy (MME)	21
2.7 Information Systems	23
2.7.1 Transaction Processing Systems (TPSs)	23
2.7.2 Management Information Systems (MISs).....	24
2.7.3 Decision Support Systems (DSSs).....	25
2.7.4 Executive Information Systems	25
2.8 Energy Information System	26

3.2.10.2 <i>Information Requirements of users in the Energy Technology</i>	
<i>Studies Department</i>	46
3.2.11 Information Sources.....	47
3.2.12 <i>Problems Encountered by the Users of the Information System</i>	48
3.3 Summary of the Survey Analysis.....	49

CHAPTER FOUR: MODEL AND DESIGN OF THE EREDPC

INFORMATION SYSTEM	52
4.1 Introduction.....	52
4.2 Input Data of the System.....	52
4.2.1 Primary Sources.....	52
4.2.2 <i>Secondary Sources: Bulletins and Reports</i>	55
4.2.2.1 <i>From Internal Sources</i>	55
4.2.2.2 <i>From External Sources</i>	56
4.3 Process Requirement.....	57
4.4 Proposed Alternative Solution.....	58
4.4 Outputs of the EREDPC Information System.....	61
4.5 SYSTEM DESIGN.....	61
4.5.1 <i>Data Analysis for Database Design</i>	61
4.5.2 Data Normalization.....	62
4.5.2.1 <i>Information related to Energy Supply</i>	63
4.5.2.2 <i>Information Related to Energy consumption (demand)</i>	64
4.5.3 <i>Entity-Relationship Diagram</i>	65
4.5.4 Data Dictionary.....	66
CHAPTER FIVE: PROTOTYPE DATABASE DESIGN	69

5.2 Input Forms to National Energy Balance.....	71
5.3 Output of the Prototype Database.....	78
CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS.....	79
6.1 CONCLUSION	79
6.2 RECOMMENDATIONS	81
REFERENCES.....	83
APPENDIX I: QUESTIONNAIRE	87
APPENDIX II: LIST OF INDIVIDUALS INTERVIEWED.....	92
APPENDIX III: QUESTIONNAIRES USED BY THE CENTRE.....	93
DECLARATION.....	99

LIST OF TABLES

Table 2.1: Energy Resource Potential of Ethiopia.....	21
Table 3.1: Manpower Requirement of the I&DS.....	37
Table 3.2: Types of Hardware Available in the Centre.....	41
Table 3.3: Categories of Information Users	42
Table 3.4: Name of Organisation that used to Obtain Information.....	47
Table 3.5: Types of reasons for the Problems Encountered by Users of the Information System.....	49

LIST OF FIGURES

Figure 2.1. Organizational Structure of the Ethiopian Rural Energy Development and Promotion Centre	30
Figure 3.2: Context Diagram of EREDPC Information	51
Figure 4.1: Data Flow Diagram Symbols	57
Figure 4.2: Data Flow Diagram for the National Energy Balance	60
Figure 4.3: Entity Relationship Diagram for National Energy Balance	66
Figure 5.1 User Interface with the EREDPC Information System.....	70
Figure 5.2 Data Entry form of Energy Type.....	71
Figure 5.3 Data Entry form of Supply Type.....	72
Figure 5.4 Data Entry form of Crop.....	73
Figure 5.5 Data Entry form of Dung yield.....	74
Figure 5.6 Data Entry form of Energy Supply Transaction.....	75
Figure 5.7 Data Entry form of Sectors	76
Figure 5.9 National Balance: Primary Traditional Energy	78

List of Acronyms and Abbreviations

Btu	: British thermal unit
CSA	: Central Statistical Authority
CSTD	: Centre for Science & Technology for Development
DDC	: Dewey Decimal Classification
EEA	: Ethiopian Energy Authority
EELPA	: Ethiopian Electric & Light Power Authority
EESRC	: Ethiopian Energy Studies & Research Centre
EIA	: Energy Information of America
EPC	: Ethiopian Petroleum Corporation
EREDPC	: Ethiopian Rural Energy Development and Promotion Centre
ESMAP	: Energy Sector Management Assistance Programme
ESSPD	: Energy Socio-economics Studies & Popularisation Department
ESTC	: Ethiopian Science & Technology Commission
ETSD	: Energy Technology Studies Department
kgce	: kilogram calorific equivalent
LEAP	: Long-range Energy Alternative Planning
MME	: Ministry of Mines & Energy
NCIC	: National Computer & Information Centre
NSTIDC	: National Scientific & Technological Information & Documentation Centre
TGE	: Transitional Government of Ethiopia

Toe : Tons of oil equivalents
UN : United Nations
UNECA : United Nations Economic Commission for Africa
UNEP : United Nations Environmental Programme
UNESCO : United Nations Educational Scientific & Cultural Organisation
UNFAO : United Nations Food & Agricultural Organisation
UNIDO : United Nations Industrial & Development Organisation

ABSTRACT

Energy is an important economic resource used in all sectors of the economy of a country. The form and type of this resource is used to categorise into modern and traditional, primary and secondary and renewable and non-renewable. The level of economic development of countries determines the form and type of energy they use, the per capita energy consumption and the proportion of energy allocated among different sectors. Developing countries like Ethiopia largely use traditional type of energy to fuel their economy.

The over exploitation of traditional energy sources brings about such problems as reduction of land fertility that causes low yield of agricultural products, climatic change and disturbs the friendliness of the environment. Research and development activities are targeted towards alleviating problems that a country faces. In Ethiopia, the Ethiopian Rural Energy Development and Promotion Centre is a parastatal under the Ministry of Mines and Energy whose goal is to alleviate problems in the energy area by conducting research.

In order for individuals engaged in energy research, planning and decision-making could be able to attain the desired result, they have to be provided with the relevant, timely and accurate information generated from energy production, conversion and consumption. This invokes for the development of an information system. To this end, this study investigated the existing information system, user information requirements, problems of the existing system and users through interview, questionnaire survey and document analysis.

The survey indicated that users require various energy and socio-economic information produced internally and externally. It is also pointed out that users had problems of getting accurate, reliable, adequate and timely information and the existing information service was not also in a position to meet users' requirements. Therefore, a prototype database is designed and recommendations are made.

CHAPTER ONE

INTRODUCTION

1.1 Background

Energy is used to fuel the activities of every sector of an economy. It is an important input to the economic development of any nation. However, there has been shortage of energy supplies since 1973. The shortage in this basic economic resource has implication for the whole world. But it is the developing countries with less financial resources that will lose out in the worldwide scramble for energy resources, as the supply constraint increasingly becomes a reality. This is particularly alarming since domestic energy requirements of developing countries are growing and are expected to grow in the future (UNEP, 1986).

Developing countries are already affected by the current high cost of energy imports and are suffering serious balance of payment difficulties in many instances. Thus, they are not situated to compete for the ever-shrinking oil supplies. The circumstances of individual developing countries vary immensely due to differences in resource endowment and levels of industrial development. However, the prevailing terms of trade make it unlikely that developing countries as a group can pay for required energy imports by exporting traditional commodities (Turner, 1979).

The majority of the population of developing countries lives in rural areas. The population living in rural areas of these countries depends on non-commercial energy for over 80% of

their energy consumption. This is due to the high price of commercial energy sources (Turner, 1979). All these facts hold equally true for Ethiopia.

Ethiopia is endowed with the various energy sources, however there is scarcity of energy supply caused by improper utilisation and high population growth rate. Lack of energy sources to users in appropriate form and affordable price is also another problem cited in the energy sector. The energy problem of the country is complicated in that it has adverse consequences on the activities of different sectors and the life style of the society (UNDP, 1984).

Both traditional and modern energy sources are consumed in the country. The traditional sources that consist of fuel wood, charcoal, branches, dung cakes agricultural and process residues meet the overwhelming proportion of the energy demand of Ethiopia. This has resulted in a massive deforestation and loosing of land fertility that brings about low agricultural productivity (CESEN, 1984).

The contribution of modern energy sources that include electricity and petroleum products to the energy consumption is small. Even though the size of modern sources is small, an enormous amount of the limited foreign exchange is expended on it (TGE, 1994). Moreover, technical inefficiency in the transformation and end-use of energy is endemic in Ethiopia. The inefficiencies are found throughout the cycle of energy forms from production to end-use. This implies more energy resources are being developed, transformed and consumed to meet end-use needs than necessary (EEA, 1993).

1.2 Statement of the Problem

Research and development activities are targeted to positively respond to the challenges that a country faces. The institutional setting known as the Ethiopian Rural Energy Development and Promotion Centre is a governmental organisation under the Ministry of Mines and Energy. One of the major activities of this body is to undertake research that facilitates:

- Reduction of dependency on imported petroleum.
- Improvement of the efficiency of fuel use and substituting fuel imports by developing local energy sources.
- Using energy economically, efficiently and environment friendly
- Developing non-renewable energy resources such as petroleum, natural gas and coal extensively
- Selection, using, repairing, modifying and producing equipment goods and spare parts that enable to generate, transport and use energy
- Increasing the efficiency of traditional stoves and develop more effective energy use practices and,
- Setting standards for energy technologies and their utilisation.

Information is an important input for any activity of a country. Researchers, policy analysts, decision-makers and planners who are engaged in information generation require some other information to produce their results. For instance, energy policy analysts may be considered

as producers of one kind of information - analytical results but demanders of another - the processed data with which to do the analysis (UNECA, 1993). Thus, the important role played by research and development activities is attainable if relevant, up-to-date, accurate information is provided to researchers, decision-makers and planners. Despite this fact, developing countries in general and Ethiopia in particular suffer not only from information famine but also from lack of proper organisation and dissemination of information to users.

In addition, there is also lack of appreciation of the value of information to the research activities that the country is engaged in. The information services provided to researchers and other categories of users such as planners is also inadequate (NSTIDC, 1992). Bernardini (1992) notes that lack of information on energy planning and research in developing countries is a major handicap. In addition, ESTC (1994) notes that the absence of adequate organisational capability to collect, store, analyse and systematically organise and disseminate information to users is one of the major problems in the energy sector.

Moreover, absence of sufficient, well-organised and up-to-date information is another most serious problem faced in the energy sector for resources development and planning purposes. It is also noted materials that are relevant to energy studies and research are dispersed in different institutions. Due to this, researchers in developing countries spend 20% of their time searching for information relevant to their problems (Atherton, 1977). It can be imagined how much the absence of proper organisation and provision of information to the right user at

the right time and place bottlenecks the research activity targeted towards alleviating the problems that the country is facing.

Hence, a country's success in the production, storage, proper use and disposal of energy depends on the establishment of a well-organised information system. An information system essentially comprises a combination of various functions, including facilities for collection and analysis of data, its storage and retrieval and its dissemination to users. The functions require institutional and other arrangements for collecting knowledge from various sources such as national and international and storing knowledge for easy retrieval and dissemination to the principal users (CSTD in UN, 1985).

From a discussion with some of the professionals of the Ethiopian Rural Energy Development and Promotion Centre, it is revealed that there is lack of properly organised energy information. The information available is not relevant and the accessibility is also very difficult due to the manual nature of the existing information system. In fact, manual organisation of information is error prone, inefficient and ineffective (Whitten, Bentley & Barlow, 1989). Therefore, the focus of this study is targeted towards investigating the information system of the centre and propose an appropriate one. In this regard, the following basic questions are formulated to be answered in the process of the study:

1. What are the specific problems encountered in the information system of the Ethiopian Rural Energy Development and Promotion Centre?
2. Who are the users and their information requirements of the system?

3. What are the types of information and their formats that should be made accessible to users?
4. What strategies should be followed in order to overcome the limitations of the existing information system of the Centre?

1.3 Justification of the Study

The important role played by information in socio-economic development endeavours of a nation has gained universal acceptance. With the advancement of science and technology, the means and techniques of information generation, collection, processing and dissemination have shown tremendous development. Today, as the world is in an information society, the capacity to generate, process, store, transmit and utilise productive information will determine the socio-economic development of a country.

There is no any sector or economic activity that can effectively function without timely, accurate and reliable information. Information on research at national level helps researchers, decision-makers and planners to keep abreast of current developments, to apply research results and to minimise wastage of resources and time caused by unnecessary duplication of efforts (NCIC, 1997). Achieving these goals in the energy and other sectors is made possible by organising and communicating information to researchers, planners, decision-makers and other users. This requires a well-organised computer-based information system which would enable such users to get timely, relevant and adequate information.

