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INFORMATION SUPPORT SYSTEM FOR ENERGY PLANNING IN ZAMBIA

A THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE DEGREE OF MASTER OF SCIENCE IN INFORMATION SCIENCE

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DEDICATIONS

To my late sister Trinnah Zipporah Kalusopa and her children: Chungu, Chibwe, Kashiwa and Kelesia who endured the inconveniences of my long absence from home.

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I am grateful to several individuals, institutions and organisations that helped me in one way or the other in my thesis work. It is not practicable to name each and every one who helped me in my work. However, my work would be incomplete if I do not mention a few names whose assistance has been particularly valuable.

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The application of information technology (more especially computer technology) is considered to be critical in the redesign and reorientation of the existing information support system. Prototype referral and object-oriented databases have been designed using Micro CDS/ISIS version 3.03 and samples of the outputs presented. Development of such databases are recommended as necessary complement to the existing information system for energy planning in Zambia. A user-interface using MTHES pascal program and a thesaurus database has been designed to facilitate information retrieval in the databases.

ABSTRACT

This study investigated the information support system for energy planning in Zambia and presents possible ways of strengthening the existing information system and services. A systems analysis has been carried out to evaluate the existing information services at the Energy Planning Unit and results presented and commented upon. Quality assurance characteristics have been used to measure the relevancy, value and quality of information services and products for the energy planners and decision makers at the Energy Planning Unit. In this context, a user requirement analysis has also been done. Findings from the interviews with energy planners and decision makers are presented.

In addition, a survey of the information systems in institutions in the energy sector and those related to it has been carried out and proposals made for a mutually compatible manual and automated network arrangement.

The draft proposals on national information policy for Zambia is reviewed with the view to examining the policy statements relating to the establishment of a coherent information infrastructure with particular reference to the energy sector in the country.

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ICLARM	International Centre for Living Aquatic Resource Management
IDIN	International Development Information Network on Research in Progress
IDRC	International Development Research Centre
ILCA	International Livestock Centre for Africa
INFLA	International Federation of Library Associations and Institutions
ISBD	International Standard Bibliographic Description
ISO	International Standard Organisation
IT	Information Technology
LAN	Local Area Network
LEAP	Long-range Energy Alternative Planning
NCDP	National Commission for Development Planning
NCSR	National Council for Scientific Research
OODB	Object-oriented Database(s)
PADIS	Pan-Africa Development Information System
PANGIS	Pan-Africa Geological Information System
PTC	Posts and Telecommunication Corporation
SDI	Selective Dissemination of Information
SEAFIS	South East Asia Fisheries Information Service
UNESCO	United Nations Educational, Scientific and

	Cultural Organisation
ZAENET	Zambia Energy Network
ZCCM	Zambia Consolidated Copper Mines
ZESCO	Zambia Electricity Supply Corporation
ZIMCO	Zambia Industrial Management Corporation

CHAPTER ONE

INTRODUCTION

1.1 OBJECTIVES

1.1.1 General Objectives

The general objective of this study is to examine the information support facilities for energy planning and to formulate proposals, plans and recommendations for the establishment of an effective and efficient information support system and services for energy planning in Zambia.

1.1.2 Specific Objectives

With the view to achieving the general objective stated above, the following specific objectives were formulated:

1. To identify the existing information support facilities and examine their contribution to energy planning in Zambia.

2. To identify information needs of energy planners and decision makers in the energy sector, with specific

emphasis on the energy planning process.

3. To establish the information flow pattern among the planners, executives and researchers in the energy sector with specific reference to the energy planning process.

4. To carry out a survey of selected information systems in the energy sector (and those that relate to it), their methods of information processing, handling and utilisation; and also examine if there was any co-ordination and collaboration with the energy planning unit with the view to:

   a. identifying the components, their respective functions and roles in supporting an information network on energy planning proposed in this thesis, and

   b. establishing how these existing information systems can facilitate, and enable easy data exchange relevant to energy planning thus enhancing the capacity of the information network.

5. To design prototype databases of profiles of institutions, information systems and experts in the energy sector and others relevant to the energy

planning process.

6. To propose, design and develop prototype object-oriented or mission-oriented databases for energy planners using Micro CDS/ISIS.

7. To design a user-interface based on the MTHES pascal program and thesaurus database which would facilitate information retrieval in the databases.

8. To examine Zambia's national information policy so as to make proposals for the integration of the energy sector information system into the national information system.

1.2 LIMITATIONS OF THE STUDY

The study focuses specifically on the information support for the energy planning process in Zambia. Although, a survey of information systems in the institutions related to the Energy Planning Unit has been done, this study does not cover information support for the discrete functional planning activities for the distinct energy resources as performed by several designated agencies such as the functional planning for electricity supply and distribution performed by Zambia

Electricity Supply Corporation (ZESCO).

The main concern of the study is the sectoral planning of all energy resources carried out at the Energy Planning Unit in the Ministry of Energy and Water Development within the purview of multisectoral planning and as stipulated by the national development plans in the country.

The anticipated or prospective users of the proposed system will be largely planners and decision makers in the energy planning process in Zambia.

1.3 JUSTIFICATION FOR THE STUDY

The importance of energy as a critical asset to developing countries cannot be overemphasized. As indicated in detail in the following chapters, energy is indeed essential to the achievement of national socio-economic development. Most government agencies and local companies are currently seriously active in developing the resource and supply systems world over.

In Zambia, like elsewhere in the world, issues relating to energy are closely linked to national development underscoring development of energy resources as essential for sustained socio-economic growth. Households, industries, agriculture and transport sectors cannot survive without adequate energy supplies based on relevant policies and proper energy planning.

A national resource, such as, energy needs to be effectively and efficiently managed for the benefit of the whole society. Effective and efficient management should be based on gainful decisions and proper planning, which in turn are dependant on the timely availability of relevant and reliable information and data at reasonable cost to the planners, decision makers and executives in the energy sector.

While the developed and newly industrialising economies have been taking giant steps in building good information support systems and networks to plan, harness, manage and develop their energy resources, less developed countries such as Zambia have been making little headway in this direction.

A wealth of information and ideas have been and continue to be generated from various sources i.e government departments, parastatals, industries, and scientific and academic institutions in Zambia. These information resources need to be properly managed for supporting effective planning in the energy sector.

Despite the importance of the subject, the essential and basic information concerning energy in Zambia still remains dispersed and often difficult to obtain. Chapter five presents a detailed appraisal of the information support to the energy sector as a whole and exemplifies deficiencies of the existing information base.

A number of plans for developing energy resources, for example, are not supported by an adequate information base in Zambia. Norman Myers, in a 1980 study of the tropical deforestation for the US National Academy of Sciences, confirmed this lack of data and information on the energy situation in the tropical areas (of which Zambia is a part) with regard to woodfuels and noted that infact, most figures available were more often simply estimates and not based on the actual survey (Timberlake 1991,88).

In addition, there has been very little research conducted to reexamine and propose an effective information support for energy planning in Zambia. One notable development in this regard has been the general recognition of the need for such an information support in the energy sector by a committee sponsored by UNESCO in 1987 to draft a comprehensive national information policy that would be the basis for development of an effective and efficient national information infrastructure in Zambia. Although, the final draft report appreciates this need, it does not however, consider in detail how viable such an information base would be specifically for energy planning (National Information Policy for Zambia: a draft proposal, August, 1987). Consequently, the importance of such an information base as a prerequisite for sound energy planning is cardinal. The detailed examination of the national information policy vis-a-vis the development of an information support for the energy sector is dealt with in Chapter five.

This study, therefore, is an attempt to examine this issue in some detail. It seeks to formulate proposals and recommendations for strengthening and enhancing the existing information support for energy planning in Zambia.

Since the energy sector is but a sectoral part of the whole national development planning and vital to the overall Zambian economy, the contribution of the information support system for energy planning towards national development would thus be significant.

It is expected that this study would reorient the existing information services and products and guide the development of new ones to satisfy the data and information needs of energy planning and thereby build a strong information infrastructure that can support energy planning and development.

1.4 METHODOLOGY

1.4.1 Planning the Investigation

1. Factors to be examined such as information use, services and products, computer resources and their management, design of directories of institutions, experts, and information system profiles and their relation to the energy planning process, were determined.

2. Examination of methods of study, such as, questionnaire and profile designs used by the Pan African Development Information System (PADIS), International Livestock Centre for Africa (ILCA), etc., provided guidelines and discovery of strengths and deficiencies of the previously used methods. It also helped in adopting certain guidelines and elements for the design of questionnaires and profiles and determine the groundwork for the surveys mentioned above.

1.4.2 Data Collection.

1. Six (6) institutions related to Energy Planning Unit were selected. Their information systems were investigated pursuant to the specific objectives cited in 5a and 5b. In the institutions listed below, researchers involved in energy projects were identified and interviewed. These include:

   - Energy Department
   - Zambia Electricity Supply Corporation (ZESCO-Lusaka)
   - National Council for Scientific Research (NCSR-Lusaka and Kitwe)
   - Central Statistics Office (CSO-Lusaka)
   - Environmental Council (Lusaka)
   - Geological Survey (Lusaka)

2. Five(5) energy planners and executives in the Energy Planning Unit were interviewed and profiled.

3. Various experts of different backgrounds within the energy sector were selected and profiled in order to design a database of profiles of experts (outputs of the databases are given in the appendices).

1.4.3 Survey Methods

1.4.3.1 Questionnaires

(a) Questionnaires were designed and distributed in order to collect information about the information systems in the institutions related to energy planning, their methods of information handling, processing and dissemination with the view to ascertaining how they collaborate with the Energy Planning Unit in terms of data exchange. This approach was also meant to examine means of achieving compatibility in terms of electronic data exchange.

(b) Questionnaires were targeted at information intermediaries and specialists in information systems (libraries, documentation centres, computer-based information systems etc.) in the six institutions selected to create a database of profiles of institutions and information systems in the energy sector.

(c) A separate questionnaire was used for profiling experts in the energy sector. The questionnaires designed, took into consideration their ease of use and response by the respondents. However, on the basis of the trial test, some modifications to the questions were found necessary.
Samples of the questionnaires are given in appendices.

1.4.3.2 Interviews and Discussions

Interviews and discussions with some of the personnel of the units were helpful in systems analysis of the computer-based information system at the Energy Planning Unit, to ascertain what types of input (data/information), processes (procedures) and output (information products and services) were generated to support energy planners and decision makers in the energy planning process. Inquiries made in the unit also guided collection of information on the type of software, hardware, system configuration, the expertise available in the Energy Planning Unit and to examine whether the resources available in the existing system constituted an adequate information support system for the energy planning process.

Overall, the interviews and planned discussions were useful for fact finding in system analysis investigations, to familiarise oneself with the system and gain more insight and identify possibilities of operational alternatives.

They were also used to assess the adequacy of the information outputs in terms of the amount, quality, timeliness and ease of use in satisfying the needs of the energy planners in the Planning Unit, and to solicit information on how the information or data was collected for input to the system information seeking habits and pattern of the prospective users were determined.

Browsing existing records enabled the documentation of information needed for the design of various databases. Chapter 6 gives a detailed design of these databases.

Other selected institutions useful to the energy planning process were visited in order to collect relevant data from various experts (human sources), institutional sources and documentary sources of information. The following institutions were visited in Zambia:

- UNZA (School of Agricultural Sciences-Biomass research)
- Natural Resources Department
- Meteorological Department
- BP Sales Offices
- Maamba Collieries HQ
- Geological Survey

1.4.3.4 Literature Survey

The following information systems were searched as part of the literature survey:

- PADIS and ILCA database resources

- Library and information sources in Zambia and Addis Ababa University libraries.

1.4.3.5 Systems Analysis and Documentation

An analysis of the existing computer-based information system at the Energy Planning Unit was conducted and documented using systems analysis techniques.