1.4 Objectives of the Study

1.4.1 General Objective

The general objective of the study is to investigate the existing information system of the Ethiopian Rural Energy Development and Promotion Centre and to propose and design an effective and efficient information system, which will alleviate the problems, associated with the current system.

1.4.2 Specific Objectives

- To identify the users of information system of EREDPC.
- To assess the type and form of information which are required by users engaged in energy studies and research activity
- To assess and analyse the existing situation of the information system
- To identify problems of the information system and propose alternative solutions
- To design a prototype database for the Ethiopian Rural Energy Development and Promotion Centre and,
- To recommend measures to be taken to implement the proposed system.

1.5 Methodology

The nature of the study was descriptive type. This method was used since it deals with depicting the present situation of a subject under investigation using such instruments as interview, questionnaire, observation and documentary analysis.

1.5.1 Literature review

Reviewing literature provided the researcher with a theoretical framework about the problem. Therefore, in order to share ideas and views of others, a review was made on the materials relevant for the subject matter under investigation.

1.5.2 Data collection

Data is one of the building blocks for the development of an information system. To obtain information on the operations and limitations of the existing system, the following data collection methods were used.

1.5.2.1 Questionnaire

A set of questionnaire (annexed on page 91) was prepared and a pilot survey was made to test its validity. The questionnaire was aimed at gathering information from the users of

the existing information system of Ethiopian Rural Energy Development and Promotion Centre. The information obtained was about the users' categories, type of information that they look for and problems that they have encountered while searching for information. Twenty-two copies of the questionnaire was dispatched for internal users of the information system and out of these 18 (81.82%) were returned. The external users were not investigated because it was impossible to access them.

1.5.2.2 Document Searching

Reports, forms and letters of the Ethiopian Rural Energy Development and Promotion Centre were assessed in order to identify their organisational structure, activities, objectives, the pattern of information flow, problems of existing information system and information users.

1.5.2.3 Interview

Unstructured interview with four users of the information system at different levels, including department heads, division heads and experts was made since the information obtained from users was important to investigate and analyse the system and to suggest a new system that will fill the gap. In addition, conducting the interview enabled to confirm and strengthen the response obtained through the questionnaire. The discussion was also made with the professionals of the I&DS.

1.5.3 System Development Methodology

System analysis and design is a problem solving methodology concerned with the process of investigating organisational situation with the aim of improving the system through better procedures and methods. Structured methods provide a formal and organised way of working the stages of design to ensure consistency, documentation, change of control and recognise that potential users of a system should have the ultimate voice in the system development process (Whitten, Bentley & Dittman, 1998). As a result, structured system development methodology is followed.

In order to describe business processes and data flow that dictate the interactions between processes, a number of information system modelling tools are used. A context diagram is depicted to show the system boundary and users that interacts with the system. Data flow diagrams are used to show process requirements of the system. Entity relationship models are used to model the data requirements.

1.5.4 Sampling Technique

Purposeful sampling was used to select respondents from the Ethiopian Rural Energy Development and Promotion Centre. This was because to include all researchers, planners and decision-makers those are the most frequent users of the system.

1.6 Scope and Limitation of the Study

Development of an information system by its nature is teamwork and calls for substantial pool of minds and resources depending on the nature and complexity of the system under investigation. Thus, this study does not claim exhaustive and full treatment of the system covering all its aspects. Due to the intersectoral nature of energy, the EREDPC information system is expected to maintain and organise a very huge amount of data. However, due to the shortage of time, the scope of the research is limited only to the design of the system for the national energy balance. A strong limitation encountered in this study was problem of accessing external users of the information system.

1.7 Significance of the Study

The stakeholders who are going to be beneficiary from this investigation first and for most are energy researchers who spend their efforts and time for searching information due to lack of efficient information system. Secondly, the rural and urban dwellers, who consume the majority of the energy supply and who suffer from increasing scarcity and cost of household fuels since this rising cost and scarcity is expected to affect the already low incomes and the quality of life of the people at large.

In addition, the high dependence of the household sector on the traditional energy source has a negative impact on agricultural yield, forest and wild life resources and environment. This

study has a direct or indirect contribution towards alleviating the problem. Moreover, it benefits the planners and decision-makers to make appropriate plan and decision that can bring about development in the sector.

1.8 Organisation of the Study

The study is divided into six chapters. The first chapter deals with background information about the problem of energy supply and consumption in different parts of the world including in Ethiopia. It also states the problem, provides justification of the work, significance of the study, objective of the study and the methodology employed.

The second chapter discusses the different topics related to energy and information systems based on the literature reviewed. These include categories of energy sources, the pattern of energy consumption in developed, developing and Ethiopia. It also discusses the energy resources endowment of Ethiopia and future energy requirements.

The third chapter is about the existing information system of the EREDPC. The data gathered about the current system are analysed in detail to provide a clear picture of what the existing system does. Information requirements and information sources of users, problems of the existing system and availability of data processing technologies are also explained.

The fourth chapter discusses the modelling and designing of the system using some tools based on the existing system description and identified problems. The fifth chapter deals with

the development of prototype database. The last chapter summarises findings of the study and provides further recommendations for implementing the proposed EREDPC information system.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

In this chapter, the concept of energy is described in detail. As an economic indicator, the pattern of consumption of energy in Ethiopia, other developed and developing countries is considered to indicate the gap in energy utilisation. Furthermore, information system and its type are discussed.

2.2 Categories of Energy

According to the "McGraw-Hill Encyclopedia of Science and Technology" (1982) *energy* is defined as the ability of one system to do work on another system. There are different sources from which energy can be obtained to provide heat, light and power. Energy sources can be categorised as renewable & non-renewable, primary & secondary and commercial & non-commercial.

2.2.1 Energy Categories by Source

The renewable sources of energy are sources of energy in which the resources are capable of extension by recycling while the non-renewable source of energy is the reverse of the

renewable energy. Renewable sources are solar, wind, waves, tides and water. The non-renewable sources include oil, nuclear, fossil fuels, coal and petroleum. Some of these energy sources are briefly discussed as here under.

Biomass fuel is derived from living organisms. It consists plant residue, harvested, dried and burned or further processed into solid, liquid or gaseous fuels (Cunningham, 1994). Biomass fuels consist of wood fuel, agricultural and process residues and dung. The most familiar and widely used biomass is wood. Petroleum is a substance derived from the remains of plant and marine life that existed on the earth millions of years ago. Petroleum ranges from solid bitumen, through liquid oils to highly volatile natural gases as methane. It is a modern and non-renewable source (Brackley, 1988).

Electricity is another modern energy source that emanates from hydro and thermal generation. Geothermal energy is obtained from hot rocks beneath the earth's surface. The most important application of geothermal is in the generation of electricity (Gilpin, 1994).

2.2.2 Energy Category by Form and Market Coverage

Primary energy is directly used for heat or motive power without being altered significantly and secondary energy is energy that is used after having passed through process - electricity. The commercial energy sources are those which either involve a technology of energy conversion or enter commercial channels beyond a limited locality. Non-commercial sources

are consumed directly as fuel without being altered significantly through the use of conversion technology and without being formally marketed (Turner, 1979).

2.3 Energy Consumption as an Economic Indicator

Like any of the economic indicators, the pattern, size and type of energy consumption and its equitable distribution among the different sectors are used to characterise countries into developed and developing ones.

2.3.1 Energy Consumption in the Developed Countries

The total energy consumption of the developed world is dominated by commercial energy. For instance, the total energy consumption of U.S. in June 1999 was 7.4 quadrillion Btu. Out of this figure petroleum product accounted for 43 percent while coal and natural gas accounted 24 percent and 20 percent respectively.

The distribution of total energy consumption in different sectors of these countries is proportionate unlike in the developing countries. US's residential and commercial sector consumption in the same year was 2.5 quadrillion Btu that accounted 30 percent of the total consumption. The industrial sector consumed 37 percent, which is equivalent to 2.7 quadrillion Btu while the transportation sector consumed 2.2 quadrillion that is 30 percent

of total (EIA, 1999). The average annual per capita energy consumption of developed world is 5000 kgce (UNIDO, 1979).

2.3.2 Energy Consumption in the Developing Countries

Two-third of the world population lives in developing countries. Of these 75% of the people living in these countries rely on non-commercial energy sources. The dependence of developing countries on this source of energy varies depending on their level of economic growth. Some countries such as India rely on non-commercial energy for about 40 to 60 percent of its total energy consumption. Some countries such as Mexico depend on this source for 20 percent of the total energy use. Bangladesh, Ethiopia and Tanzania rely on such type of energy sources for 80 to 98 percent of total energy consumption (Turner, 1979).

In addition, developing countries are characterised by a low use of per capita energy consumption. Their annual average per capita energy consumption is 300 kgce. Many of these countries have energy consumption as little as one-half of this figure. The distribution of energy within a country is also inequitable. Energy is predominantly used for cooking. Regarding this, Reddy & Prasal in Turner (1979) note that 130 kgce of the annual per capita consumption is used for cooking.

Commercial energy use is small in developing countries. The major proportion of this energy source is consumed in the urban and industrial sector and for transportation. Although

agriculture contributes to the major proportion of the national income and provides employment opportunity for the majority of the workforce, it consumes only 5 - 10 percent of the total commercial energy sources. Energy is not only scarce in developing countries but also used inefficiently in urban and rural areas. This results in the per unit consumption of energy to be much higher than the per unit increase in national gross domestic product (FAO, 1990).

2.3.3 Energy Consumption in Ethiopia

Ethiopia like many of the developing countries consumes large amount of non-commercial energy sources. Concerning this ESMAP (1996) notes that the great majority of the population uses the traditional energy sources. Biomass fuel is the dominant source of traditional energy. The consumption of modern energy sources in Ethiopia is small. These sources of energy are cited to be vital to the functioning of modern agriculture, industry and commerce. In addition a sharp increase in their use is crucial for the accomplishment of Ethiopia's development goals. But their contribution to the total energy consumption is only 7 percent (ESMAP, 1996).

Around 65 percent of the total petroleum fuel supply is consumed by the transportation sector. As the estimate for the year 1993, the annual per capita petroleum consumption was equivalent to 15kg. Petroleum products are generally in adequate supply in urban centres that in most cases are with reasonable economic costs (Mekonnen, 1997). In Ethiopia, electricity

emanates from hydro and thermal generation. EELPA is a national body responsible for electricity generation, transmission and distribution and sales. Ethiopia's per capita energy consumption is the lowest in the world, at only 0.30 Toe (the average for Africa in 1989 was about 0.47 Toe). Relatively few people have access to modern/commercial energy supplies. The per capita consumption of commercial energy is 0.02 Toe (the average for Africa in 1989 was 0.28) (ESMAP, 1996).

It has been stated that the energy available to the rural areas has to be increased so as to reduce human drudgery, especially of women, such as long hours and physical efforts required for gathering fuel, fetching water and carrying heavy load (UNIDO, 1979). Despite this fact, only 4 percent of the rural population is connected to the electricity supply. It is also estimated that some 96 percent of the rural population would remain without a conventional electricity supply in the year 2011(ESMAP, 1996).

Thus, the great majority of rural Ethiopian families have no chance of obtaining a conventional electricity supply within their lifetime. Petroleum products are also often in short supply and available only at high prices in rural areas. This is because the private companies have little interest in moving significant amount of product into these areas (ESMAP, 1996). Hence, it is possible to say that modern energy is a resource in which social exclusion is being prevalent.

There is unproportionate energy consumption among the different sectors. The household sector consumes the dominant amount accounting for 87.5 percent of total energy

consumption. The energy consumption of industry, commercial and transport sectors accounts for 5 percent, 4 percent and 3.5 percent respectively. Energy resources are mainly used for cooking and lighting (Mekonnen, 1997). This implies that a large proportion of the country's supply is not utilised for development activity (Draft Proclamation, 1999).

2.4 Energy Demand Forecast of Ethiopia

Overall energy demand is expected to increase at approximately 3.2 percent per annum for the period 1994-2005. Economic growth is 5.5 percent and population growth in urban and rural areas is 3.1 percent, which are believed to be the causes for the increase in energy demand. The growth of demand is expected to prevail in each type of energy. To begin with electricity, demand is estimated to grow at 8 percent per year. Similarly, demand on petroleum products will grow on the average of 6.4 percent per annum with LPG and kerosene grows much faster than the average (31 percent & 10 percent respectively). Demand for traditional energy is also expected to rise at 2.9 percent annually (ESMAP, 1996).

2.5 Energy Resources Potential of Ethiopia

Ethiopia is endowed with renewable and non-renewable energy resources. The hydropower potential is estimated at 650 million Twh/year. The wind energy potential that ranges from 2.5 m/s to areas with wind speed of 3.5 to 5.5 m/s is 2000 – 6000 ms/m². There is also

reasonably sufficient solar energy potential (ESMAP, 1996). The following table provides a summary of the size of each type of energy resources potential of the country.

Source	Total Resources	
	Toe * 10	%
Hydropower	55.5	23.2
Natural gas	71.8	30.0
Petroleum	-	-
Coal	10.0	4.2
Geothermal	0.5	0.2
Fuel wood	93.5	39.1
Bagasse	0.1	0.0
Dung & Crop Residues	7.7	3.2
Total	239.1	100

Table 2.1: Energy Resource Potential of Ethiopia

2.6 Energy Institutional Settings in Ethiopia: Ministry of Mines & Energy (MME)

The organisation of Ethiopia's energy sector is similar with most African and other developing countries. The organisation is made in such a way that a ministry exercises tight

central control and direction while operations in the principal sub-sectors are in the hands of parastatal corporations with limited authority.

The MME is the dominant institution with clear responsibility for energy policy formulation and implementation. The MME has recently undergone an extensive reorganisation in line with the responsibilities and authority indicated in the governmental organisation proclamation of issued by the TGE (4/1994). The broad duties of the MME include:

- ◆ Formulate policy
- ◆ Collect and maintain data
- ◆ Regulate exploration and development of mineral by state owned and private enterprises/ companies.
- ◆ Study energy demand and promote expansion of the country's electricity supply
- ◆ Co-operate with appropriate agencies or companies to ensure the availability of oil, gas and refined products
- ◆ Issue licenses and regulate the exploration, development and production of energy
- ◆ Supervise the generation of electricity from small scale sources and
- ◆ Establish energy training activities and centres

The Ministry of Mines and Energy based on its mandate has established the various parastatals. One of these is Ethiopian Rural Energy Development & Promotion Centre (EREDPC).

2.7 Information Systems

The effective and efficient use of information is no longer merely a strategic advantage for corporations and individuals, it has become a necessity in the normal course of doing business. In our complex society, a piece of decision requires a collection and processing of vast amount of information; otherwise the result will bring devastating effect. This requires for an information system.

An information system is an arrangement of people, data, processes, interfaces and geography that are integrated for the purposes of supporting and improving the day to day operations in a business, as well as fulfilling the problem solving and decision making information needs of business managers. There are several types of information systems, each serving the needs of different users (Whitten, Bentley & Ditman, 1998). Type of information systems are discussed briefly in the following part:

2.7.1 Transaction Processing Systems (TPSs)

TPSs are information system applications that capture and process data about business transactions. They are sometimes called data processing systems. Transaction processing system can either respond to business transactions or initiate transaction. They can respond to both internal events and external events (Whitten, Bentley & Dittman, 1998).

2.7.2 Management Information Systems (MISs)

MIS is a system that supports the management of functional areas by providing periodic information for managers and other employees on such issues as operational efficiency, effectiveness and productivity. It also serves the functions of planning, controlling and decision making at the management level. MIS condense information obtained from transaction processing system and present it to managers in the form of reports. MIS primarily serves middle level managers. Its information input can be summary transaction data, high volume data and simple models, where as the output will be summary and exception reports (Warner, 1996).

Davis and Olson (1985) note that MIS is a four layered structure. The bottom layer consists of information for transaction processing, status inquiries, etc. The second layer consists of information resources in support of day to day operations and control. The third level consists of information system resources to aid in tactical planning and decision making for management control; and the top final level consists of information resources to support strategic planning and policy making by higher level of management. Each level of information processing may make use of data provided for lower level but new data may also be introduced.

2.7.3 Decision Support Systems (DSSs)

Decision support systems are interactive computer based information systems that provide the end-user with decision-making information when a decision-making situation occurs. DSSs have analytical capability that permits the user to employ several different models to analyse information. These systems draw internal information from transaction processing systems and MIS and they often bring in information from external sources (Whitten, Bentley & Barlow, 1989).

A DSS does not typically make decisions or solve problems – people do. They are concerned with providing useful information to support the decision process. DSSs are usually designed to support unstructured decisions – those decision-making situations that cannot be predicted in advance. It provides the decision-maker with tools to access that information and analyse it to make a decision (Whitten, Bentley & Dittman, 1998).

2.7.4 Executive Information Systems

An EIS is also known, as executive support system is a technology that supports the decision-making processes by senior managers. EISs are designed to provide corporate executives and senior managers with the information they genuinely need in their job. EISs are user friendly and are supported by graphics and provide exception reporting and drill down capability. EIS can also be easily connected with online information services and e-mail. It is a

comprehensive support system that goes beyond EIS to include analysis support, communication, office automation and intelligence (McLean & Whetherbe, 1996).

In commercial organisations, EIS are normally added onto an existing organisational system, where they enable the executive to have direct access to all financial and operational information as well as strategic information (Warner, 1996).

2.8 Energy Information System

Energy information system is crucial for professionals engaged in energy related activities (researchers, planners, decision-makers, etc) and to users of the end product of energy (governmental and non-governmental organisations, private sectors, household, etc). The proper functioning of the system should facilitate efficient and economic utilisation of energy by the society as a whole. Hence, there is a pressing need that any manual system should be automated to facilitate the organisation and dissemination of energy related information. Kilemile (1995) who did a thesis entitled “ A computer-based Information Support System for Energy Resources Development in Tanzania” envisages that the energy sector requires automated information system in order to break away from the past history of slow energy development.

CHAPTER THREE

SURVEY OF THE EXISTING INFORMATION SYSTEM OF THE EREDPC

3.1 Introduction

This chapter discusses the components of the centre. This includes background, the objectives, organisational structure, the major activities of the centre, the internal and external interaction, data maintenance, data processing technologies, information requirements of users, sources of information and problems of the existing information system.

3.2 Ethiopian Rural Energy Development & Promotion Centre

3.2.1 Background

Ethiopian Rural Energy Development and Promotion Centre is an institution which undertakes energy research and development activities in the country. It is responsible for energy development. Ethiopian Rural Energy Development and Promotion Centre has been modifying its name and objectives since its establishment as Ethiopian National Energy Committee (ENEC) in 1976 under the Ministry of Mines and Energy (ESTC, 1998a).

To begin with, ENEC failed to play its role in the energy research and development endeavour. As a result, it was realised to establish an institute that alleviates the prevailed problem was important. Thus, according to the proposal of the MME, the Ethiopian Energy Authority (EEA) was set up in 1988. This authority was responsible for the dissemination of alternative and modern energy technologies in rural areas and carrying out meaningful and co-ordinated energy studies and research (ESTC, 1998a).

However, the authority also unable to meet the expected roles. This failure was attributed to the absence of defined responsibilities, organisational structure and the failure of the government to allocate the required manpower, finance and facilities. To overcome this, the Transitional Government of Ethiopia has re-established the authority as the Ethiopian Energy Studies and Research Centre in 1994. Yet, the centre could not be up to its expectations and therefore it was reorganised in 1999 as Ethiopian Rural Energy Development and Promotion Centre.

The centre is currently engaged in facilitating rural development based on energy research and study results with the aim of supporting the five-year economic development programme of the government. The major activity of the centre is to solve the energy problems of the rural society by undertaking study on the various energy sources and technologies. It is also responsible for the development and promotion of renewable energy in the country.

3.2.2 Objectives of the EREDPC

In order to achieve the above activities, the centre has set out the following objectives:

- Conducting research on energy sources and technologies based on the socio-economic condition of the society; expanding the supply of each type of energy; disseminating and promoting research results so as to build the economy of the rural community.
- Maximising the efficiency of energy supply and consumption in the different sectors of the economy with special emphasis to the rural community; distributing improved appliances used for energy generation and use.
- Popularisation of potential energy resources and technology of the country, providing up to date information on the size and type of energy supply and consumption in each of the economic sectors.
- Organisation and integration of up to date information that enables to predict the general trend of energy demand and supply of the country and to disseminate the information to target users or groups
- Prioritising regional energy resources research and development and
- Providing training on energy to the community in collaboration with regional mines and energy offices.

3.2.3 Organizational Structure

Analysis of the organisational structure, in addition to providing the necessary information to this study, helps in defining the system's boundary. The analysis of the organisational structure also enables the system analyst to understand what tasks are being performed by each department and to design the information system that would provide relevant information for accomplishing the tasks effectively.

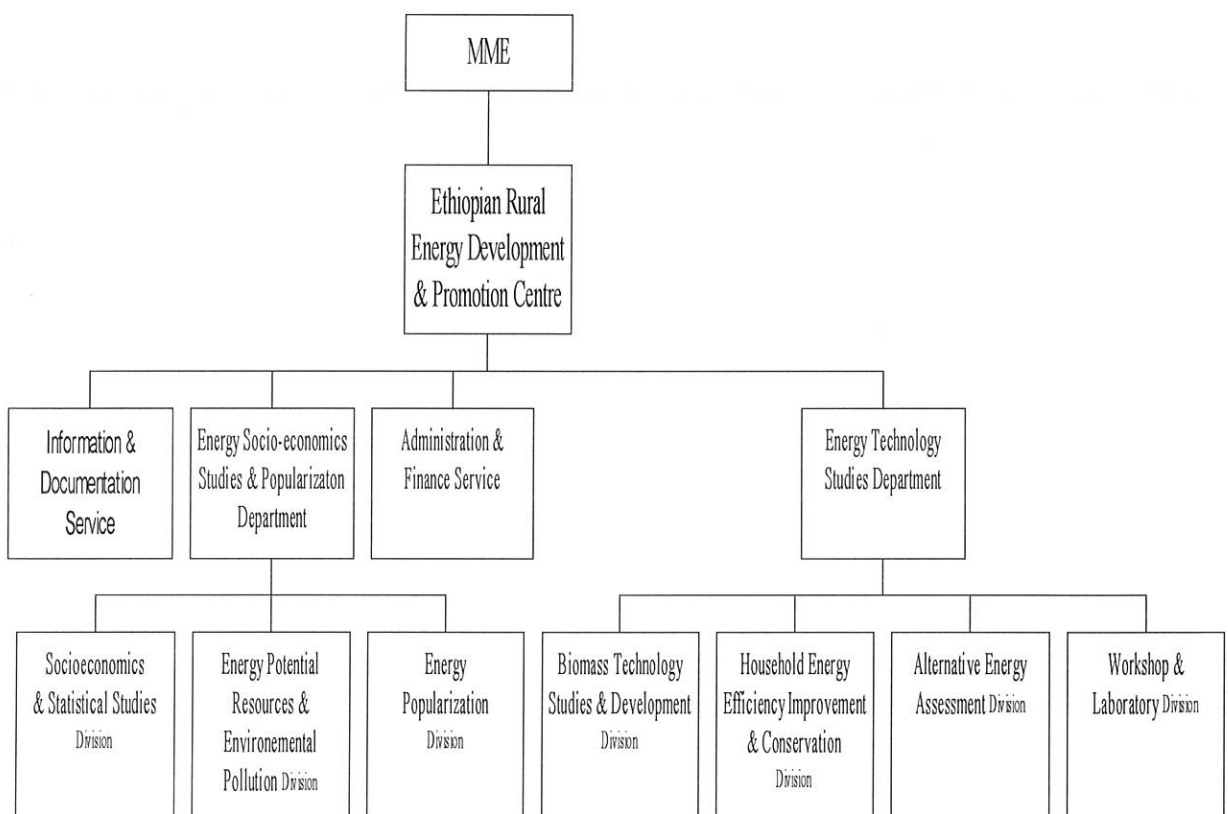


Figure 2.1. Organizational Structure of the Ethiopian Rural Energy Development and Promotion Centre

As depicted in the organizational structure, the center is accountable to the MME. In order to achieve its objectives stated previously, the center is organized into two functional departments. These are Energy Socio-economics Studies and Popularization Department and Energy Technology Studies Department. The departments are further segmented into divisions with a relatively distinct but related responsibilities.