1.4.4 Data Processing and Analysis Methods

The collected data was analyzed using both manual (since most of the data was largely qualitative and descriptive) and automated techniques. The following software packages available at SISA computer laboratory facilities were used:

- Havard graphics to process graphical data
- Micro CDS/ISIS for creation of prototype databases.
- Word Perfect 5.1 for word processing

CHAPTER TWO

BACKGROUND INFORMATION

2.1 ENERGY FOR DEVELOPMENT: A MAJOR GLOBAL CONCERN.

Energy is essential to life. Human society cannot survive without continuous supply of energy. The original source of energy for social activities was human energy. From the dawn of history it provided the mechanical power (muscular power). Then came the production, control and use of fire from the combustion of wood and the ability to exploit chemical transformation to generate heat energy which enabled human society to cook food, warm up dwellings and extract metals (bronze and iron from the ores). The energy of draught animals also began to play an important role as did the water pump, in agriculture, transport and even industry.

Subsequently, gradually human societies acquired control over coal, steam and electricity. It can be said that, in one sense, human history is an account of the attempts at controlling energy sources for the benefit of society. So important is energy to the development of society that the amount of energy consumed per capita has become one of the indicators of a country's "modernisation" (Goldemburg etal, 1988).

As societies became increasingly larger, energy demands exceeded the capacities of the local sources of supply. Consequently, the energy supplies of some countries have had to be bought and brought from halfway around the world. At the same time, the intensity of energy production and use had deleterious impacts on the environment through pollution and the threat of nuclear war. These environmental consequences of the pattern of energy consumption were virtually ignored for a long time.

There is a perceptible shift from such a trend and these issues are receiving urgent attention. Contemporary views thus stress the need to increase energy supplies on the one hand and the introduction of new technologies in view of getting alternative "environmental pollution-free" energy sources, on the other. It is anticipated that this would balance life sustenance on energy and reduce the threat of environmental degradation.

The fundamental link between energy issues and basic long-range goals of sustainable development, security and efficient use ensures that the issues will continue to draw attention of both national development planners as well as people at large, the beneficiaries of the plans.

Given its importance, the whole economic planning of any country today has to be linked to the available as well as future sources of energy. A strong energy foundation must be built guided by an integrated set of policies, programs and investments. Ideally, the integration should be (a) between local and national levels, (b) between the energy sector and the related areas (e.g., agriculture, forestry, water, etc.), (c) between energy demand and supply options and, (d) between energy and environmental issues.

In addition, the character of energy markets and environmental consequences of the global use patterns will make international co-ordination increasingly important. In a sense, therefore, development of any sector of national life can be accelerated only if such an imperative is met.

2.2 ENERGY SITUATION IN ZAMBIA.

2.2.1 Need for Survey of the Energy Situation in Zambia

This section presents a detailed survey of the energy situation in Zambia. In proposing for the strengthening of the information support for the energy planning in Zambia, there is a need to have a clear conception of how the energy resources are harnessed, managed, distributed and utilised. It is also equally important to know the institutions that are designated the functions of managing the various energy resources.

Energy planning focuses on the programming, implementation, monitoring the optimal allocation and mobilization of the energy resources to the components of the programmes under planning. Energy planning needs can be viewed as an ongoing process. Information will emerge over time on such factors as economic and demographic trends, energy demands, energy technologies, fuels, capital costs and environmental impacts in the country. In the light of new information, strategic energy plans will need to be updated and action programmes for realising plan objectives will have to be revised. To be effective, energy planning must be embedded in the energy institutional framework in the country which in turn will have to be built into the overall national development framework.

The information support will have to respond to the needs of this energy institutional framework. The information system desired must, therefore, be designed to suit the complexities of the energy planning programmes in Zambia. This in turn depends on a detailed understanding of the energy situation in the country.

The energy planning exercise is also based on the reliable forecasts and gainful decisions and calls for timely, reliable and precise data on the energy resources available in Zambia; their characteristics and conditions of availability, strategies for mobilising them, prior experience in similar environments, characteristics and trends in the development of the energy resources and on the physical, economic, social and cultural, political and technological indicators relating to the energy resources. This imperative can only be met if the energy situation in Zambia is understood through a thorough survey. Such information will give a direction of what kind of information services can respond to the challenges of energy planning in Zambia.

Consequently, the knowledge and information on the existing energy situation in Zambia is important in order to have an understanding on:

- type of energy resources available and how they are managed in various institutions both public and private;
- trends of supply, demand and distribution patterns over a period of time;
- trends in the consumption by the major sectors of the economy;
- issues relating to energy balance and future forecasts;
- priority areas emphasized in the exploitation and development of the energy resource;
- policy issues as they may relate to the methods of adopting technologies that would be cost-effective and with less environmental consequences etc.

An analytical description of the scenario is presented in the sections that follow.

2.2.2 General Overview.

Zambia has a land area of about 752,000 km^2 and the population in 1990 stood at 7.8 million (Central Statistics, 1990), giving a population density of approximately ten (10) persons per square kilometre. About forty-two percent (42%) of the population live in the urban area.

The main sources of energy used in the country are woodfuel (i.e. firewood and charcoal), electricity, coal and petroleum products. Petroleum products are the only major energy imports.

At national level, woodfuels contribute the largest share of final energy consumption. It is the dominant fuel in the household sector. Thus it accounted for sixty-seven percent (67%) of the total energy consumption in 1986, sixty-six percent (66%) in 1988 and fifty-nine percent (59%) in 1990 (Energy Statistics Bulletin, 1974-1990).

Potential hydro-electric power is estimated at over 4,000 MW. The total existing electricity generation capacity is about 1,788MW of which ninety-four percent (94%) is hydropower.

Existing coal reserves are in the estimated at 30 million tonnes and can supply the country for more than twenty-five (25) years at the present rate of domestic and export demands. Extensive coal deposits are known to occur in the Luangwa valley and other parts of the country though they remain unproven.

With minor fluctuations, the consumption of petroleum products, electricity, and coal (i.e. conventional or commercial sources) has been on the decline over the past fifteen years from about 1.7 million tonnes of oil equivalent (TOE) in 1977 to 1.4 million in 1990. Table 1 shows this trend.

Table 1: Final Energy Consumption by source (excluding woodfuels). (Tonnes oil equivalent-TOE)

Year	Petroleum Products	%	Electricity	%	Coal	%	Total
1977	778,505	47	486,558	29	406,731	24	1,671,795
1978	727,595	43	466,196	28	499,591	30	1,693,381
1979	647,117	42	476,936	31	398,930	26	1,522,983
1980	665,443	43	486,988	31	401,518	26	1,553,949
1981	652,158	44	502,797	34	321,015	22	1,475,971
1982	609,370	41	536,048	36	349,110	23	1,494,528
1983	596,788	41	534,158	37	313,842	22	1,444,788
1984	549,841	40	524,191	38	298,961	22	1,372,993
1985	525,856	39	529,947	39	305,641	22	1,361,445
1986	505,237	36	553,403	40	338,769	24	1,397,410
1987	544,546	39	560,277	40	286,775	21	1,391,597
1988	564,370	39	546,389	38	326,756	23	1,437,515
1989	698,104	45	544,887	35	304,334	20	1,547,325
1990	550,348	41	545,982	41	243,474	18	1,339,804

Source: Energy Statistics Bulletin 1974-90.

The general decline in the energy consumption is attributed to the poor performance of the economy since the mid-seventies. The mining sector has been reducing its operations; the industrial base for a long time has, until recently, been stifled by government control and monopolies; the transport sector has been facing economic constraints while the agricultural industry has shown a slow growth over these years. It is not surprising, therefore, that the energy consumption has recorded a net fall during this period.

Commercial sources of energy are almost entirely used in the mining, transport and industrial sectors, with mining being the dominant sector consuming about fifty-two percent (52%) in 1986; forty-five percent (45%) in 1988 and forty-seven percent (47%) in 1990 (Energy Statistics Bulletin, 1974-1990). The household and agriculture sectors account for a very small percentage of the total conventional energy use in the country.

Alternative and renewable energy sources such as wind and solar energy remain largely untapped. With the prevailing wind speeds below 4.0 m/s, wind mills in Zambia are only utilised for water pumping. Photovoltaic solar technology, though still new and expensive, is increasingly being used for power supply.

A detailed account of the energy resources in Zambia is given in the succeeding sections.

2.2.3 Petroleum Products.

Petroleum products consumed in the country are entirely imported. Petroleum feedstock purchased in the Middle East are shipped to Dar-es-salaam, Tanzania from where they are transported to the refinery at Ndola through the 1,700 KM TAZAMA pipeline. The feedstock is imported as a mixture of crude oil and refined products called "spiked crude oil" or reconstituted crude. The ratio between crude oil and refined products can be varied in a manner that allows the refinery flexibility to produce the exact mix of refined products required by the domestic market.

Petroleum imports are handled by ZIMOIL, which is a division of ZIMCO. The volume of petroleum imports has declined from about 870,000 tonnes in 1975 to 575,000 tonnes in 1985. After 1985, imports have been showing an upward trend. During the same period, the percentage of refined products in the stockfeed went up.
In the late seventies and the early eighties, the percentage of refined products in the feedstock went up around eighty percent (80%) and from 1987 onwards it is

almost hundred percent (100%).

Refined products (See Table II) from the refinery are sold in bulk by ZIMOIL to five oil marketing companies which distribute and resell the products to the consumers. These companies are AGIP, BP(Z) Ltd, CALTEX, MOBIL and TOTAL. The largest of these is BP and AGIP which market more than fifty (50%) and twenty (20%) percent of all the petroleum products respectively (Energy Statistics Bulletin 1974-1990).

Table II: Refinery Input and Output Balance (Tonnes).

Year	Refinery Input	Refinery Output	Losses/Own Consumption	(% of Input)
1974	780,402	731,875	48,527	6.2
1975	802,196	750,576	49,342	6.2
1976	852,632	803,697	47,417	5.6
1977	792,640	743,122	49,382	6.2
1978	777,943	734,739	43,204	5.6
1979	735,187	697,179	38,008	5.2
1980	767,655	726,734	40,921	5.3
1981	730,232	685,856	44,376	6.1
1982	638,441	602,333	36,108	5.7
1983	642,921	606,935	35,986	5.6
1984	665,997	624,299	41,698	6.3
1985	564,263	527,623	36,640	6.5
1986	540,153	502,310	37,843	7.0
1987	674,438	631,107	43,349	6.4
1988	687,811	637,927	49,884	7.3
1989	648,092	597,007	51,085	7.9
1990	689,671	639,568	50,103	7.3

Source: Indeni Reports, 1991.

The consumption of petroleum products increased slightly in 1987 after some years of continuous decline. Mining and transport are the dominant petroleum consumers in the economy with more than eighty percent (80%) of the final consumption being in these sectors.

The export of refined products to neighbouring countries is minimal. The retail prices of refined petroleum products have shown an upward trend over the years with minor fluctuations.

2.2.4 Electricity

The total installed electricity generating capacity in Zambia is 1.778 MW of which 1,640 MW is owned and operated by ZESCO and the remainder by ZCCM (See Table III). Ninety-four percent (94%) of the installed capacity is hydropower. The thermal generating plants owned by ZCCM are usually on the cold standby while the hydropower station at Mulungushi produces electricity for the mines at Kabwe.

Virtually, all the electricity is generated, transmitted and distributed by ZESCO. The transmission and distribution system is divided into two parts; the inter-connected network and the isolated systems. The threatened most commercial undertakings' profit, plunging most them into budget deficits following the liberalisation of the economy and the depreciation of the Kwacha (Zambian national currency). Notable electricity consumers such as ZCCM and PTC protested against the increases. The situation was not, however, reversed.

Table III.1: Capacity of Electricity Generating Plants

Power Station	Installed Capacity (MW)	Available Capacity (MW)	Firm Energy (GWh/year)
Interconnected systems:			
Kariba North	600	600	3750
Kafue Gorge	900	900	5200
Victoria Falls	108	108	769
Lusiwasi	12	12	105
Subtotal	1620	1620	9824
ZCCM:			
Gas Turbines	80	80	N/A
Hydropower	38	38	216
Thermal	20	20	N/A
Subtotal	138	138	216
Isolated system:			
Diesel stations	8	8	N/A
Hydro stations	12	12	47
Subtotal	20	20	47
TOTAL	1778	1778	10087

Source: ZESCO Reports, 1990.