The department of Energy Socioeconomics Studies and Popularization consists of such divisions as:

- ◆ Socioeconomic and Statistical Studies
- ◆ Potential Energy Resources and Environmental Pollution Studies and
- ◆ Energy Popularization

Similarly, the department of Energy Technology Studies has four divisions, namely :

- ◆ Biomass Technologies Studies and Development
- ◆ Household Energy Efficiency Improvement and Conservation
- ◆ Alternative Energy Sources Assessment and
- ◆ Workshop and Laboratory

The main organizational components that play major roles in attaining the goals of the centre are the two departments. The other two services in general and the I&DS in particular provide support that facilitate the tasks of these departments. Without the important support to be provided by the I&DS, the roles played by the departments will be very difficult to meet.

3.2.4 Functional Departments

The activities done in meeting the objectives of the centre are events that caused the user to request information from the system. To know these situations, it is important to state the functions performed by each of the departments and the I&DS.

3.2.4.1 Energy Socioeconomic Studies & Popularization Department

Energy Socio-economics, Studies & Popularisation Department deals with the energy problem of the society. The department is responsible for gathering, processing and dissemination of information on the size and type of energy supply and consumption in each and every sector of the economy. It is also expected to undertake research on the design of energy system and on the interdependence that exist between the economy and energy. In addition, it promotes the efficient and proper utilisation of the energy resources of the country by disseminating the appropriate technology to the community.

Moreover, it generates assessment reports as to which energy sources are appropriate to use in certain environment of the country and which energy is economical and suitable to which sector of the economic activity. It is also responsible for ensuring/checking the quality of information gathered on size and types of energy supply and consumption that enables to make projection. The promotion and application of research results on energy sources and technologies to the development of the rural economy is another major duty of the

department. It gathers data about the whereabouts of potential new and renewable energy sources.

3.2.4.2 Energy Technology Studies Department

The department deals mainly with research on the application of appropriate, cost effective and improved energy technologies. This enables to attain efficiency in energy consumption and generation. It is also responsible for undertaking research on the local fabrication of energy technologies and their distribution/dissemination to the rural community with the aim to protect the rural dwellers from health hazardous fuels.

The department also carries out research on the development of biogas technology through the selection of appropriate agro-ecology and devising a mechanism for its distribution. In addition, it controls the quality assessment and reporting as to the feasibility of biogas from socio-economic, financial and environmental perspectives. Furthermore, it studies the fabrication and application of effective technology for charcoal production so as to minimise the wastage of fuel wood due to the use of traditional techniques. It pre-tests the technology before its distribution to the rural community.

It is also responsible for the investigation of the availability of different energy sources in different regions of the country so as to achieve proportionate distribution. It controls the proper organisation of inventions and research results of the centre in order to provide appropriate information to governmental, non-governmental and private enterprises. It

popularises and provides training on the proper and efficient consumption of energy sources and energy technology application.

3.2.4.3 Information & Documentation Service

In restructuring the centre in 1999, it is studied and realised to incorporate a component responsible for the organisation and management of information centrally. Thus, I&DS is included as a service in the organisational structure. The I&DS is formed from the merging of the Energy Databases and Computer Section and the Library of EESRC. The Energy Databases and Computer Section was responsible for providing information on energy and energy related information for researchers, planners, policy makers and others within and outside ESSRC (ESSRC, 1996).

In order to do this and conduct their work, experts of the centre were engaged in collecting and compiling energy data since the beginning of EPTAP training on energy balance in 1982. The data being collected was on biomass fuels, petroleum, electricity, retail prices, calorific value of fuels and energy fertiliser. The database in the section was jointly maintained by the experts in the different projects of EESRC. The section was also providing technical assistance on the use of the hardware and software within the centre.

The second component that makes up the I&DS is the Library. It is responsible for providing bibliographic information service to users in and outside the centre. Since the I&DS is

composed of these components, it is responsible for provision of information and computer services. In order to provide these services it has the following functions.

3.2.4.3.1 Functions of the I&DS

- Acquiring books, journals, bulletins, audio-visual material and software that helps the preparation of reports on potential energy resources, up to date energy consumption and energy balance from local and international sources through purchase, exchange and gift.
- Organising the information sources in such a systematic way that users can have access to the right information at the right time.
- Establishing local area network and wide area network for efficient resource sharing available locally as well as internationally
- Providing computer services so as to facilitate the effective performance of the activities of the various units of the centre
- Documentation of energy resources, technology and use data in collaboration with the ESSPD of the centre and
- Providing library, printing and audio-visual services.

3.2.4.3.2 EREDPC Library

According to the discussion made with the librarian, the library is mainly established to serve the employees of EREDPC. However, external users can also use the library with the permission of the general director of the centre. According to the librarian's estimation, it has

a collection size of 100,000. Out of these 20,072 consists of books, encyclopedias, directories, manuals, handbooks, dictionaries and other reference materials. It has also 30 titles of journals, bulletins and other serial holdings having 3000 volumes 89 maps, satellite and aerial photographs. The rest, which consists around 75031 of the collection, is technical reports, research reports and other governmental publications.

Some of the library materials are available in the different departments and services on permanent basis. The library computerised only 237 records out of its collection using micro CDS/ISIS software. Though the collection size is large, it is managed by a librarian with a qualification of diploma in Library Science. The information sources are acquired through purchase, gift and exchange. The collection is organised by its subject, title and author using DDC scheme and Anglo-American Cataloguing Rule. Not all of the collection is organised. There is a card catalogue that describes some of the collection.

3.2.5 Manpower

The centre has 112 employees. Twenty-two of the employees are experts engaged in research, planning, project designing and decision making. It was revealed from the discussion with the head of the ESSPD that there is manpower shortage in the two functional departments. The head of the I&DS also pointed out that the activities of the service are currently being carried out by two individuals though the personnel requirement is set to seven as indicated in table 3.1. One is the head of the I&DS whose qualification is MSc. in

Energy Systems and Environment. The second is a librarian with a qualification of diploma in Library Science. In addition to this, the head is expected to play other roles than the I&DS.

Due to this problem the preparation of National Energy Balance and National Greenhouse report have been discontinued since 1996. In addition, the primary data is collected from only three regions and the rest of the country is not covered. The personnel requirement of the I&DS with their position is shown below.

Position	No.
Information & Documentation Head	1
Documentation Higher Expert	1
Documentation Expert	1
Programmer	1
Library Head	1
Librarian	1
Printing & Documentation	1
Total	7

Table 3.1: Manpower Requirement of the I&DS

3.2.6 Budget

The centre is funded by the budget allocated by the government and international aid organisations such as UNDP and UNEP. There was no formal budget allocated for the I&DS. The experience was that some amount of the budget allocated for any project is set aside for procuring computer facilities and purchasing reports.

3.2.7 Internal and External Interaction

The departments indicated above work together in order to meet the objectives of the centre. Based on the result of the research made and reports prepared, the ESSPD provides information to the ETSD as to which energy technologies should be improved so as to minimise energy wastage. Depending on the information obtained, the later department selects appropriate technologies, designs improved prototype technologies and provides technical training to selected private artisans on how to manufacture the technology.

The ESSPD then carries out the dissemination of the technologies. Besides this interdepartmental co-ordination, the centre collaborates with different organs involved in the production, distribution, and utilisation of the various types of energy including regional bureaux in exchanging energy information.

3.2.8 Data Maintenance and Data Processing Technologies in the Centre

3.2.8.1 Data maintenance by the Centre

The ESSPD collects data about the pattern of energy consumption, energy type and size in the different sectors. This is achieved through questionnaire surveys and from secondary sources. The surveys and secondary sources are used to gather demographic data, energy consumption and supply, devices and technologies used in the different sectors of the economy to consume and produce energy. The collection of these data is aimed at preparing the various energy reports. The preparation of these reports is done manually which is time consuming and error prone.

The ESSPD is collecting the data for the purpose of preparing the reports important for:

- ◆ Projecting the pattern of energy consumption, supply and resources availability in the future using energy modelling packages such as ENERPLAN and LEAP
- ◆ Conducting research activities that can bring about the proportionate distribution of every energy source in every sector and region of the country
- ◆ Showing the flow of energy from primary to useful energy and losses of energy caused by the conversion process
- ◆ Designing projects that aim at introducing new devices and improving existing ones and policy analysis and
- ◆ Knowing the pattern of the substitution of a type of energy source for another

It is vital to investigate about the facilities used to organise and process information that enhances fast access to the required information. To this end, the components of these facilities are explained depending on the interview made, the data gathered from the users through questionnaire and document review.

3.2.8.2 Computer Software & Hardware Facilities

The computer facilities available in the centre are mainly used for data analysis and processing, projection and for word processing purposes. The types of computer software and hardware available in the centre are listed as follows:

3.2.8.2.1 Computer Software

- Operating systems – Windows 98, 95, 3.5, and DOS 6.2
- Database Management System software – ACCESS, PARADOX
- Spreadsheet software – EXCEL, LOTUS
- Word Processing software – MS_WORD, Word Perfect 6.0.
- Energy planning software – Long Range Energy Alternatives Planning (LEAP) system, ENERPLAN, MARKAL
- Information retrieval software - CDS/ISIS
- Presentation software – Power point and
- Internet – EUDORA, Internet Explorer 2.0, 3.0

3.2.8.2.2 Computer Hardware

Types of Hardware	Quantity
Computers with processor of 286	5
Computers with processor of 386	4
Computers with processor of 486	10
Computers with processor of Pentium	6
Laser jet Printers	5
EPSON Printers	3
Scanners	1
LAN accessories	-
Modems	4
TV	1
Video cassette recorder	1
Projectors	2
Photocopiers	2
Microfiche reader	1
Video camera	1
Still camera	1

Table 3.2: Types of Hardware Available in the Centre

From the interview the head of I&DS and the figure shown above, it is possible to note that the facilities in the centre are adequate enough to carryout the activities that require the application of computers. Yet, the problem is lack of knowledge on how to use these resources effectively.

3.2.9 Categories of Information Users

In attaining the objectives of the centre, the experts in the two departments are involved in different activities as explained above that determines their categories as information users. Having known the activities being carried out by these departments through interview and the questionnaire survey, the user categories are identified. Users of the system are both internal and external. According to the questionnaire survey made the categories of internal users are presented in the table as follows.

User's Category	No. of Users	%
Researchers	14	43.75
Planners	5	15.63
Project Designers	8	25.00
Decision Makers	2	6.25
Policy Analysts	3	9.37
Total Frequency	32	100
Total No. surveyed = 18		

Table 3.3: Categories of Information Users

According to the interview conducted with the head of I&DS, the external users' category includes researchers, planners, decision-makers, policy analysts, students and investors. These categories of users were inaccessible. But, it was possible to know from the discussion that they come from governmental organisations, private companies, academic institutions, international organisations and others.

From the discussion it was also revealed that the provision of energy information to external users is informal in that if a user acquaints with a staff in the centre, she/he is able to know about the availability of the energy information in the centre. Most of the potential external users lack awareness as to the availability of energy information. This is because there has been no promotional activity being conducted both at media level, through dissemination of brochures, pamphlets and conducting awareness programmes.

3.2.10 Information Requirements of Users

The reason behind any information system development is to provide information to users. Users' information needs should be known to provide information tailored to their needs. Therefore, user information requirement analysis occupies a central place in the design of a new system.

In relation to this Horrocks (1985) notes that every information system is only as good as meeting the information needs of its users. Any system worth supporting must meet actual

(as opposed to perceived) user needs in such a way that it should be accessed, addressed and maintained both physically and intellectually on a reasonable basis. The requirements of system users dictate to a large extent the major characteristics of the information content of the system. Similarly, Senn (1987) notes that much of the success of the information system depends on identifying the right requirement for the application and ensuring that the development meets these requirements.