Table III.2: Electricity Consumption by Sector.

SECTOR	1986		1987		1988		1989		1990	
	GWh	%	GWh	%	GWh	%	GWh	%	Gwh	%
AGRIC. & FORESTRY	98	2	149	2	175	3	186	3	179	3
COMMERCE & INDUSTRY	877	13	778	12	703	11	567	9	619	10
MINING	4643	71	4709	72	4637	73	4626	73	4498	71
TRANSPORT	15	0	12	0	6	0	9	0	10	0
HOUSEHOLD	498	8	536	8	411	6	494	8	581	9
GOVT/SERVICE	365	6	337	5	428	7	460	7	467	7
TOTAL	6496	100	6521	100	6359	100	6342	100	6355	10

Source: Energy Statistics Bulletin 1974-1990.

2.2.5 Coal

Almost all the coal consumed in the country is mined at Maamba Collieries Ltd, a subsidiary of ZIMCO. Like the other energy sources, consumption of coal as reflected in sales volume, has been on the decline from a peak of about 742,000 tonnes in 1975 to about 374,920 tonnes in 1990. The largest reduction started from 1981 (See Table IV). This was due to production constraints experienced at Maamba mines resulting from a lack of equipment and spare parts. In 1985, a rehabilitation programme to restore production capacity was initiated. The Collieries can now satisfy local demand and some exports to neighbouring countries (Maamba Collieries Report, 1990).

The consumption pattern of coal is dominated by the copper mines accounting for sixty-one percent (61%), sixty-four percent (64%), fifty-four percent (54%) of the total coal sales in 1977, 1979 and 1989 respectively (Maamba Collieries Report,1990). Although the share and volume of coal sales to ZCCM has declined in recent years, mining still remains the largest consumer of coal. This is despite the fall in the volume of copper production due the closure of certain mines and energy substitution and conservation practices introduced by ZCCM at certain times.

A feature of Zambian coal is that, so far, it has only been used in the mines and the industrial sectors and not in households. In recent years however, NCSR has made efforts to make a coal briquette from slurries suitable for household use. A pilot plant has already been constructed.

Coal exports have generally been on a very small scale accounting for only a fraction of the t production. The mines have been importing some coke for their own use. The data on the amount of coke imported is, however, very scanty.

The pricing of coal has been changed since 1986. Prior to this year, pricing was based on the size (in diameter) of the coal e.g cobbles were larger than nuts, while nuts were larger than fines etc. As from 1986, t pricing is based on the quality which takes into account the energy content of the different types of coal.

2.2.6 Woodfuels

About fifty-five percent (55%) of the total land area is covered by woodland. Over seventy-seven percent (77%) of the natural vegetation of Zambia is woodland. Table V.1 shows the Department of Forestry's estimates of the woodland cover.

Table V.1: Classification of Woodland Areas (1979).

Woodland Type	Area (Million hectares)
Production Reserves	5.3
Protection Reserves	1.8
Total State Forests/1	7.1
Unreserved Woodlands	32.0
Old Barotse Forests	0.3
Other Forests/2	1.8
Total Woodlands	41.2

1/ Gazetted woodlands managed by Forestry Department
2/ Forest reserved for use by Mining Timbers Ltd and other enterprises.

Source: Energy Statistic Bulletin 1974-1990.

Woodfuel is the principal household fuel and the nation's largest source of energy. In the rural areas household woodfuel consumption is mainly in the form of firewood, while in the urban areas it is mostly in the form of charcoal. The dominance of woodfuels in meeting household energy is illustrated in Table V.2 which shows that about eighty-eight percent (88%) of all the households depend on woodfuels for energy. Overall woodfuel accounts for about sixty-six (66%) of the total energy consumption.

Table V.2: Fuels used for Cooking in household.

Fuels used for cooking	Percent of Households		
	Rural	Urban	Total
Electricity	8.82	4.12	17.99
Gas/Paraffin	2.76	2.40	3.45
Wood, Charcoal & Coal	87.50	92.19	78.35
Other	0.92	1.29	0.21
Total	100.0	100.0	100.0

Sources: **Adapted from Energy Statistics Bulletin 1974-1990.**

The best available estimates on woodfuel consumption are the reports of the FAO/Forestry Department "Wood Consumption and Resource Survey" in 1986 and the World Bank ESMAP on Urban Household Energy Strategy, 1990. The per capita consumption of firewood and charcoal from these reports is shown in Table V.3.

Table V.3: Per capita Consumption of Firewood and Charcoal.
(kg/capita/year)

	Firewood	Charcoal
Households		
Rural	1,241	22
Urban	148	170

Sources: FAO Study, 1986 and World Bank/DOE Urban Household Survey, 1988.

Charcoal is almost entirely produced in the traditional earth kiln. The efficiency of the kiln is estimated to be about twenty-five percent (25%) on a weight basis. This means that a quantity of hundred kilograms (100kg) of wood produces only twenty-five kilograms (25Kg) of charcoal. The price trend of charcoal has been upward since the depreciation value of the Kwacha and increase in the transport cost.

2.2.7 New and Renewable Sources of Energy.

2.2.7.1 Wind Energy

The Meteorological Department and its stations spread through out the country collect data on wind energy. The wind data is recorded at 10m height above the ground. Wind speeds vary between 0.1 to 3.5m/s with an annual average of 2.5m/s as presented in Table VI.1.

Table VI.1 - Annual average wind speed and range.

Location	Annual Avg With speed(m/s)	Range between diff.months m/s)
Lusaka	3.5	2.00 - 4.00
Ndola	2.3	1.60 - 3.45
Kasama	2.5	1.95 - 3.60
Chipata	2.3	1.50 - 3.30
Mansa	1.9	1.15 - 3.45
Livingstone	1.6	1.40 - 2.15
Kabwe	2.7	1.85 - 3.65

Source: Meteorological Department, Lusaka.

2.2.7.2 Solar Energy

Solar energy data is also collected by the Meteorological Department. The average annual solar insolation is about $4kWh/m^2$ per day. Table VI.2 shows some global data recording in some stations.

Table VI.2: Annual Average Insolation by location.

Location	Global radiation kWh/metre squared per day
Lusaka	1,971
Ndola	1,905
Kasama	2,070
Mansa	1,980
Mfuwe	1,885
Livingstone	2,147

Source: Meteorological Department, Lusaka.

Sunshine hours vary between 2600-3000 per year. These sunshine hours can be translated into their energy equivalent of 450 calories/cm^2. The energy from the sun is at its peak between October and November.

2.2.7.3 Solar Energy Utilisation.

The solar energy used for crop drying etc., cannot be measured. Increasingly, the use of solar energy for other purposes such as lighting, refrigeration, water pumping is becoming common. BP(Z) Solar Ltd is the leading supplier of photovoltaic technology equipment. Table V.3 shows the volume of solar equipment sales by BP Solar Ltd between January, 1987 and December, 1991.

Table VI.3: Volume of Solar Equipment sales.

Equipment/Type	Number of Units
Lighting system	1,800
Solar lanterns	300
Solar Water pumps	23
Refrigerators (Medical & Domestic)	16
Power supply to microwave stations	13
Radio power unit	171

Source: BP Solar Ltd Sale Offices, Lusaka.

CHAPTER THREE

THE PLANNING PROCESS

The preceding chapter has presented in some detail the energy situation in Zambia. It has also been argued that such an important resource needs to be effectively planned if it has to have meaningful benefits to society. This chapter, therefore, explores the fundamentals of the planning process in general and emphasizes the need for the type of information support that would respond to such a process. If, as we have seen that the energy planning is but a sectoral part of the socio-economic national development planning, then an understanding of the broader conception of the planning process would be essential for our purpose.

3.1 The Planning Process

Planning is more of a complex and many sided phenomenon. It is an attempt to select the best available alternatives among several to meet a specific goal. It, therefore, represents the rational application of human knowledge to the process of reaching decisions which serve as the basis for the establishment of relationships between means and ends (Sundaram 1991,58).

Planning can thus be seen as the optimal allocation of available or mobilisable resources to the components of the entity whose development is the subject of the plan. This implies decisions regarding the options that appear open for the future and then securing their implementation with allocation of the necessary resources such as manpower, finance, material, information, etc. By and large, planning has a strong political aspect as options will have to be selected that may not benefit equally or equitably all the members of the society. Planning involves societal choice about the future which in turn implies political intervention. To exercise choice calls for genuinely alternative views and scenarios of the future (Neelameghan, 1993).

In order that the choice from among possible courses of action is purposeful and deliberate, a knowledge and understanding of the present and explicit anticipation or foresight of future consequences of present action are required. Such knowledge and understanding can be productive only if appropriate data and information needed on each of the alternative course of action are accessible at the right time at reasonable cost and that they are reliable, precise and presented in a conveniently usable forms.

Planning is, therefore, largely knowledge-based and it is information intensive. Knowledge here is meant to include ideas, facts, relationships, theories and models. These ingredients also form large part of the elements of the planning process.

In a more explicit sense, planning is the creative and analytical process of:

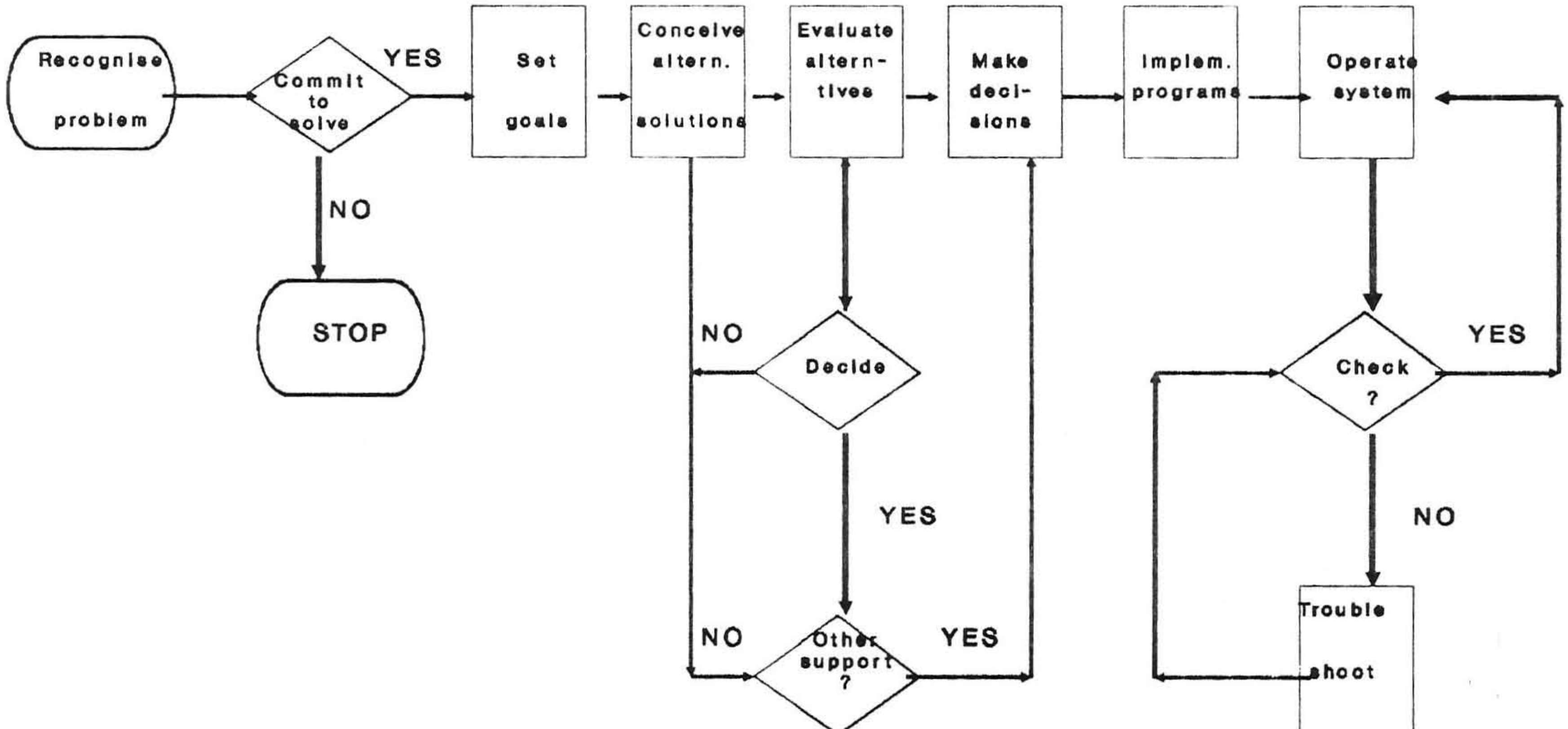
- hypothesizing sets of possible goals;
- assembling needed information to develop and systematically analyze alternative courses of action for the attainment of such goals;
- displaying the information and consequences of alternative actions in an authoritative manner;
- devising detailed procedures for carrying out the actions and;
- recommending courses of action as an aid to decision makers in deciding a set of goals.

The planning process does not differ much from the decision making process because, decision making is in fact the end result of the planning process since it depends on extensive utilisation of information and knowledge as well. Grigg (1985,35) also expressed this view when he observed that the decision maker to the best of his ability in judgement and with the available information can:

- thoroughly canvass a wide range of the courses of action;
- survey the full range of objectives to be fulfilled and the values implicated by such a choice;
- carefully weigh whatever he/she knows about the cost and the risks of negative consequences that would flow from each alternative;
- intensively search the new information relevant for further evaluation of the alternatives;
- correctly assimilate and take account of any new information or expert judgement to which he/she is exposed, even when the information or judgement does not support the course of action initially preferred;
- reexamine the negative and positive consequences of all known alternatives including those originally regarded as unacceptable, before making the final choices; and
- make detailed provision for the implementing or executing the chosen.

Thus the planning process and decision making can in most cases be seen to involve all problem solving processes. Figure 1 shows a flow cart indicating the model in the planning and problem solving process.

Figure 1. MODEL FOR THE PLANNING PROCESS.



Source: Adapted from Grigg (1985).

3.2 SCOPE OF PLANNING PROGRAMS

It may be helpful to group the planning programs in three broad categories namely multisectoral planning, sectoral planning and functional planning.

3.2.1 Multisectoral Planning

This implies co-ordinated planning for all levels of public endeavour such as land use, housing, transport, water resources, education, health, energy resources etc.

Multisectoral planning must be directed towards identification and protection of the national interests as stipulated within the national development plans and policies (Grigg, 1985). It must rest on the definition and resolution of intersectoral problems such as health, education, manpower (human resources), energy etc.
It is largely involved with the establishment of policies and guidelines to ensure implementation of national policy.

3.2.2 Sectoral Planning

This focuses on one sector of the public endeavour. It is an integrated planning for all functions within one sector such as energy resources, water resources etc.

3.2.3 Functional Planning

This is planning to meet a specific need within a sector. For example, within the energy sector, there is a need to plan for electricity supply and distribution. Such planning, however, should fit in the sectoral and multisectoral framework of plans in a country.

3.3 STAGES OF THE PLANNING PROCESS

Generally, planning for public endeavour takes the form of the stages given below:

3.3.1 Policy Planning

This implies the definition of overall goals and programmes objectives, policy development, overall budget and priority analysis, dissemination of programme guides and evaluation of results.

3.3.2 Framework Planning

This involves identification of general problems and the needs outlining a range of possible alternative rest on the characteristics of decision information i.e. amount, quality, timeliness and reliability. It is these characteristics that "model" the type of information and the format it is communicated and presented if viable decisions are to be made and problems practically addressed. Consequently, it is important to balance these characteristics in the provision of information that support any planning process.

In analyzing the value of information vis-a-vis quality, Andrus (1977) observed that even when information is efficiently presented and correctly interpreted, it may not be used effectively. Accordingly, the quality of information is determined by how it motivates human action and contributes to effective decision making. The value of information may, thus, be theoretically determined by the value of change in decision making behaviour.

Andrus (1977) further suggests that the value of information can be seen within the perception of the decision maker in light the utility of information, information satisfaction and error and bias. He identifies four information utilities:

- **Form utility**: As the form of information more closely matches the requirements of the decision maker, its value increases.

- **Time utility**: Information has greater value to the decision maker if it is available when needed.

- **Place utility (Physical accessibility)**: Information has greater value if it can be accessed or delivered easily. On-line systems, for example, maximise both time and place utility.

- **Possession utility**: The processor of information strongly affects its value by controlling its dissemination to others.

In addition, information satisfaction in decision making can be seen as the degree to which the decision maker is satisfied with the output of the formal information system. If a decision maker requires information and readily finds it, satisfaction with the information system is reinforced. On the other hand, non-availability of information, leading to considerable effort in extensive searches creates dissatisfaction. Detection of the bias and error are also core to that value of information. They, infact represent the ability satisfactory rather than optimal solutions), "optimal ignorance" (not trying to know what is not worth knowing) and "appropriate imprecision" (not measuring more precisely than needed" (Sundaram 1991,59).

The understanding of these concepts are critical in determining what information services and products planners need in their various tasks in the planning process. They also challenge the provision of data and information in the dynamic planning process. It should be appreciated, therefore, that such a challenge can be met through the positive assessment of "critical minimum and selective" data or information on the one hand and the efficient application and utilisation of Information Technology (IT) on the other if the information support is to be adequate, effective and efficient in the planning process.

Since most planning processes are "institutionalised authority structures and mechanisms", the above recognition is, therefore, meant to make the "information structures" respond to this framework.

The planner must thus keep up with the evolving and emerging methods of planning and evaluation, econometric modelling, forecasting techniques, resource management, within an institutional framework.

These sources, however, cannot be the sole input to planning because external factors may at certain times invalidate projected historical performances. For example, in energy planning, forecasts on past coal sale without consideration of the impact of alternative sources of energy sources and its rate of consumption over a period under forecast may be misleading.

3.6.2 External Data

External data and information can be obtained from traditional sources such as published reports, government documents and other grey literature. Data and information can also be obtained from data banks covering a wide range of information on economic aspects. Most national statistical agencies actively maintain data banks on socio-economic data.

In most instances when appropriate data banks are available, they should be considered as an important source for planning data and information instead of direct data collection especially when the following conditions apply (Davis and Olson 1985,307):

- the body of knowledge is large and expensive to collect,

- the data bank is frequently updated, and
- no competitive advantage will be lost, or any significant security risk incurred, by relying on such an external source.

3.6.3 Environmental Scanning

Planning data and information should also collected through environmental scanning. This includes methods for analyzing the environment and generating planning data. The following are some examples:

3.6.3.1 Scenario Writing

With this technique, individuals are asked to write scenario of events they think may occur. These represent a set of plausible future events that should be considered in planning for such an endeavour.

3.6.3.2 Simulation

Here the effects of the external event on the endeavour under plan is simulated. For example, the effects of urban migration on the unemployment may be simulated.

3.6.3.3 Cost Impact Analysis

The impacts on the events in one of the environments on the endeavour being planned for is estimated. Environmental elements are social, political, institutional-legal and technological. For example, a cost-impact analysis of the introduction of technological advances on clerical jobs may be necessary.

3.6.3.4 Econometric Models

Econometric models may be used for estimating demand for resources, products and services; environmental scanning will look for environmental changes affecting the factors in the model. For example if construction activity is an important variable, then factors affecting interest rates are of concern (assuming the interest rates are part of the model).

3.6.3.5 Input-output analysis

The effects of activities or changes in one sector of the economy are traced to other sectors. For example the cost effect of oil price increase in a country can be traced to other sectors using oil or oil-based products.

3.6.3.6 Delphi Projections

Here, those concerned with assessing or forecasting the future are asked to specify their projections. The projections are summarized and participants are asked whether they wish to revise their estimates based on the average estimate. The process may go through several iterations in order to find areas of consensus or reasons for the differences in projections.

3.7 GEOBASED OR GEOGRAPHIC INFORMATION SYSTEMS

As earlier indicated, planning is a complex process and takes different forms. The use of maps as sources of information for socio-economic planning, for example, is also significant.

Management of natural resources and the environment has to take into account such matters as the distribution of the natural resources in different regions, the movement of wildlife during different seasons, distribution of various species of fauna and flora in a given area, the impact of any change on their living conditions and patterns etc., caused by human and nature's activities. Rapid urbanisation, deforestation, pollution of all kinds, land and water resources, transportation and communication are all closely related issues. Effective and efficient management of these resources poses a variety of challenges. To meet these challenges, planners require reliable, pertinent and timely information on the resources, their location, amount, current demand, supply, use etc.

Spatial data and spatial analysis may, therefore, be useful in socio-economic development planning. Thus, cadastral agencies need detailed data on the distribution of land and resources in towns and regions. Health service agencies may need to know about the pattern of distribution of diseases, pollution resulting from various economic activities etc, for effective health service planning. Data on infrastructure especially service utilities (such water and sewerage, gas, electricity, telephones etc.) need to be collected, recorded and manipulated in map form. Likewise, commercial firms need data on markets and sale outlet for effective business planning.

The following are some of the advantages that may accrue from the use of Geographic Information System in planning (Neelameghan, 1993):

- Large amount of information can be visualized in a small space. In certain situations a data table may run several pages to explain a prevailing condition and it may be difficult to get a synthetic or composite picture of the situation. A cartographic picture, thus, provides an organised visual translation of the pattern.

- Visual perception will also allow a planner to focus attention on particular features where concerted effort would be needed in decision making and practical problem solving.

- They also draw the attention of the planner to unreliable data where quantitative statistics have not been properly collected or has not been made available or used. Such discrepancies are more easily noticed in a map than in a table of data. This in turn leads to the adoption of improved data collection methods.

- Maps can also be helpful in identifying gaps in development. Zones very much neglected, for example, can easily be identified in the map. Administrative action to remedy the lapses in the infrastructure can be called for and necessary resources allocated.

- Maps can act as representations of qualitative information. For example, electrified or unelectrified areas can be represented by symbols on the map thus bringing into focus which areas are electrified and which are not.

Thus, with the wider availability of the microcomputer technology and GIS packages there is a growing trend of using geographical or geocoded information system, to support the planning process.

3.8 COMPUTER-BASED PLANNING MODELS

A planning model is the method for structuring, manipulating and communicating future plans. A planning model, therefore, provides (a) a format for presenting the results from processing the model; (b) a set of input data; and (c) a set of processing statements to operate on the input data.

The model and the output from the model should assist planners to understand the nature of the process and effects of the changes in the variables.

There are various advantages of using computer-based planning models in the planning process.

Seaburg and Seaburg (1973) summed them as:

- **Reduced Information overload:** Planning involves a large number of variables which must be simultaneously considered. Computer-based models aid the decision maker by processing the information quickly and efficiently.

- **Information selection:** Key variables identified within the model building process can assist in defining the information to be included in the database.

- **Economic solutions:** By enabling decision maker to experiment, models can provide answers at low cost with the minimum human resources.

- **Interrelation of operations and planning system:** Computer-based models facilitate the operating results to be explicitly incorporated into the planning process without delay.

- **Communication aid:** An integrated model, encompassing the functional areas of the endeavour under plan, can provide a common language between functions and can, therefore, improve communication of the plans.

- **Direct Involvement:** Interactive modelling capability can be used directly by decision makers bypassing such obstacles as communicating ideas to the programmers.

There is a wide range of computer-based planning models and they all depend largely on the endeavour under plan, and the purpose and the stages of the planning process. Some of them include accounting models, representational model, etc.

In a computer-based planning model there is a need for a model generator to facilitate model development.