The type of information that users require to have depends on the type of work that they carry out. Since the users' work in the two departments some how differ, their information requirements also vary to some extent. Thus, in the following part the information requirements of each of the departments will be discussed.

3.2.10.1 Information Requirements of the Socio-economic & Statistical Studies and Popularization Department

Users who work at this department require the various types of energy information. In addition to energy information, they require socio-economic information such as population size, growth rate, income level and demography of a society. This is because there is an interrelationship between the socio-economic condition of a population and its energy consumption. For instance, the educational and economic status of the population in a given area determines the pattern and size of energy consumption, devices used, type of end-use, and sources of energy.

Knowledge about the size and location of the population is also important since it determines the size of energy consumed, the type of energy sources available for consumption, the means of acquiring the sources and devices used for energy consumption. The information on the past and present consumption of energy is used to project about the future requirements by taking some indicators such as population growth, economic development and others into consideration.

Besides, they need to realise about the wastage of energy as a result of the use of inappropriate devices for production and utilisation. They also need to know about the carbon emission produced as a result of the consumption of the various energy sources. Thus, to build this understanding and about the types and size of energy sources consumed, produced and marketed in each and every sector of the economy, experts in this department require the following information:

- Household sector energy consumption
- Transport sector energy consumption
- Agricultural sector energy consumption
- Industrial sector energy consumption
- Service/commercial sectors energy consumption
- Types and size of energy consumption in all the sectors
- Type and size of energy supply/resources
- Trade information of energy sources
- Types and size of devices/plants/technology used in all the sectors

- Population
- Geographical/location information
- Energy suppliers
- Production of energy
- Energy requirements
- Expertise information (experts engaged in the energy and related activities), regional and international organisations involved in energy development activities and
- Referral information on energy documentary sources.

3.2.10.2 Information Requirements of users in the Energy Technology Studies Department

Users who work in these departments are largely dependent on the outputs generated by the previous department. In addition to the information that they obtain from Energy Socio-economics Studies and Popularisation department, they need information on the following since their focus is on the technology aspect of energy:

- Alternative Energy Production Technologies
- Alternative Efficient Transportation & Utilisation Technologies
- Alternative End-use devices
- Availability of local materials used for the local fabrication of devices
- Expertise information (experts engaged in the energy and related activities) and regional and international organisations involved in energy development activities and
- Referral information on energy documentary sources.

3.2.11 Information Sources

According to the responses of users, information sources that they employ in order to meet their information requirements are of different types. Some of these are primary data that is obtained through questionnaire surveys. Some are secondary sources. Secondary sources of information used by the experts of the centre are documentary sources and organisations. Documentary sources include books, bulletins, technical and research reports. The major organisations that users used to gather information are presented in the following table.

Name of Organisations	No. of Respondents	%
MME	10	9.09
Ethiopian Geological Survey Institute	5	4.55
Ministry of Agriculture	7	6.36
Central Statistical Authority	14	12.73
Ministry of Trade and Industry	3	2.73
National Meteorological Authority	11	10.00
Ethiopian Investment Authority	6	5.45
Ministry of Natural Resources & Environmental Protection	8	7.27
Ethiopian Petroleum Corporation	12	10.91
Ethiopian Electric Power Corporation	12	10.91
Ethiopian Science & Technology Commission	10	9.09
National Bank of Ethiopia	2	1.82
Ministry of Planning and Economic Development	12	10.91
Total Freq.	110	100
Total users surveyed = 18		

Table 3.4: Name of Organisation that used to Obtain Information

Even if the data is collected through questionnaire surveys and from other internal and external sources, the head of I&DS made clear that the information collected from secondary sources are not reliable and accurate. In support of this, ESTC (1998b) notes that it is uncommon that different and conflicting figures are reported on energy supply, consumption and traditional energy sources.

In addition, Mekonnen (1997) states that the energy demand forecast in each type of fuel and sector made in 1986 by CESEN-ANSALDO for the rest of the years after 1986 did not match. The reason for this is not identified or attributed to any of the parameters used. However, the data compiled and presented in the CESEN report is still used for preparing different energy reports.

3.2.12 Problems Encountered by the Users of the Information System

From the questionnaire survey it was disclosed that the users were unable to get adequate, relevant, up to date and accurate information. In explaining the reasons for this, 36.59% of respondents have pointed out that there is inconvenience of information organisation, 19.51% of users responded unavailability of information sources, 24.39% answered lack of systematic retrieval of information and 19.51% responded inaccessibility of sources such as Internet. The magnitude of these problems as expressed by users is shown in the following table.

Reasons for the Problems	No. of Respondents	%
Inconvenience of information organisation	15	36.59
Unavailability of information sources	8	19.51
Lack of systematic retrieval of information	10	24.39
Inaccessibility of Internet	8	19.51
Total Freq.	41	100
Total users surveyed = 18		

Table 3.5: Types of reasons for the Problems Encountered by Users of the Information System

3.3 Summary of the Survey Analysis

From the above discussion it was possible to summarise the problems of the existing information system as follows:

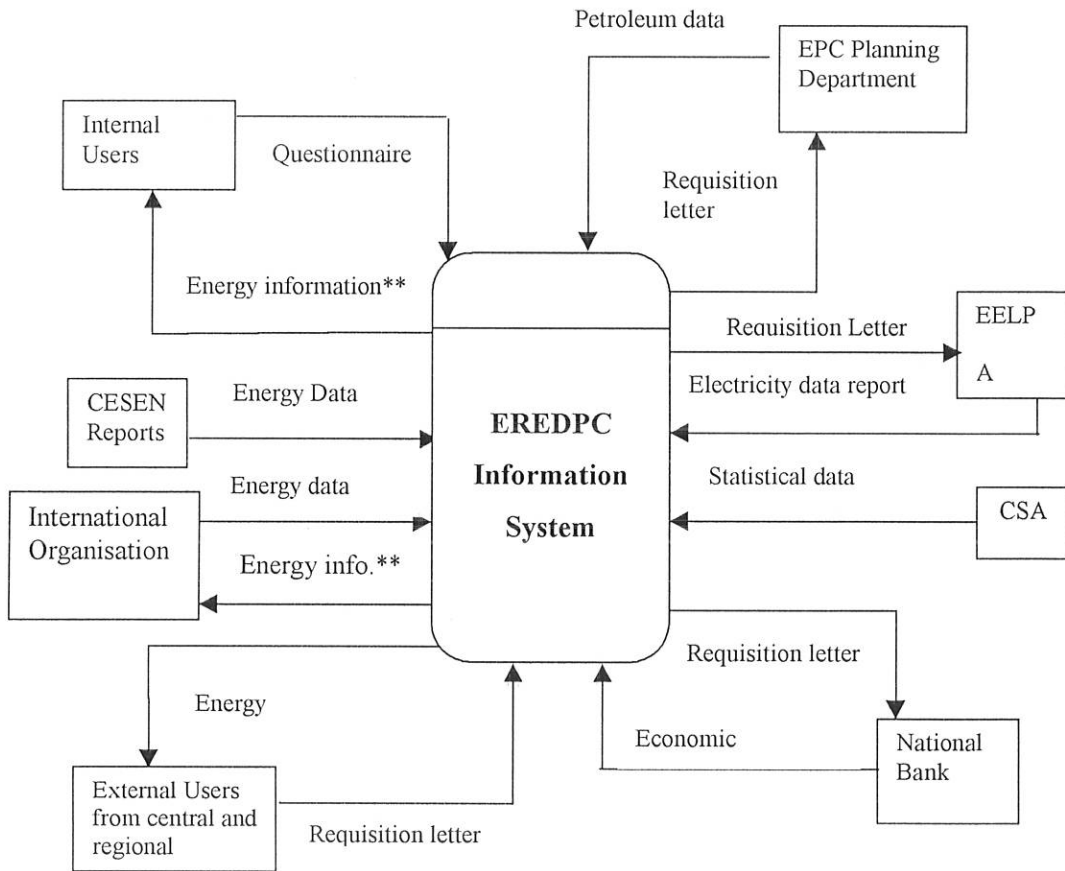
- There is shortage of manpower. Due to the shortage and turnover of qualified energy professionals, the preparation of the various types of energy reports such as national energy balance, regional energy balance and national greenhouse have been discontinued since 1996. Because of this manpower shortage, the collection of primary data on the various energy parameters is restricted to sample survey and some regions of the country.

- The information collected from external sources is subject to problems of inconsistency, inadequacy and unreliability.
- The partial data maintained in LOTUS 1-2-3 is not fully verified. The verification is made to some sample records on the screen.
- There is mismatch between the energy demand forecast made in 1986 by CESEN-ANSALDO and the rest of the years after 1986.
- There is lack of efficient and effective management of information resources and computer facilities available in the centre
- There is problem of obtaining up to date, relevant and accurate information because of inconvenience of information organisation, unavailability of information sources, lack of systematic retrieval of information and inaccessibility of sources
- Users do not have access to internet services though it is relevant as a source of information
- The library with a huge collection of research and technical reports are not properly organised and computerised and
- There has not been awareness programme conducted to promote the information resources available in the centre

3.4 Context Diagram of the EREDPC Information System

In the previous part, an attempt was made to survey the existing information handling system of the EREDPC and identify the problems based on the questionnaire, interview and document analysis. In this section, the internal and external interaction of the EREDPC

information system is documented using the context diagram that shows the boundary of the system. Internal users include all departments, services and general director offices. The external interaction is with EELPA, CSA, National Bank and others.



** Energy information includes national & regional energy balance, national greenhouse report & Lib. materials

CHAPTER FOUR

MODEL AND DESIGN OF THE EREDPC INFORMATION SYSTEM

4.1 Introduction

In this chapter based on the analysis made in the previous chapter, an attempt is made to model and design the new system that should alleviate the problems of the existing information handling system. To this end, input, process and output requirements of the system are identified and presented below.

4.2 Input Data of the System

The information system inputs data from two basic sources namely, primary - obtained from questionnaire survey and secondary - obtained from the reports and bulletins compiled internal and external of the centre. In order to give an overview of the input data that the system uses, it is important to discuss the following.

4.2.1 Primary Sources

There are about seven different questionnaires (annexed on page 92) designed by the experts in the ESSPD in order to gather the various data related to sectoral energy supply and

consumption in different regions of the country. The collection of data is done by enumerators under the supervision of the experts of the ESSPD. The collection of data covers only a sample of a population under investigation. All the questionnaires discussed below involve the use of codes to represent the various data values. A brief account of the purposes and data collected using these questionnaires is given below.

Questionnaire I: Energy Consumption in the Transport Sectors: the purpose of gathering this type of data is to know how many gasoline and diesel oils consumed by each type of road transport (passengers and freight) and the location of transportation.

Questionnaire II: Energy Consumption in Large and Medium Scale Industries: the purpose of this questionnaire is to know how much and what type of energy consumed in the large and medium industries that are used as a component of the consumption of the industrial sector. This questionnaire has three parts. The first part aims at enlisting location information. The second part is about production of the industry. The third part of the questionnaire is about the size of energy consumption.

Questionnaire III: Energy Consumption in the Construction Sector: the purpose of this questionnaire is to collect data about the type, size and end-use of energy in this sector. This questionnaire has three components. The first component contains data about construction company identification. The second component is data on the performance of construction companies under consideration. The final part is about energy consumption by fuel and end-use.

Questionnaire IV: Energy Suppliers: this questionnaire is used to gather data about the number and availability of energy suppliers in the different urban and rural areas so as to know the percentage of settlements that have access to energy supply services and to improve for areas with low accessibility. The parts of the questionnaire aim at collecting data useful for area identification of suppliers, the distribution of petroleum products and the supply of electricity.

Questionnaire V: Settlements: this questionnaire is about the settlement's identification, settlement demography, the local fixed infrastructure, public transport sector, accessibility to transport network, availability of small industries and the availability of social and commercial services.

Questionnaire VI: Consumption of Energy in the Household Sector: is required to know the potential for disseminating more efficient stoves to the households, to realise the time and effort exerted in water fetching since rural dwellers use wells and rivers, in milling using mortar/pestle (Mukecha) and stone (Wofcho). In addition, the questionnaire is used to know the relationships that exist between the income of a society and its energy consumption since energy consumption is a function of income, price and obtained and to estimate energy availability from animals. It is required to know the amount of human and animal energy applied for agriculture so as to determine the type of appropriate mechanised power sources required.