3.8.1 Model Generator

A model generator (or decision support generator) is a software package which facilitates the development of models. It is a comprehensive package incorporating the capabilities of the programming language, spreadsheet processor and statistical package. Ideally, it contains facilities to define models, to perform statistical analyses, to link models to a database, and to create appropriate dialog. In practice, it may be limited in one or more of these capabilities. For example, one model generator may have a convenient language for access and usability of data but limited modelling capability;

another may not have database access, but may be very flexible and adaptive in terms of modelling. Two basic objectives of a model generator are:

- To permit quick and easy model development
- To be flexible and adaptive enough to facilitate interactive design of systems and simple modifications.

In order to satisfy these objectives, a model generator should have:

- **Usability:** The model generator should create models which are easy and convenient for non-technical people to use. It should be also easy and convenient to build and modify a model.

- **Data:** The model generator should provide access to a wide variety of internal and external data sources.

- **Analysis:** the model generator should have analysis capabilities to support a wide range of users, problems and contexts.

3.9 PLANNING PHASES AND INFORMATION REQUIREMENTS

3.9.1 Conceptual base for deriving Data and Information for the Planning Process

Planning, within the context of development planning, implementation, management and monitoring are continuous activities that take place at national, sectoral and local levels. The type of data and information provided to support development planning may also be influenced by the planning methodology and the strategy adopted at a specific level in the country (Sundaram, 1991).

Data and information, as earlier observed, are essential basis for planning. In this context, therefore, their potential roles include:

- Problem definition, measurement and analysis;
- Inventory taking and decision making;
- Evaluation of plans, programmes and projects.

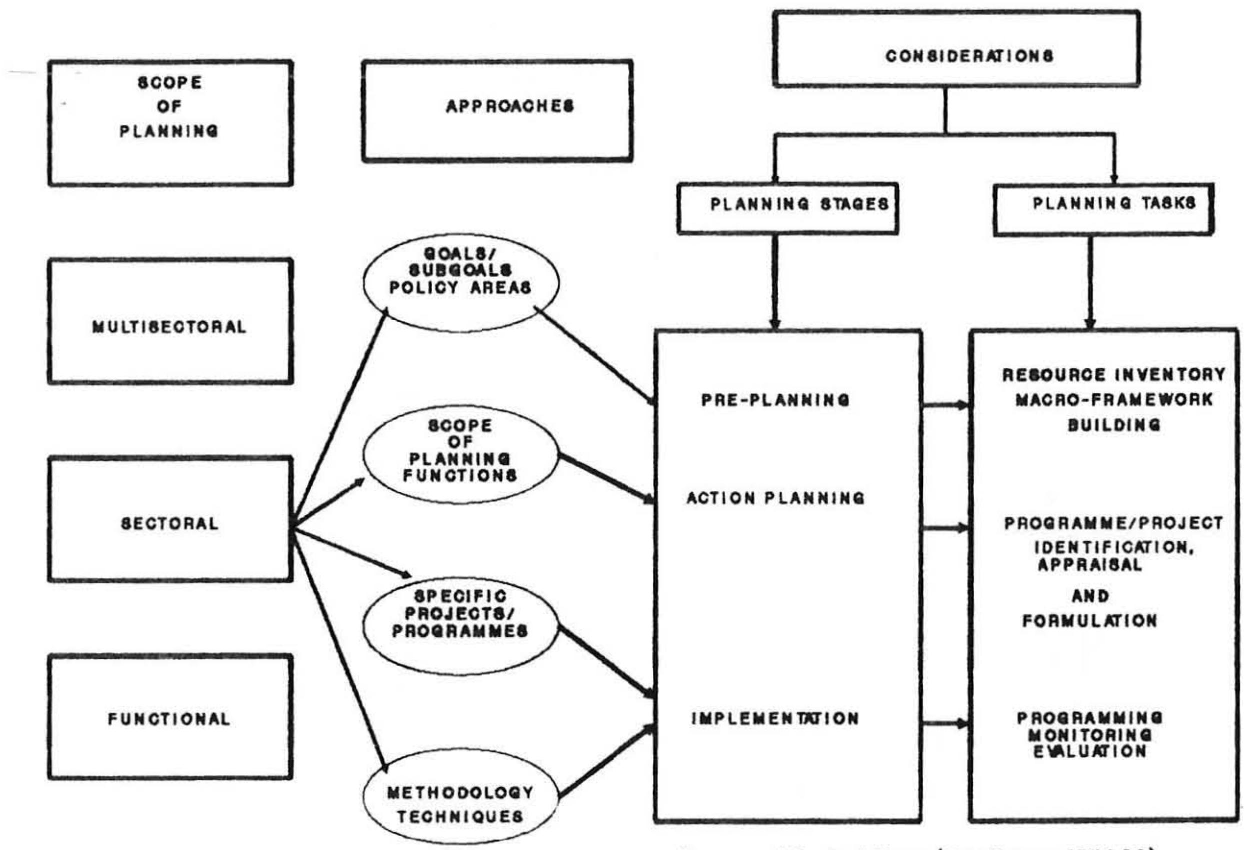
To meet the above planning related purposes, various types of information and data will be required. They could be spelt out or derived conceptually by adopting some rational approaches and building them into planning considerations.

Figure 2 illustrates such a conceptual base for deriving information and data within the three different planning ways discussed earlier i.e multisectoral, sectoral and functional planning. For each of these, the information and data requirements may be derived through the combination of four major approaches, whose key determinants include:

- Goals and subgoals and policy areas;
- Scope of the planning functions;
- Programmes/Projects included in the plans and;
- Methodology/techniques used for planning.

In the illustration (Figure 2), the different planning ways may be broken down into various levels. In decentralised planning, for example, the sectoral planning can further be broken down into region, local, community and household levels.

Figure 2. CONCEPTUAL BASE FOR DERIVING INFORMATION/DATA FOR PLANNING REQUIREMENTS.



Source: Adapted from (Sundaram 1991,62).

The identification of information and data could also be further aided and refined by two other considerations vis-a-vis the planning stages (pre-planning, action planning and implementation planning) and the major planning tasks or steps involved in each one of the stages. This is illustrated in Table VII.

Table VII: Data Requirements by planning stage and Planning Requirements.

Planning stage	Planning phase	Data requirements
Pre-planning (Diagnosis)	a)Inventory b)Formulation of development strategy and definition of targets	Broad magnitude and aggregates on the state of the sub-national and local economy; natural and human resources data and other socio-economic information
Planning (Prognosis and programmes)	c)Prognostication phase changes in the present situation for various sectors- forecast or anticipated developments	Policy changes envisaged; information on factors that may promote or retard development
	d)Programme/Project identification/ appraisal/formlation phase	Detailed project-specific, scientific and technical information inclding costs and benefits
Implementation	e)Monitoring/ evaluation/ control phase	Constraints and problems encountered in implementation; impact of projects and programmes.

Source: Neelameghan, 1993.

CHAPTER FOUR

ENERGY PLANNING IN ZAMBIA

4.1 ENERGY PLANNING: OVERVIEW

The fundamental goal of energy planning is to establish a set of effective policy objectives, programme measures, and a workable investment strategy for achieving those objectives. Sufficient energy sources must be available for both the modern sectors which rely primarily on commercial (often imported) fuels, and traditional sectors, which depend heavily on indigenous non-conventional energy. Policy initiatives and investment decisions must invariably be made under severe financial constraints. Consequently, the accurate and timely identification of investment priorities becomes crucial. For example, a commitment to a conventional capital-intensive energy supply may be less cost-effective in meeting national socio-economic objectives than a package of dispersed small-scale measures. Such trade-offs need to be evaluated in an integrated framework.

All the basic strategies for adjusting energy flows to meet changing needs such as fuel switching, indigenous resource development, conservation, and new and renewable energy options must be blended into a comprehensive plan. This plan should be consistent with parallel plans and projections emerging from other governmental units addressing such areas as environmental policy, agriculture policy, forestry programmes, demographic patterns and economic targets. The development of an effective energy plan is thus a demanding and ongoing activity.

4.2 APPROACHES TO ENERGY PLANNING: CONVENTIONAL VS NORMATIVE END-USE

There are various approaches to planning for energy resources. At almost all levels of energy planning i.e global, multisectoral, sectoral or functional planning; the conventional and end-use approaches in energy planning are becoming increasingly applied and useful.

4.2.1 Conventional/Traditional Approach

Most analyses in this approach stress and call for a doubling of the overall energy requirements over a period under forecast. Conventional projections imply that the scarcely affordable energy would significantly constrain development and the over-dependence on fossil fuels would give rise to formidable environmental problems.

The main preoccupation here is the focus on the increase of energy supplies and stepping up the production of energy resources. The basic tenets in this approach also involve:

- Estimating future energy demands on the basis of assumptions about the future demographic and economic trends and, the historical correlations between such trends and energy demands. The process of estimating future demands involves, for the most part, the use of historical (time series) relationships between energy demands and various economic and demographic variables to calculate the future energy demands for assumed future variables. The results of these projections are then adjusted in various ways to reflect "professional judgement" about the demand saturation, supply constraints etc.

- Matching the demand to a mix of energy supplies. This mix is chosen such that it is compatible with estimates of the energy resources base and in the case of new energy supply technologies with judgements about how much energy can be produced with such technologies at various future dates.

Thus, most conventional analyses are supply-oriented. Increase in the supply of energy is seen as a long term solution to any energy problem that may manifest in the forecast of various scenarios.

4.2.2 Normative End-Use Approach

The analyses of this approach are a shift from the conventional approach in that they do not emphasize on increased energy supplies. The concern is with the ways in which energy is used and the exploration of more effective ways of directing energy resources to human needs.

In this approach, energy supply or consumption is not treated as an end in itself, rather the focus is on the end-uses of energy and the service that energy performs. Energy use is seen as only a means of providing illumination, heat, mechanical power and other energy services associated with satisfying human needs.

Special interest is paid to the understanding of how patterns of energy use might be shaped so as to promote the achievement of certain basic societal goals i.e. equity, economic efficiency, environmental soundness, long-term viability and self-reliance.

An important ingredient of this approach is that it is possible to formulate energy strategies which are not only compatible with, but which even contribute to the related problems, such as, poverty, food scarcities and undernutrition, environmental degradation, population growth pressures etc.

Closer attention is also paid to the present and future human needs served by energy and, the technical and economic details of how energy is being used and alternative technological options for providing the energy services needed.

4.3 TRENDS IN ENERGY PLANNING IN ZAMBIA

4.3.1 Challenges and Prospects

Energy planning in Zambia like in any African country is more complex than in the developed world, partly because the majority of the energy needs are met at present by woodfuels, most of which are collected and not purchased (conventional). Chapter two presented an analytical survey of the energy situation in Zambia confirming this trend. It also indicated that for the past ten years woodfuels accounted for over fifty percent (50%) of the national level energy consumption. Thus, the market forces which dominate European and American energy planning are largely absent. In such a scenario, energy planning will have to realise a balance between demands on conventional sources and alternative ones such as woodfuels, the national consumption of which is very large.

This situation is also compounded by the heavy dependence on oil imports that drain most of the foreign exchange reserves leading to general national budget deficits, balance of payment problems and debt crisis. There is also the dilemma of striking a balance between this dependence on the one hand and the urge to develop indigenous fossil energy resources in existence in the country.

With the limited financial resources, prospects of exploration have remained dim. Past experiences indicate that partnerships with foreign multinationals in an effort to find indigenous fossil fuels have ended up without any tangible results or in political problems. For example, in 1986 the Zambian government entered a contract with an American company (Placid Oil) to carry out exploration and drill oil in the eastern part of Zambia. After two years, these explorations produced no results and ended up in a political dispute between Parliament and the Presidency.

New and renewable energy sources, such as the sun and wind, have provided little energy sources in Zambia. Little research has so far been initiated in this direction. They also not only face fierce competition from the conventional sources but the technology involved to harness and manage them is still expensive. The installation of a small solar powered pump can cost $10,000 or more (Tamberlake, 1991).

Given the foregoing, planning for energy resources in Zambia becomes a serious issue and calls for concerted efforts by the energy planners and decision makers in the government.

In this context, there is also the environmental issue to consider. Most fossil fuels and alternative sources such as woodfuel present environmental degradation through pollution. Although, accelerating fossil fuels and woodfuel supplies have often brought about this situation, the demand for such energy resources has shown an upward trend over the years. Therefore, overall energy planning becomes both a technical as well as a political issue.

Currently, the importance of energy planning in Zambia though recognised is beset by a number of constraints. Practically, the preconditions for establishing an adequate energy planning capability are rarely met. Most of the problems relate to institutional commitment in the Energy Department such as:

- Unsystematic collection and processing of data and information;
- Infrequent periodic reviews and updating of the goals and policy issues; and
- Inactive overall review of programme elements.

Other constraints include:

- Failure to attract high quality staff in sufficient number to sustain serious energy planning. There are presently only four energy planners in the Department. The practice of developing local human resource for energy planning purpose has not received adequate attention.

- External funding has frequently been used for individual energy supply projects whose justification within a comprehensive policy framework may be dubious.

4.3.2 Present Dimension

Generally, Zambia applies multisectoral, sectoral and functional planning. There are various organisational units charged with the task of formulating, monitoring and evaluating development plan. The National Commission for Development Planning (NCDP) does the overall planning for all the resources in accordance with the national development plans in the country. In addition, operating organisations (ministries and parastatals) perform sectoral and functional planning and programming.

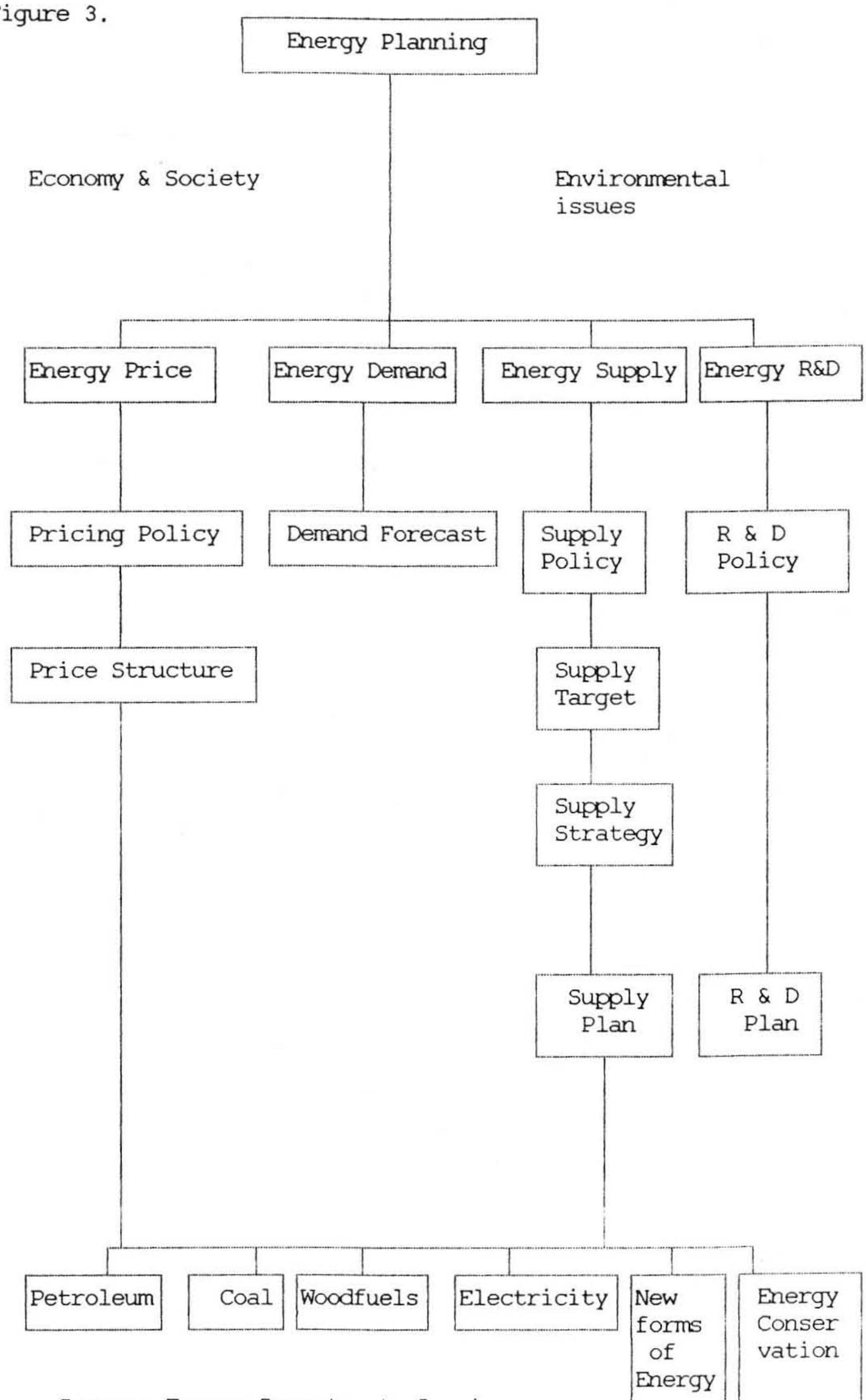
National energy planning is a state function done at sectoral or ministerial level. This planning function is a statutory function charged to the Ministry of Energy and Water Development and performed by the Energy Planning Unit under the Energy Department. This section formulates, monitors and evaluates plans as they relate to the total socio-economic development policies of the country.

It, therefore, aims to capture information in the energy sector as it relates to:

- Facts, trends and analysis in the development of energy resources;
- Prescription for decision making for the energy resources;
- Consequences, operational experiences and evaluations on energy;
- Characteristics, conditions of the energy resources;
- Strategies for mobilising the energy resources, etc.

The approaches adopted in energy planning in Zambia are both the conventional and normative end-use with the stress on the latter in the planning for indigenous resources. The national energy planning process is reflected in the energy plans drawn by the Energy Department. The structure of the energy planning process in Zambia is presented in a systems flow chart (Figure 3).

Figure 3.



Source: Energy Department, Lusaka.

4.4 ENERGY POLICY IN ZAMBIA

The present energy policy is still in draft form. The key assumptions of the Energy Policy are those tenets built into the energy plan elaborated in the preceding sections. Although it is still in draft form, it is helpful to examine the tenets.

The present policy does not shift much from the previous policy. It is based on past experiences and the studies carried out on energy conservation and management towards sustenance.

The policy of the Zambian government is to institute necessary measures to facilitate a reduction in fuel oil consumption, upgrade the quality of most forms of energy resources to protect the environment and sustain an ecological balance by avoiding environmental pollution in the exploration, development, production, transportation, storage and utilisation efforts of all the energy resources requirements in the country.

Based on studies, such as, the 1983 industrial energy audit, the policy stresses the improvement of the industrial structure by shifting away from energy intensive industries. This is meant to be an energy cost saving measures covering:

- **No-cost measures:** Which refer to the improvements of the operating efficiency of the existing processes and the equipment in the industries.

- **Low cost/Minor Capital measures:** Implying relatively simple modification to the industrial plants and equipment.

- **High Cost/Major Capital Investment measures:** This involves the replacement and or the modifications of the plants and equipment with more efficient technologies.

The aim of the energy substitution programme is to encourage measures that will result in major consumers' such as, industries using more local electricity and coal than imported oil.

This self-reliance is hoped to be achieved through intensive use of other energy applications that are environmental pollution free. This in turn calls for application of further research on geothermal, solar and biomass energy. Stepping up research in these areas is recommended in the policy framework.

Energy pricing is set to be rationalised within the changing orientation of the national economy towards a liberal market economy. It is thus stressed that energy prices should reflect the real cost and these should be interrelated to other sectors with due concern for energy conservation and competitiveness of export goods. For example, the pricing of petroleum products should be based on their respective heating values and possibility of mutual substitution. Likewise, electricity rates (tariffs) should be based on time-of-the-use costs to encourage off-peak power consumption and higher load factors.

4.5 INFORMATION NEEDS FOR ENERGY PLANNING IN ZAMBIA

The energy system in Zambia can be seen as intersectoral and interdisciplinary and, therefore, requires collaboration of different agencies for effective planning and operation. As already indicated, energy planning is an ongoing and continuous activity and requires information support system that integrates itself and is compatible, with the dynamic plans and strategies adopted from time to time.

It involves establishing an optimal set of policies and programmes that in turn require a considerable amount of data and information. In such a process, different types of information from various sources may emerge leading to information overload and/or pollution and the information system must have an orientation that stresses on the quality of information products and services through the critical selection of relevant information at a specific time and targeted to relevant audiences and in usable forms for effective energy planning and overall management of the national energy resources. Hence, the information system must be built into the integrated institutional framework of the energy policies and plans outlined in the preceding sections.

Identifying the data and information needs for sectoral energy planning in Zambia is one aspect of designing the information support system. Other logical, strategic and operational requirements should also be taken into account with the view to maximising the use and the application of the information system.
These requirements are summarised below:

1. Logical requirements:

- **consistency** - the information produced within the system should not be self-contradictory.

- **comparability** - uniform data classification methods must be adopted in the system in order to allow a comparison through time and with other related agencies in the energy planning process.

- **validity** - the information provided should allow for statistical robustness.

- **measurability** - individual nominal and aggregate data metric must be easily measured.

2. Operational requirements

- **availability** - the relevant information should be available to the target users (energy planners and decision makers) upon request and in anticipation of demand in the execution of their various planning tasks.

- **completeness** - the information provided to the target users should satisfy their respective information needs.

- **usability** - the data should be usable without employing complex operations and interpretations.

- **multiformity** - the information produced should be usable for other related planning activities such as environmental, urban, socio-economic development planning etc.

3. **Strategic requirements**

- **relevance** - the information should represent the most important policy objective and measures of the problem at hand in the energy planning process.

- **flexibility** - the system should be easily adjustable to new policy interests and new circumstances arising within the institutional framework of the energy plans.

- **comprehensiveness** - components of the system should provide integrated information that enable forecasting simultaneous scenarios arising within the energy planning framework and the sectoral policies linked to it.

- **effectiveness** - the impacts of energy policy measures should be easily be judged and evaluated (before and after).

- level of the energy planning programme e.g. national, regional, local levels to which energy planning programmes are geared.

4.5.1 Type of Information

Generally, the type of information required in most energy planning processes covers the following:

- **Sociological** - Energy consumption levels affected by sociological variables such as population, housing, income etc.

- **Economic** - Information covering industry location and type, employment, capital investments and demand and their influence on energy flows.

- **R & D** - Technological developments affecting the energy flow in the country.

- **Environmental Aspects** - Issues emanating from environmental consequences of energy utilisation.

- **Energy Consumption** - Pattern of consumption of the type of energy by various sectors at various level of development.

- **Energy Supply** - Situation of the supply of energy resources focusing on the indigenous sources and those obtained externally.

- **Energy Pricing** - The policies, regulations and framework under pricing of energy resources fall and their effects on various socio-economic variables.

- **End-use of Energy** - Various purposes for which the energy resources are utilised by the various social groups and sectors of the national economy.

In the collection of data and information for energy planning in Zambia, the classification of the type of data and information becomes paramount. A detailed presentation of the type of information identified for the energy planners in Zambia is given in the next chapter.

4.5.2 Information Sources, Collection, Processing and Provision

In the energy planning process, information and data originate from:

- Within the planning institutional framework;
- Other institutions that collect and process planning data and information;
- Surveys initiated from within the energy sector.

Identification and collection of data are only the first steps in the provision of information in the energy planning process. The collected data and information must be verified, classified, organised, aggregated, statistically processed, stored, retrieved and communicated. Since energy planning requires critical minimum information to respond to the "time-squeeze" in such a planning process, the application of information technology (especially computer technology) for processing, handling and ultimate utilisation becomes significant for effective energy planning in Zambia.