The parts of this questionnaire aim at gathering data on sample identification, household characteristics, the characteristics of household energy supply, energy consumption for domestic uses and household industry, type of stoves owned by the household, water provision, grain milling, household income, livestock and poultry possession and crop cultivation.

Questionnaire VII: Energy Consumption in the Mechanised Agricultural Sector is used to collect data about the extent of energy consumption in the agricultural sector while using mechanical instruments. The remaining parts of the questionnaire aim at gathering data about farm identification, production data and energy consumption by fuel and end-use.

4.2.2 Secondary Sources: Bulletins and Reports

Due to the shortage of financial and manpower resources, all the data required for the generation of energy information are not only collected through questionnaires but also the sample does not cover all the regions. Thus to supplement the data obtained through the questionnaires, secondary sources such as reports and bulletins produced internal and external of the centre are used.

4.2.2.1 From Internal Sources

CESEN Reports are used to obtain the following data:

- Conversion rate of each type of energy based on their heating value in mega joules/kg

- Ratio of each sector's share of each type of energy consumed
- Annual dung yield of each type of animal
- Type and size of sources used for non-energy use (e.g. size of dung used for house construction and size of petroleum used for asphalt, etc)
- Annual increase of demand for each type of energy by each sector
- Crop to residue ratio of each type of cereal including coffee
- Average market price of each type of traditional fuels in different regions

EEA Report is used to obtain such data as:

- Specific fuel consumption (lit/km) of each type of transport

4.2.2.2 From External Sources

CSA's Bulletins & Reports used to obtain the following data:

- Total number of each type of animal (cattle, hen, horse, etc)
- Types of trucks, pickups, other types of transport and distance travelled by each category of transport
- Annual crop yield
- Size and growth rate of the population of the country

Annual Statistical Report produced by EELPA annually is used to obtain the following data relevant for the preparation of various types of energy reports:

- Generation capacity of EELPA systems

- Electricity generation by EELPA systems
- Energy inputs for the generation of electricity in the EELPA system
- Electricity sales by EELPA system

EPC report is used to obtain the following:

- ◆ Petroleum products imports
- Petroleum products Stock changes
- ◆ Petroleum consumption in customer category

4.3 Process Requirement

A logical data flow diagram is a tool for drawing a model or picture of an information system's processing requirement. It is employed to show the flow of the input to the system, storage and outputs of the system. The notations used to depict a DFD are:

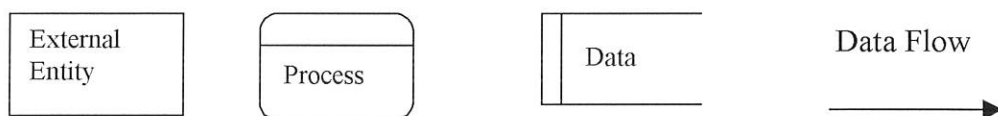


Figure 4.1: Data Flow Diagram Symbols

Since it is impossible to cover all the reports generated by the system, the focus is on the generation of National Energy Balance report. Currently the preparation of the National Energy Balance of the country is based on data obtained from secondary sources. The

existing system maintains the data required for the generation of the National Energy Balance using one of the spreadsheet software known as LOTUS 1-2-3. Maintaining data using spreadsheet software is not convenient for data entry, data modification and generating reports. Hence, there is a need to develop database management system that enables to automate energy information system for data entry, storage and data retrieval.

4.4 Proposed Alternative Solution

As described earlier, in order to overcome the limitation of the existing information system, design database has to be made. For the proposed database design, the following entities are identified.

- | | |
|--|--|
| <input type="checkbox"/> Energy Type | <input type="checkbox"/> Supply Type |
| <input type="checkbox"/> Energy-Supply Transaction | <input type="checkbox"/> Crop |
| <input type="checkbox"/> Cattle Sectors | <input type="checkbox"/> Sectors-consumption Transaction |

The main processes involved in generating the national energy balance report are maintaining the required data (see figure 4.3). The data maintenance activity is factored into:

- A process for storing *Energy type data*
- A process for storing *Supply type data*
- A process for storing *Energy-supply transaction data*
- A process for storing *Crop data*
- A process for the storing *Cattle data*

- A process for storing *Sectors data*
- A process for storing Sectors-consumption data

The data maintenance activities discussed above include all of the custodial activities needed to ensure that accurate data is available for generating National Energy Balance. The report process generation has the following sub-processes:

- Computing Net Energy Supply
- Compute Crop Residue
- Compute Dung Yield
- ◆ Computing Energy Consumption
- ◆ Computing National Energy Balance

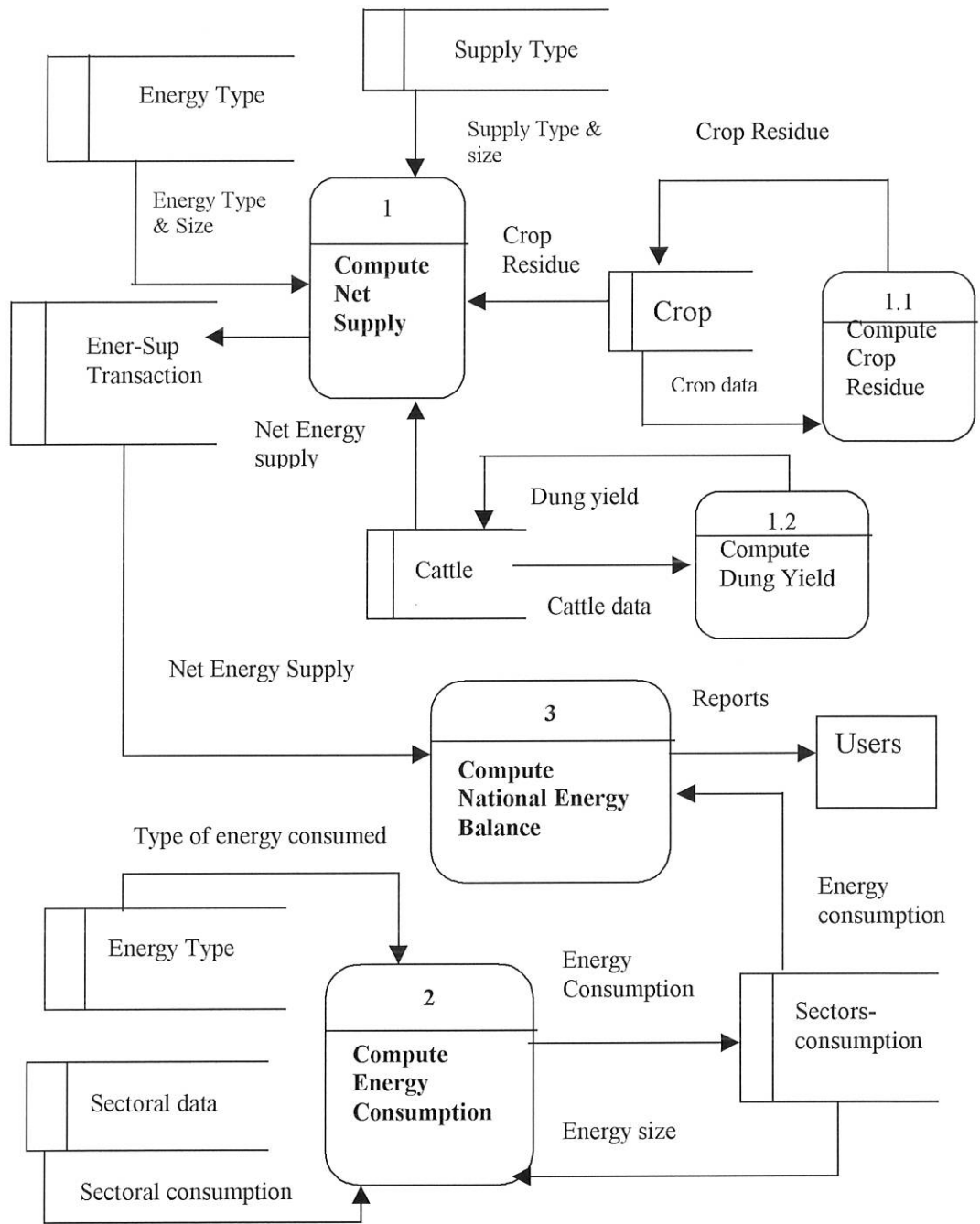


Figure 4.2: Data Flow Diagram for the National Energy Balance

4.4 Outputs of the EREDPC Information System

The following are outputs of the information system:

- National Energy Balance Report contains:
 - Biomass Energy Balance Report
 - Petroleum Energy Balance Report
 - Electricity Energy Balance Report
 - Primary Energy
 - Secondary Energy
- Regional Energy Balance
- National Greenhouse Report

4.5 System Design

4.5.1 Data Analysis for Database Design

Data analysis modelling is used as a mechanism of preparing that data model to communicate database design requirements to database builders (programmers) (Whitten, Bentley and Dittman, 1998). The data requirements identified during the analysis phase is converted into a relational data model. This data model is preferred over other data models such as network and hierarchical because it is simple and relatively flexible; more over most contemporary DBMSs are based on this data model (Furtuck, 1995).

Database requirements specification mapped from the data requirements identified in the analysis phase may contain structural characteristics that reduce flexibility and expansion, or create unnecessary redundancies. To prepare the data model for database design and implementation, a procedure called data normalisation needs to be applied.

4.5.2 Data Normalization

Normalisation is “a technique that organises data attributes such that they are grouped to form stable, flexible and adaptability” (Whitten, Bentley and Dittman, 1998,p.408).

Normalisation enables to produce a good data model having the following features.

1. A good data model is simple, which means the data attributes that describe an entity should describe only that entity. In addition, each attributes of an entity instances should have only one value.
2. A good data model is essentially non-redundant. This means that each data attribute, other than foreign keys, describes at most one entity.
3. A good data model should be flexible and adaptable to future needs.

In order to come up with a data model having these features, normalisation places data in three normal forms (1st, 2nd and 3rd normal forms). Kozar (1989) states that usually the objective of the system designer is to express data in third normal form. The first normal

form (1NF) removes repeating groups. An entity is in 1NF if there are no elements or groups of elements that repeat for the single occurrence of the entity.

The second normal form (2NF) further removes non-key data elements not fully dependent on all data elements in the key. Therefore, the primary key is first set for the entire entity and checked if it contains more than one data element, concatenated key. Finally the third normal form (3NF) removes data elements uniquely identified by another non-key data elements (transitive dependency). If a non-key element depends on another non-key element, the two related items should be separated and treated as an independent entity. In the present study, only the appearance of data after the third normal form is presented. Mean while it should be noted that the underlined fields for a given table represent a uniquely identifier/primary key/ for each entity.

4.5.2.1 Information related to Energy Supply

To organise a detailed information on energy supply and consumption, the necessary data are identified and then the normalisation of this data resulted in the following table.

Energy Type Table

<u>Energy code</u>	Energy name	Conversion rate

Supply Type Table

<u>Supply code</u>	Supply description

Energy-supply Transaction table

<u>Ene-Sup code</u>	Energy code	Supply code	Fuel Size

Crop Table

<u>Crop name</u>	Yield size	Ratio

Cattle

<u>Cattle name</u>	Cattle Size	Dung yield

4.5.2.2 Information Related to Energy consumption (demand)

Sectors-consumption Table

<u>Demand code</u>	Energy code	Sector code	Fuel Size

Sectors Table

<u>Sectors code</u>	Sector name

4.5.3 Entity-Relationship Diagram

Entity relationship diagram is, an easy to read and understand logical (implementation independent) data modelling tool, that complements the process models of a system. It is used to remove biases, communicate with end users in non-technical language and to reduce the risk of missing functional requirements (Whitten, Bentley & Barlow, 1989)). Thus, to supplement the process requirement model of the National Energy Balance, the following entity relationship diagram is depicted.

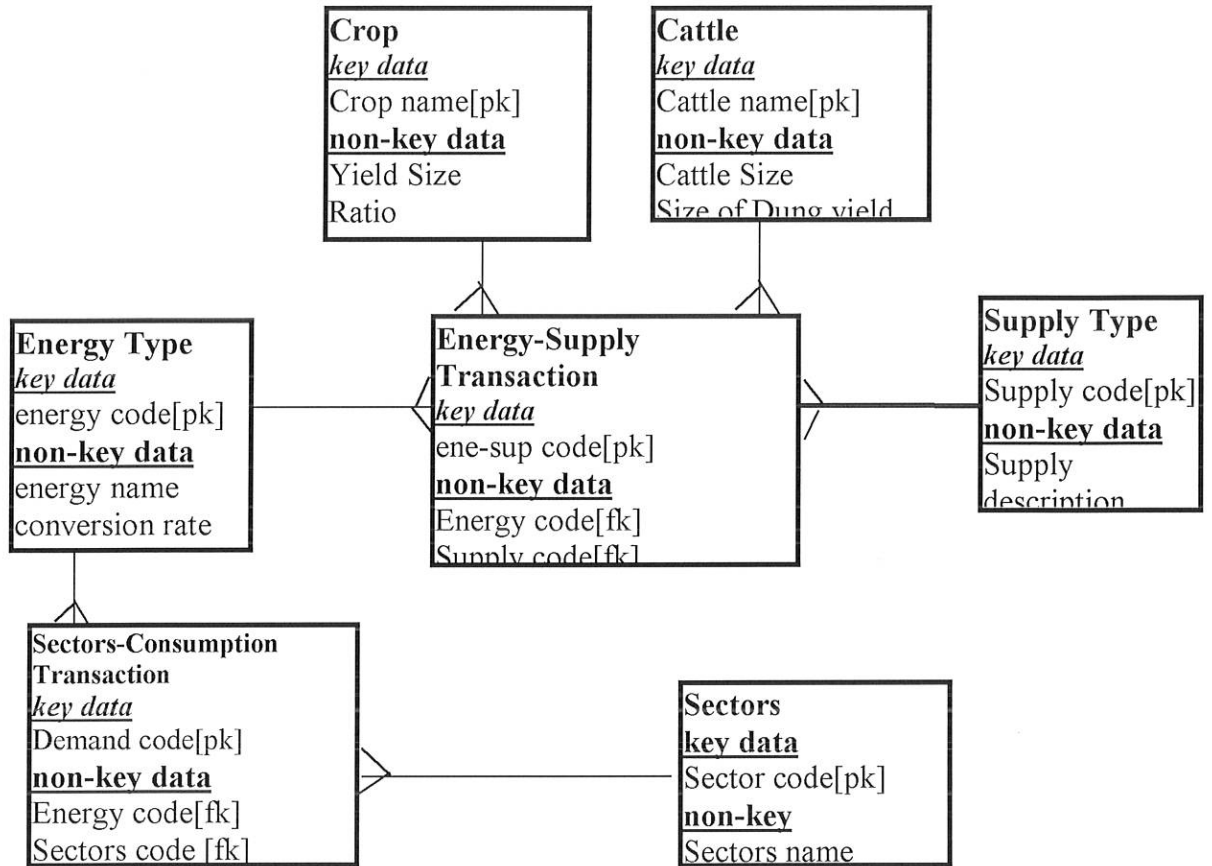


Figure 4.3: Entity Relationship Diagram for National Energy Balance

4.5.4 Data Dictionary

Data dictionary is a data documentation tool. It enables to specify the type, size and description of entity attributes. More formally, it is a tool for maintaining data about data in files and databases for an entire system (Whitten, Bentley and Barlow, 1989). In the tables below, the data dictionary of the entities identified in the previous step are presented.

Energy Type table

No.	Field Name	Type	Size	Indexed	Key
1	Energy Code	Text	4	Yes	Primary Key
2	Energy Name	Text	50	Yes	Non-key
3	Conversion Rate	Numeric	4	No	Non-Key

Supply Type table

No.	Field Name	Type	Size	Indexed	Key
1	Supply Code	Text	6	Yes	Primary
2	Supply Description	Text	50	No	Non-Key

Energy-Supply Transaction table

No.	Field Name	Type	Size	Indexed	Key
1	Ene-Sup code	Text	8	yes	Primary
2	Energy Code	Text	4	Yes	Foreign
3	Supply Code	Text	6	Yes	Foreign
4	Fuel Size	Number	10	No	Non-Key

Crop Table

No.	Field Name	Type	Size	Indexed	Key
1	Crop name	Text	8	Yes	Primary
2	Yield Size	Text	4	Yes	Non-Key
3	Ratio	Text	5	Yes	Non-Key

Cattle Table

No.	Field Name	Type	Size	Indexed	Key
1	Animals name	Text	8	Yes	Primary
2	Cattle size	Number	10	Yes	Non-Key
3	Dung Yield	Number	10	Yes	Non-Key

Sector-Consumption Table

No.	Field Name	Type	Size	Indexed	Key
1	Demand code	Text	8	Yes	Primary
2	Energy code	Text	4	Yes	Foreign
3	Sectors code	Text	5	Yes	Foreign
4	Fuel Size	Number	10	No	Non-Key

Sectors table

No.	Field Name	Type	Size	Indexed	Key
1	Sectors Code	Text	5	Yes	Primary
2	Sectors Name	Text	50	No	Non-Key

CHAPTER FIVE

PROTOTYPE DATABASE DESIGN

This chapter presents the prototype database design of EREDPC information system. For the purpose of demonstration, the prototype databases of the National Energy Balance database has been developed using ACCESS 97.

As presented in the previous chapter, the data relating to National Energy Balance sub-system is stored in Crop, Energy Type, Supply Type, Energy-Supply Transaction, Cattle, Sectors and Sectors-Energy Consumption. For the prototype National Energy Balance, seven database files (tables) have been created using ACCESS 97 that corresponds to each data file. The seven database files are linked with each other in order to retrieve and use data stored in these files to manipulate all data relevant to generate the energy balance report.

This study was users' participatory throughout its phases. The prototype design was presented to users in order to test the convenience of the forms and the report designed in this stage. Users commented and suggested that some facilities that help to navigate between the forms/report and menu, the forms/report and the database window and to quit automatically from the program. Based on the comments the necessary commands are included in all the forms and the report.

5.1 User Interface

To start the prototype program being on the Windows NT operating environment, the user has to click on the start button and choose the access program icon from the program submenu. While ACCESS 97 program is opened, the database window will appear on the screen and the user is prompted to choose from the list of the databases. The user has to select the DBF3 that is used to maintain the data relevant for the energy balance report. In opening this file the main menu of the EREDPC Information System will appear for the user to interact with the system friendly. As shown in the menu below if a user clicks on one of the controls, the corresponding commands will be performed.

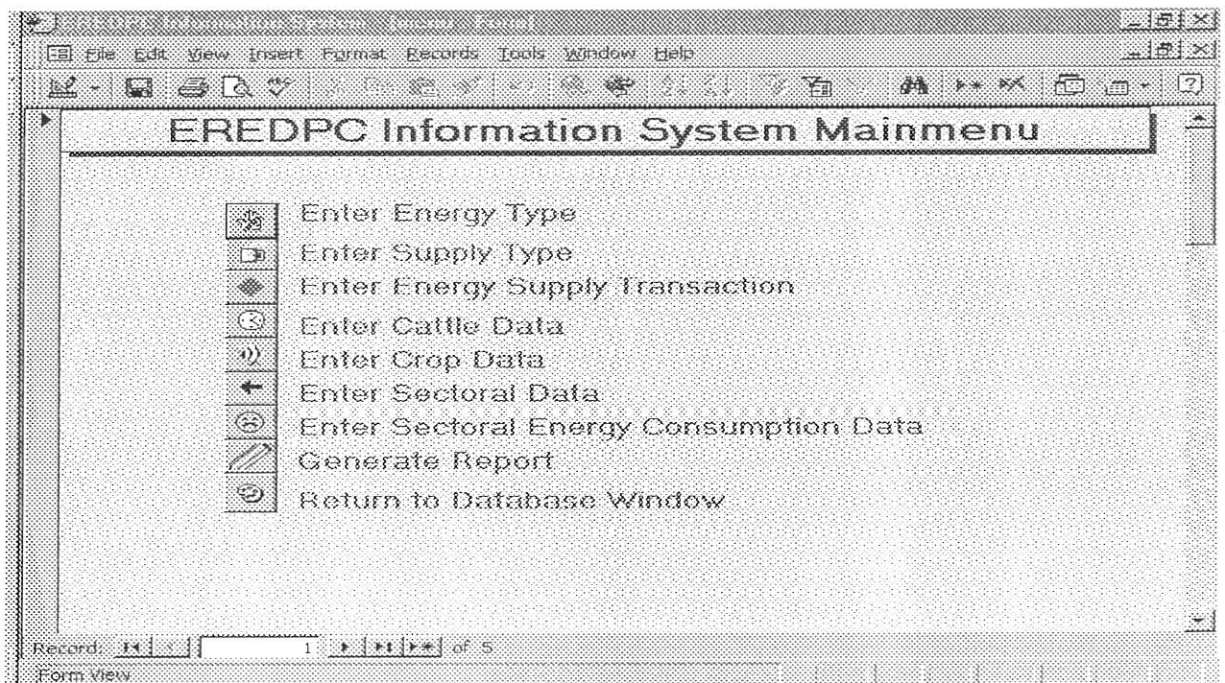


Figure 5.1 User Interface with the EREDPC Information System

5.2 Input Forms to National Energy Balance

The following input forms are used to enter energy data that are used to prepare the energy balance report. Each of these forms will be presented and discussed as follows:

This form is used to enter data about energy type, modify records and navigate through records. The user can either return back to the main menu or database window or quit the program automatically by clicking in either of the corresponding controls in the form.

The screenshot shows a software window titled "EREDPC Information System - (enertype - Form)". The window has a menu bar with "File", "Edit", "View", "Insert", "Format", "Records", "Tools", "Window", and "Help". Below the menu bar is a toolbar with various icons. The main area of the window is titled "Energy Type Form" and contains three input fields: "Energy Code:" with the value "3V", "Energy Name:" with the value "aviation gas", and "Conversion Rate:" with the value "15". To the right of these fields are three buttons: "Back to Mainmenu", "Close", and "Quit". At the bottom of the window, there is a status bar that says "Record: 1 of 16" and "Form View".

Figure 5.2 Data Entry form of Energy Type

This form is used to enter data about the nature of the supply. It is also used to modify and navigate through records. The controls on the form can be used to return back to the main menu or database or quit the program.

The screenshot shows a software window titled "EREDPC Information System - [Energy Supply : Form]". The window has a menu bar with "File", "Edit", "View", "Insert", "Format", "Records", "Tools", "Window", and "Help". Below the menu bar is a toolbar with various icons. The main area of the window is titled "Supply Type Form".

Inside the form, there are two input fields: "Supply Code:" with the value "FCR" and "Supply Type:" with the value "Crop Residue Fertil". To the right of these fields is a vertical stack of three buttons: "Back to Main Menu", "Close", and "Quit". Below these buttons are four navigation buttons: a left arrow, a double left arrow, a right arrow, and a double right arrow.

At the bottom of the form, there is a "Record:" label followed by a small grid of navigation icons and the text "1 of 34". Below this is a "Form View" label.

Figure 5.3 Data Entry form of Supply Type

This form is used to enter data necessary for computing the crop residue of each type of cereals and the total of the crop residue. It is also used to modify and navigate through records.

EREDPC Information System - [crop residue : Form]

File Edit View Insert Format Records Tools Window Help

Crop Residue Form

Type of Crop:

Size of Yield:

Ratio:

Back to Mainmenu

Close

Quit

Record: of 6

Form View

Figure 5.4 Data Entry form of Crop

This form is used to enter data required to compute dung yield of each type of cattle and the total dung supplies. It is also used to modify and navigate through records.