CHAPTER FIVE

FINDINGS OF THE SURVEY

5.1 SCOPE OF CHAPTER

This chapter presents the analysis and evaluation of information systems and services that support energy planning in Zambia. It also presents the identified information needs vis-a-vis the type of information required for energy planners and decision makers in the Energy Planning Unit as obtained from the survey.

Since the energy planning process is intersectoral and interdisciplinary and depends largely on secondary data from the related institutions, a survey of the information systems in these institutions related to the Energy Planning Unit was also carried out. This was intended to assess the feasibility of any meaningful information and data exchange between these institutions and the planning unit through a computer-based network system.

Further, an appraisal of the national information policy is done vis-a-vis the development of an information support system for energy planning to be integrated in the national information system framework in Zambia.

5.2 INFORMATION SYSTEM AT THE ENERGY PLANNING UNIT: SYSTEMS ANALYSIS AND EVALUATION

5.2.1 The Information System

5.2.1.1 Hardware

The information system at the Energy Planning Unit is a computer-based system. The system configuration consists of five IBM microcomputers. One is IBM PC PS/02 modes 386SX HAS 1.44" floppy drive disk, 101 key board, VGA color monitor, one parallel and two serial ports with a memory capacity of 2MB and a hard disk storage capacity of 80MB. The other four are IBM XT 286 machines and all have floppy disk drives of 3.5", 101 keyboard, VGA color monitors, each with a parallel and two serial ports and memory capacity of the range of 512K and 640K and a hard disk capacity of 32MB. All the microcomputers run on MS DOS. The first PCs were first installed in 1978. Four of the microcomputers are located on one site, while one is

This section of the study thus, assesses the quality assurance mechanism of the information system for energy planning process at the Energy Planning Unit in order to establish value and quality of information resources and products. This assessment is based on the characteristics chosen as representative of quality assurance of any information system which are discussed in the preceding section. The information system in the Energy Planning Unit is examined in this light.

Quality is defined as excellence or fitness. It is not an absolute concept. It is often defined relative to a particular context. Usually, an application has quality relative to it's primary and secondary users (Davis and Olson, 1985).

Generally, perfect quality is very costly and virtually impossible in practice. Quality should be within acceptable limits as defined by the organisation. The quality limits reflect the consequences of lack of quality and the cost of achieving it.

Quality in information systems has a number of characteristics. The importance of each depends on the application and its contexts. Davis and Olson (1985) identified the following (Table VIII) as some characteristics to be included in the concept of quality in information systems.

Table VIII: Quality Assurance Characteristics

Information System Quality Characteristics	Implementation of Concept
Complete data	All data items are captured and stored for use. Data items are properly identified with time period
Accurate data	The correct data values recorded
Precise data	Measurement of variable meet user needs for precision
Understandable output	The output of the system is understandable to the users
Timely output	The output of the application is available in time for the actions and decisions
Relevant output	The outputs are relevant to the actions and decisions taken
Meaningful outputs	The format, labelling, data provided, and the context in which data is presented makes the output meaningful for actions and decision making

User friendly Operations	The system provides user interfaces that are understandable and designed to conform to human capabilities
Error resistant Operations	Suitable error prevention and detection procedures are in place
Protected system and operation	The system and its operations are protected from various environmental risks. There should be provisions for recovery in the event of failure or destruction of part or whole system

For the purpose of the present work, quality will be assessed using the above characteristics and as judged by the end-users (energy planners). It will also viewed in terms of capacity of the system in relation to information need identification, resources utilisation, efficiency and effectiveness of information resource management. The assessment does not, however, rest on one component subsystem of the information system, rather it examines the whole information system.

5.2.3 Quality Assurance of the Information System at the Energy Planning Unit

Five energy planners and executives in the energy planning unit were asked through structured interviews to give their views about the computer-based information system in the planning unit. In assessing their views with regard to various aspects on quality of the information products and services, their responses were recorded, categorised, computed for frequency distribution and tabulated with respect to the required characteristics of quality assurance identified above as illustrated in the tables below. All those interviewed responded. The results of the findings are summarised in the preceding sections.

5.2.3.1 Information Use, Services and Products

END USE OF THE INFORMATION SYSTEM

	Frequency	Percent
Forecasting/Modelling	3	60
Resource allocation	2	40
R & D	0	0
Other uses	0	0
Total	5	100

USEFULNESS OF DATA AND INFORMATION TO USERS

	Frequency	Percent
Useful to other units	1	20
Useful to planning unit	3	60
Useful to parent institution	1	20
Useful to related field(s)	0	0
Useful to intern. agencies	0	0
Others	0	0
Total	5	100

PERIODICITY/FREQUENCY OF INFORMATION PROVISION

	Frequency	Percent
Daily	3	60
Weekly	1	20
Monthly	1	20
Bimonthly	0	0
Quarterly	0	0
Half Yearly	0	0
Annually	0	0
Rarely	0	0
Total	5	100

TIME-FRAME OF USE/USEFULNESS INFORMATION

	Frequency	Percent
Immediate	1	20
Near future	0	0
Distant future	0	0
Difficult to predict	4	80
Total	5	100

RECENCY OF DATA AND INFORMATION

	Frequency	Percent
Current	1	20
Past data wanted	1	20
Other essential data	3	60
Total	5	100

PERIOD OF VALIDITY OF DATA AND INFORMATION

	Frequency	Percent
Latest (Valid until subsequent data is available	1	20
Limited (e.g 1 to 5 years)	3	60
Period of validity not specified	1	20
Total	5	100

RELIABILITY OF INFORMATION

	Frequency	Percent
Precise	1	20
Accurate within limit	1	20
Unspecified (as-is-basis)	3	60
Total	5	100

DATA SECURITY/PRIVILEGES

	Frequency	Percent
Strictly confidential	1	20
To named persons only	1	20
Open use	3	60
Total	5	100

MODE/FORM OF DISSEMINATION OF INFORMATION

	Frequency	Percent
Current awareness (CAS)	0	0
SDI	0	0
On request	1	20
On-line access	1	20
Statistical forms	3	60
Analyzed/repackaged (e.g. digests)	0	0
Referral databases	0	0
Bibliographic databases	0	0
CD-ROM searches	0	0
Others (e.g.invisible college)	0	0
Total	5	100

TECHNICAL/OPERATIONAL REQUIREMENTS

	Frequency	Percent
Users friendly	1	20
Error resistant	0	0
Understandable output	1	20
Meaningful output	1	20
Relevant output	2	40
Total	5	100

5.3 DISCUSSIONS OF THE FINDINGS

5.3.1 End Use of Information

Of the five energy planners and executives interviewed, three (60%) indicated that they used the information system for forecasting and modelling in energy planning, while two (40%) indicated they used it for energy resource allocation i.e decision making. None of them indicated they used it for R & D or any other functions.

5.3.2 Usefulness of Data and Information

Most of the respondents stated that the use/usefulness of the information system was largely confined to the Energy Planning Unit (60%) in their planning and decision making functions. About 20%, however, felt that it was useful to other units within the department as well, while none felt it was useful to related fields such as agriculture, forestry, environmental and industrial planning etc.

5.3.3 Periodicity/Frequency of Information Provision

The response towards utilisation of the information system was overwhelming. About 60% of the potential users indicated they used or relied on the information system for various planning purposes. Only 20% felt they used it weekly and 20% monthly.

5.3.4 Time-frame of use/usefulness of Data and Information

Only 20% felt the data and information they received was timely and helped in immediate decision making on a wide range of issues. The majority (80%) could not, however, predict the time-frame on the usefulness of the information they obtained was.

5.3.5 Recency of Data and Information

Most of the respondents felt that the data and information obtained from the system was not current, only about 20% indicated that the coverage was current. Past data (i.e. historical data) and information needed for forecasting in energy planning was reported largely absent.

A majority of them (60%) indicated that essential data needed such as on past trends and prescriptions on the energy resources in the country; data on related issues such as environmental and forestry with regards to the effects of the production, transportation and utilisation of certain energy resources such as fossil fuels and woodfuels was also reported absent.

5.3.6 Period of Validity of Data and Information

Only 20% felt the information system provided latest information of the current situations on energy in terms of national and international issues with respect to the period of validity and thought the information they received was in most cases valid until subsequent data and information was obtained. Sixty percent (60%) indicated that most of the data and information they obtained from the system was limited to a specific period in terms of value to certain energy resources. For example, latest information on mostly utilised energy resources such as woodfuels and new and renewable sources like wind and solar was cited as lacking most of the time. About 20% could not specify the extent of validity of the information they received.

5.3.7 Reliability of Data and Information

Only one respondent (20%) felt that the information obtained from the system was reliable. Another(20%) thought it was reliable within some specific limit, while the majority (60%) felt most of the information was on as-is-basis, that is unspecified and did not, therefore, signify reliability in relation to their information needs and ultimate execution of their various planning tasks.

5.3.8 Data Security, Privacy and Privileges

Most of the energy planners and executives stated that the information was more for open use and lacked data security, privacy and privileges (60%). Only 20% indicated that it provided data security, privacy and privileges and another 20% felt such security, privacy and privileges was limited to specific persons within the unit.

5.3.9 Mode/Form of Dissemination of Information

The majority depended on the statistical outputs generated from the integrated energy planning tool-LEAP (60%). Only 20% indicated they got the information on request. There is no current awareness or Selective Dissemination of Information (SDI) offered presently. Neither are there any digests, state-of-the-art reports produced through the process of information analysis and consolidation from various information sources. Also, no referral databases such as profiles of experts, institutions etc., are created. At the time of the survey, the information system was trying to create some prototype bibliographic databases using dBASE IV.

5.3.10 Technical and Operational Requirements

Only 20% reported that the information system was user-friendly. None reported that the system was error resistant. This indicated that the system was prone to error and, therefore, not fully reliable. Forty percent (40%), however, expressed satisfaction with the output and stated that the outputs were relevant to their planning tasks.

5.4 DATA SOURCES

The following were identified as the sources of data and information input in the system:

- Socio-economic surveys conducted by the Central Statistics Office-Lusaka, every five years.

- Monthly and annual reports on fuel consumption from ZIMOIL.

- Reports from marketing companies such as BP, AGIP, CALTEX, MOBIL and TOTAL.

- Reports on electricity supply and distribution from ZESCO.

- Annual reports from Indeni Refinery-Ndola
- Reports from Forestry Department on woodfuels
- Reports on wind and solar energy from the Meteorological Department.

5.5 INFERENCES FROM THE SURVEY FINDINGS

The survey with regard to quality assurance of the information system at the Energy Planning Unit revealed the following:

- The usefulness of the information system in the Energy Planning Unit is appreciated by potential users i.e. energy planners and decision makers.
- The information system does not provide comprehensive services to the energy planners in supporting the execution of their various planning tasks. It shows gaps and deficiencies and depends upon on only one computer-based planning model (LEAP) as information support for energy planners. Close interaction with energy planners and decision makers indicated that LEAP alone cannot answer all their information requirements.

- The coverage of the data and information generated is inadequate and incomplete leading to poor energy planning performance and risky decision making. As a planning computer-based model, LEAP depends on secondary data collected by other agencies, whose coverage and authenticity cannot be easily verified.

- The reliability and timeliness of data and information provision are unsatisfactory in relation to the energy planning process which is dynamic, ongoing and time-bound. Information generated does not, in most cases, help users to immediate decision making and consequently they often have to look to other sources which in turn may require to exhaustive searches and ultimately to risky decisions.

- Collection of data to be input into the system is slow since most secondary data are often scanty and difficult to obtain. Surveys to collect primary data are expensive and often difficult to carry out. For example, data on woodfuels, a dominant energy resource is lacking.

- Statistical outputs from LEAP are the only forms and mode of dissemination and although relevant to some energy planners cannot be the sole information support in energy planning. Other methods of dissemination such CAS, SDI, digests are also required.

- The technical and operational capabilities of the system showed inadequacies as well. Close examination indicated that most energy planners are not very computer literate, and therefore, user friendliness of the system is paramount in this regard. There is no continuous institutional training on a wide range of computer application. In addition, the survey showed that the system is prone to errors, although the outputs are to some extent meaningful and relevant to the potential users (energy planners).