The screenshot shows a software window titled "EREDPC Information System - [cattle : Form]". The window has a menu bar with "File", "Edit", "View", "Insert", "Format", "Records", "Tools", "Window", and "Help". Below the menu bar is a toolbar with various icons for file operations and data management. The main area of the window is titled "Cattle's Dung Yield" and contains three input fields: "Cattle:" with a dropdown menu showing "DOW", "Cattle size:" with a text box containing "20", and "Dung yield size:" with a text box containing "10". To the right of these fields are three buttons: "Back to Mainmenu", "Close", and "Quit". At the bottom of the window, there is a record navigation bar showing "Record: 1 of 5" and a "Form View" label.

Figure 5.5 Data Entry form of Dung yield

This form is used to enter data about each energy type, method and size of supply and the purpose of losing certain amount of a type of energy. It is also used to modify and navigate through records.

The screenshot displays a software window titled "EREDPC Information System - [transform : Form]". The window contains a menu bar with "File", "Edit", "View", "Insert", "Format", "Records", "Tools", "Window", and "Help". Below the menu bar is a toolbar with various icons for file operations and editing. The main area of the window is titled "Energy Supply Transaction Form".

Inside the form, there are three input fields:

- Energy code: A dropdown menu showing "CI".
- Supply code: A dropdown menu showing "IDG".
- Fuel size: A text input field containing "600".

To the right of these fields are three buttons: "Back to Main Menu", "Close", and "Quit". Below these fields and buttons are four navigation buttons with left and right arrow symbols.

At the bottom of the window, there is a status bar that reads "Record: 1 of 10". Below the status bar, the text "Form View" is visible.

Figure 5.6 Data Entry form of Energy Supply Transaction

This form is used to enter data about each sector. It is also used to modify and navigate through records.

The screenshot displays a software window titled "EREDPC Information System - [sector : Form]". The window features a menu bar with "File", "Edit", "View", "Insert", "Format", "Records", "Tools", "Window", and "Help". Below the menu bar is a toolbar with various icons for file operations and navigation. The main area of the window is titled "Sectors' Data Form".

Inside the form, there are two input fields: "Sector-Code:" followed by a text box containing "5", and "Sector:" followed by a text box containing "Agriculture". To the right of these fields is a vertical stack of three buttons: "Back to Mainmenu", "Close", and "Quit".

At the bottom of the window, there is a status bar. It contains the text "Record: 1 of 11" with navigation icons on either side, and "Form View" on the far left.

Figure 5.7 Data Entry form of Sectors

This form is used to enter data about each sector's energy consumption for each type of energy. It is also used to modify and navigate through records.

EREDPC Information System - [consumption : Form]

File Edit View Insert Format Records Tools Window Help

Sectors - Energy Consumption Form

Energy Code: 02

Sector-Code: inl

Size Consumed: 4.9

Back to Mainmenu

Close

Quit

Record: 1 of 53

Form View

Figure 5.8 Data Entry form of Sectors Consumption Transaction

5.3 Output of the Prototype Database

National Energy Balance of Ethiopia				
Primary Traditional Energy				
	<u>Wood</u>	<u>Dung</u>	<u>Crop Residue</u>	
Gross	700	90	460	
C O N S U M P T I O N	HouseHold			
	Rural Househ	20	50	120
	Urban Househ	10	20	62
	Service			
	Service	19.5	35	94.1
	Industry			
Large Indus	14.9			
Small-scale	158	12		

Figure 5.9 National Balance: Primary Traditional Energy

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.1 CONCLUSION

The system analysis and design exercise reported in this study was aimed at examining the existing information system of EREDPC, identifying its shortcomings, defining requirements of the system and proposing the development of an improved system that would overcome the problems prevailing in the existing system. In relation to this, questionnaire survey, interviews and document analysis were made. Based on the questionnaire survey, interview and document review, the major findings of the study are explained as follows:

Due to the shortage and turnover of qualified energy professionals, the preparation of the various types of energy reports such as national energy balance, regional energy balance and national greenhouse have been discontinued since 1996. In addition, this manpower shortage restricted the collection of primary data on the various energy parameters to sample survey in some regions of the country. Thus, the preparation of the national energy balance is dependent on the secondary data obtained from different reports. The information taken from secondary sources is subject to problems of inconsistency, inadequacy and unreliability.

There is lack of efficient and effective use of existing information technology resources due to low level of knowledge.

The partial data maintained in LOTUS 1-2-3 is not fully verified by the existing system. The verification is made to some sample records on the screen. The sample may not cover all erroneous records. Thus, the use of reports or information compiled based on the erroneous data will result in wrong research results, decision and planning.

It is also identified that the energy demand forecast in each type of fuel by each sector made in 1986 by CESEN-ANSALDO for the rest of the years after 1986 did not match. The reason for this is not identified or attributed to any of the parameters used. However, the data compiled and presented in the CESEN report is still used for preparing different energy reports.

There has not been promotional activity conducted by the centre as to the availability of information resources. This has resulted in low level utilisation of the resources.

Though the centre has a library with a very huge collection of documentary materials, it is not properly organised and managed. Thus, there is no way to know the available materials in the library. This will create inconvenience to the users.

6.2 RECOMMENDATIONS

In order to overcome or minimise the problems of the existing information system identified, the following recommendations are forwarded:

There is a need to design a system that allows database management. An attempt was already made to design a prototype system in the present research. The centre has to follow the present approach in automating the entire the entire information system.

Qualified professionals should be hired both in the functional departments and I&DS. This has to be done in order to base both national and regional energy balance on the primary data since primary data is more accurate and reliable than secondary data. This has to be done since the experts in ESSPD are responsible for the primary data collection and the professionals in the I&DS are responsible for organisation and maintenance of data.

Adequate budget should be allocated for training staff on information technology related courses, procuring computer facilities and acquiring documentary information sources.

All the primary data maintained using LOTUS 1-2-3 has to be changed to software that are basically designed for database management system.

Wide area network should be established between the centre and the information sources identified in the study and other organs involved in the production, conversion, storage and use of energy. Since significant amount of information required by the centre come from the governmental and non-governmental organisations, establishment of network will improve exchange of information.

Local area network should also be established so that the users of EREDPC information system can have access to the Internet without incurring any extra Internet fee and they can access national energy balance and other energy reports online.

The EREDPC has to maximise its users by creating awareness programme about the availability of different energy information resources.

The system has to conduct periodic users study and continue the periodic preparation of the reports that are discontinued.

Finally, the library should be properly organised and managed using WINISIS software package.

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APPENDIX I

Questionnaire

The questionnaire is to be filled by Information Users of the Information System of the Ethiopian Rural Energy Development and Promotion Centre. This is being conducted as part of the research project entitled "Information System for the Ethiopian Rural Energy Development & Promotion Centre" that aims at assessing the categories of users, their information requirements, sources and formats of information sources and studying the existing information system so as to suggest a system that will meet users' requirements. The research is carried out as a partial fulfilment for the Master of Science in Information Science. As the success of this study depends on your co-operation, I am keen to receive your responses at your convenience. All your co-operation will be handled in strict confidence.

Thank you in advance for your co-operation.

Please handle the filled questionnaire to W/ro Masresha.

1. Identification

Your Educational Qualification _____

Your position/Occupation _____

In which department/division/services are you working? _____

2. With which of the departments/divisions/services of EREDEC do you interact in doing your activities?

Socio-economic, Popularisation & Studies Department

Socio-economic & Statistical

Potential Energy and Environmental Pollution Studies

Energy Popularization.

Energy Technology Studies Department

Biomass Technologies Studies and Development

Household Energy Efficiency Improvement and Conservation

Alternative Energy Sources Assessment

Workshop and Laboratory

3. What type of information do you need for conducting your activities?

Household sector energy consumption information

Transport sector energy consumption information

Agricultural sector energy consumption information

Industrial sector energy consumption information

Service/commercial sectors energy consumption information

Types and size of energy consumption in all the sectors

- Inconvenience of the information organisation
- Unavailability of information sources relevant to your interest
- Lack of systematised information retrieval
- Others, please specify _____

9. To which user category do you belong?

- Researcher
- Planner
- Consultant
- Technicians
- Student, please mention the level of your education _____
- Investor
- Policy maker
- Decision maker

10. Do you use computers in conducting your work?

- Yes
- No

11. Is there a computer centre that facilitates your computer utilisation?

- Yes
- No

12. What do you suggest to solve the problems related to information access and use in the information and documentation services or institutions that provide information?

APPENDIX II

List of Individuals Interviewed

Ato Getnet Tesfaye	Head of Information & Documentation
Ato Dereje Kebede	Head of Energy Technology & Studies Department
Ato Mekonnen Kassa	Head of Socio-Economics, Studies & Popularisation Department
Ato Hilawi Lakew	Head of Energy Popularisation Division
Ato Fikre Teshome	Head of Library
Ato Eyasu Chiroka	Higher Expert in the Socio-Economics, Studies & Popularisation

APPENDIX III

Questionnaires used by the Centre

Ministry of Mines & Energy Ethiopian Energy Studies & Research Center The Regional Energy Survey

SECTION E: HOUSEHOLDS

E1: Enumerator Identification

Enumerator	Name	Sign
Supervisor		
Date	Interview Start	Interview End
18-07-1988 E.C.	1:32	3:22

E2: Sample Identification

1	Settlement	Bahar Dar
2	Region	3
3	Zone	Special
4	Wereda	higher
5	Kebele	07
6	House No.	B-518
7	Respondent	Meseret Alemu

E3: Household Characteristics

I	NAME	A G E X C		
		2	3	4
1	Ato Anenah Alemu	31	1	8
2	Ageyo Alemu	25	2	7
3	Meseret Alemu	22	2	3
4	Hilda Alemu	18	1	13

Sex:
Male 1
Female 2

Occupation:

1	Civil servant	8
2	Sales of fuels	9
3	Retired	10
4	House wife	11
5	Student	12
6	Unemployed	13
7	Other (specify)	14

Questionnaire used by the Centre [Continued]

E8: Grain Milling

Technology	Trans. means	crop	ref per	freq	ref/ year	Distance (km/RT)	Trv Time (min/RT)	Mill Time (min)	Amount (kg)
1	2	3	4	5	6	7	8	9	10
5	1	1	3	1	12	-			50
5	1	4	4	5	5				15
5	1	3	4	2	12				18.20
5	1	4	4	2	2				17

Technology:

Mortar & pestle	1
Stone on stone	2
Water mill	3
Diesel mill	4
Electric mill	5
Other(specify)	6

Transport Means:

Human labour	1
Animal back	2
Animal drawn cart	3
Other (specify)	4

Grain:

Teff	1
Maize	2
Sorghum	3
Wheat	4
Barley	5
Millet	6
Other grain	7
Pulses	8
Pepper/Spices	9
Other (specify)	10

Reference Period:

Day	1
Week	2
Month	3
Year	4

E9: Household Income

Source of Income	INCOME								
	IN CASH				IN KIND				
	ref per	freq	ref/ year	Birr	ref per	freq	ref/ year	Birr	
1	2	3	4	5	6	7	8	9	10
1	3	1	12	1160	-	-	-	-	-
2	7	3	12	240	-	-	-	-	-

Reference Period:

Day	1
Week	2
Month	3
Year	4

Source of Income:

Farming	1	Civil servant	8
Mechanized farm	2	Sales of fuels	9
Commerce	3	Retired	10
Services worker	4	House wife	11
Industrial worker	5	Student	12
Artisan	6	Unemployed	13
Daily labourer	7	Other (Aid/gift)	14.1
		Other (specify)	14.2

E10: Livestock and Poultry Possession

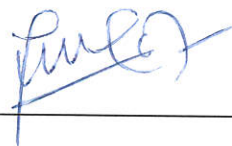
Livestock	Number Owned	Number Used for Energy			Agri-Residue Feed		Number Penned	
		Transport	Crop cult	Other	kg/day	days/year		
	1	2	3	4	5	6	7	8
Oxen	1							
Cows	2							
Horses	3							
Mules	4							
Donkeys	5							
Camels	6							
Pigs	7							
Sheep	8							
Goats	9							
Poultry	10							

DECLARATION

The thesis is my original work, has not been presented for a degree in any other university and that all sources of material used for the thesis have been duly acknowledged.

Yeshiwork Bizualem Mihiretie

The thesis has been submitted for the examination with my approval as a university advisor.



Gezahegn Yirgu (Ph.D.)



Workshet Lameneu (Ato)

May 19, 2000