- There is some data security, privacy and privileges provided to a few named persons, but most of the system is for open use.

- The available manpower in the information system is inadequate to provide other services critical to the energy planning process; there is only one information specialist.

- There is very little interaction between the information specialist and the energy planners and decision makers, making the effort at modification of the existing system quite difficult.

- The computer resources, such as, hardware and software are inadequate to support the energy planning process. Some of the cited problems include:

(a) Lack of or inadequate peripheral devices such as printers, mouse etc.

(b) Lack of a wide range of software packages

(c) Inadequate memory and mass storage capacity

(d) Slow processing speed

(e) Poor maintenance

(f) Unstable environmental conditions (e.g. heat, dust, electricity cuts) and no stabilisers such as the UPC.

- The microcomputers and software, although used through out the planning unit are acquired at random without consideration of near future plans and of their functional compatibility.

- The information system faces budgetary constraints in general and this makes it difficult to strengthen information provision to the energy planning process.

5.6 USERS REQUIREMENT ANALYSIS

5.6.1 Information for Energy Planners

The interviews undertaken also enabled the identification of the information needs of the energy planners in the energy planning process in Zambia. This section presents the findings.

The analysis and identification of the potential users'information requirements is a prerequisites for the success of any information system. Sein (1987) observed that the success of the information system depends on identifying the right requirements for the application and ensuring that the development of the information system meets these requirements.

One important aspect in identification of user requirements relates to the purpose for which the information is required and this in turn is determined by the various tasks that the users carry out in achieving their own defined goals. In the case under study, the ultimate purpose is already determined i.e. energy planning and decision making, hence the concern here must be specific needs such as the format, and the quality of the information discussed in the preceding sections and the type of information and sources elaborated in the next sections.

The latter task (i.e identification of the type of information), requires close examination of the energy planning process in as far as it relates to problem of definition, measurement and analysis and evaluation of the energy plans, project and programmes. It also calls for close interaction with energy planners in such a process in order to come up with various categories or types of information needed.

5.6.2 Type of Information for Energy Planners

For the identification of the type of data, a framework was drawn from the energy planning programme which was broken down into phases, subtasks and the activities and then data required identified for each of them. Such analysis and the interactions with the energy planners and decision makers through interviews helped to identify the information required. These areas and the type of data and information can be categorised as discussed below.

5.6.2.1 End Uses of Energy

This data may be quantitative showing the consumption rate of the different types of energy in Zambia for various purposes. This is important for the energy planners in contingent, short range and long energy planning. It also enables them to get a clear picture of the consumption patterns within the country.

5.6.2.2 Energy Supply

Energy planners need data and information on the supply of energy. The supply of energy can be subdivided by energy sources with information on the estimates and the comparisons of the local sources with the imported ones in terms of the costs of conversion, refining, distribution etc of the various energy resources.

5.6.2.3 Energy Consumption Pattern

Data on the energy consumption pattern will help in understanding the energy demand and supply pattern in the country. It may be categorised further by the type of energy (i.e coal, oil, electricity, solar etc.) or by geographical area (city, district, province etc.) or by pattern of consumption by specific sectors and distinct social groups.

5.6.2.4 Energy Distribution

From this parameter, information may be derived on the network distribution of various types of energy and would help in short term or contingent planning of various types of energy resources to specific user groups and in situations where energy planners may have to select from several alternatives.

5.6.2.5 Energy Pricing

Information on energy pricing is normally dictated by supply and demand patterns. The national and international pricing of energy and as it relates to various user groups is another important parameter that energy planners consider.

5.5.2.6 Energy Balance

Energy planners and decision makers need reliable data and information on the status of the imports in relation to the exports of different forms of energy in order to ascertain the nation's consumption of energy products, losses and waste resulting from environmental degradation.

5.6.2.7 Research and Development

Zambia's draft energy policy stresses the need to diversify to other cheaper and alternative sources and reduce dependence on conventional sources of energy. Information on the new research findings and on developments in technology and equipment in non-conventional energy sources was stated as important by those interviewed

5.6.2.8 Socio-economic Information

Energy consumption levels are influenced by socio-economic parameters. Information on such parameters as population size and growth patterns and their impact on consumption of different energy categories was cited as essential for decision making.

5.6.2.9 Information on Environment

Effects on the dispositions of energy on the environment and seeking pollution free energy resources.

In addition, information on land use and deforestation caused by the use of woodfuels was also stated as critical to the overall energy planning process.

5.7 SURVEY OF INFORMATION SYSTEMS IN INSTITUTIONS RELATED TO THE ENERGY PLANNING UNIT.

The six institutions selected in the energy sector and those related to it and specifically to the energy planning unit were surveyed. Their present status, services rendered, human and computer resources available and their attitude towards co-operation in electronic data exchange through a network with other related information systems in the energy sector particularly with the planning unit were assessed through a questionnaire supplemented by interviews and on-site observations. The findings of the survey are summarised in the succeeding sections.

Since the aim of the survey of these institutions was to examine if there is any meaningful ways of data exchange through a network, it would be helpful to discuss the general requirements for networking.

5.7.1 General Requirements for Establishing a Network

5.7.1.1 Networks

The wide diversity that characterizes different networks makes it difficult to arrive at a precise definition of what constitutes a network. In a more descriptive sense, information networks are groups of individuals or organizations that exchange information and other resources on a co-ordinated basis according to predetermined norms and standards. A network usually consists of a formal arrangement whereby materials, information and services provided by a variety of information systems are made available to potential users. A network may be operated totally manually or use information technology partially or fully.

Information network is a relatively new concept arising from the need to come together to facilitate easy access to information and sharing of resources. The need for networking arises out of problems faced in information transfer due to the rapid rate of growth in production and use of information.

Another contributing factor is the scarcity of resources. The information resources required in the generation, processing or dissemination of information such as skilled manpower, finance, and other materials make it difficult for many institutions to generate or acquire all the necessary information sources required for various purposes. It is felt that sharing of resources would alleviate such problems.

In addition, the recent developments in information technology present the possibilities to get fast access to a wide range of information resources.

5.7.1.2 Success of Information Networks

There are various factors which lead to successful networking. The diversity of networks and their characteristics normally preclude the drawing of generalizations which could be universally applicable to all categories of networks (Ramani and Shams, 1989). The following have been identified as factors that lead to success of a network system:

1. Networks are supposed to be built around shared ideas which can present potentials for development and induce concerned parties who may be dispersed

geographically, culturally and professionally.

2. The shared idea or a common vision of what can be accomplished may not be sufficient alone to sustain a network. A number of organisational practices need to be addressed which may act as hinderance. In addition, there is need for very concrete plans to operationalise the idea of networking in order to achieve a common objective. This would require a high level of human interaction/personal commitment and group activities.

3. There is also the need for follow-up activities consisting of action training, action research, policy dialogue, dissemination efforts and regular exchange of information to sustain a network arrangement.

4. Although, in practice, it may not be a realisable goal, ideally, a network should be practically self-reliant.

5. Networks once put in place must acquire a capacity of internal review and self-reflection.

5.7.1.3 Network Organization

The management concern for the overall network and within the participating institution is paramount. Organization of a network depends on different factors, the most important ones include:-

- number of participants;
- geographical location of the nodes;
- type of function carried out by the participants
- type of language and culture (UN ESCAP, 1988)

A planned development of a network should give emphasis to these factors in selecting the network organizational structure (model). Network models can be centralised, decentralised or a combination of the two. Patterns of network structure may takes the following forms; **star network, hierarchical network, distributed network** **or a combination (simple structures) of these,** etc.

5.7.1.3.1 Star Network

In this type of network, participants are interconnected through a co-ordinating centre. The operations are centralised. Collection, processing, preparation of databases, provision of information products and services are performed at the centre.

It is a directed type of network in which the direction comes from the central node (host organization). A central library with its branch libraries is an example of this type of networking. Another example is ICLARM - Network. The main advantages of this type of network is that management of the network is relatively easier. On the other hand, the cost load on the central nodes can be heavy. Further, if the co-ordinating centre fails to operate efficiently, the entire communication system would breakdown.

5.7.1.3.2 Hierarchical Network

In this type of network, individual systems are configured to have multiple levels. Network members (users) are grouped in hierarchical areas of increasing/greater capabilities (in information sources, experience, equipment, etc).

The hierarchical network is a design with subsystems for specific aspects or levels. The design is advantageous in designing subsystems for various economic structures, such as agriculture, industry, health etc.

It can be applicable for different geographical levels, such as local, national, regional and international levels.

The hierarchical structure or the information system, as far as possible, should reflect existing hierarchical structures of policy and decision making authority in order to a facilitate the organization and flow of information. (General information programme and UNISIST, 1984)

What is more, participants share resources locally and if need are not met, will pass to the next higher level resource centre. The free, flow of information through out the network, from one level to another and not necessarily an immediate hierarchy, is not facilitated in such type of arrangement.

5.7.1.3.3 Decentralised Networks

Unlike the hierarchical network, in this model, systems communicate with each other directly. The network participants have common interest and exchange data and information.

Although, management of the network can be more difficult, other communication channels are available since there is a direct link between members. The design facilitates public participation through accessibility to information. An important element of such a network arrangement is that each participating body would be involved in the process of planning at various levels.

The decentralized type of networks rely on effective and efficient co-ordinating between co-operating organizations. An example of this type of network is PANGIS (Pan-African Geological Information System).

5.7.1.3.4 Combination of Simple Structures

In this type of network arrangement, a combination of some or all of the above type of networks may exist. The principle here is to link-up related units which have autonomous structures. Examples include a combination of clearing houses or co-ordinating stand alone systems and freely interacting bilateral/multilateral arrangements.

5.7.1.4 Network Components

The following can be identified and selected as important components of an information network:-

- Organizational structure (with which a network would be non-existent);
- Information resources;
- Information service guidelines;
- Processing (formats) norms and standards;
- Referral tools (index codes);
- Central bibliographic record that provide the location of needed items within a network;
- Switching capability, interfacing which other networks and determining of human communication path within the network;
- Evaluation criteria;
- Training programmes, also to provide user education;
- In computer-based network, adequate computer applications and telecommunications support must exist.

5.8 RESULTS FROM THE SURVEY OF INSTITUTIONS

5.8.1 Information system(s) Activities

The information system at the Energy Department is computer-based and it does not have any other conventional forms of information services. Most of the other institutions surveyed had both computer-based information systems and back up information services such as traditional libraries and documentation centres. Most of the information systems perform bibliographic numeric/statistical and referral activities, irrespective of whether computers are used or not. Out of the six institutions, that provided bibliographic services, for example, four (i.e NCSR, Energy Department, Environmental Council and Geological Survey) reported that they used computers for this activity.

It should be noted that on-site examination of the systems revealed that the computer-based bibliographic activities are not full-fledged. Most of them are in the process of still creating bibliographic databases in prototype form and may take time before the use of computer in information processing gains ground in these institutions.

5.8.4 Application Software

Four of the six institutions (NCSR, Environmental Council, Energy Department and Geological Survey) had database management software packages. The Energy Department and Geological Survey used dBASE IV; NCSR and Environmental Council used Micro CDS/ISIS and dBASE IV.

It is important to note that, version 3.0 released late 1992 by UNESCO for public use has a multiuser capacity in Local Area Network (LAN) environment. CDS/ISIS has a data import/export facility in ISO 2709 format and programmes available for converting record forms of dBASE IV to ISO 2709. Programs are also available to convert structured text in ASCII format to ISO 2709 format. These features make it possible to exchange data bases of different packages and formats among the information systems in a co-operative network environment.

Past experiences, for example, indicate that participants in information networks such as PADIS, DEVINSA, IDIN, DIVINER, SEAFIS etc., are using the same software for such data exchange

5.8.5 CD-ROM Drives and Databases

Only one institution (NCSR-Kitwe) reported to have CD-ROM drives and used them for on-line searches on CD-ROM databases.

5.8.6 Networking

In the five of the institutions surveyed, all the computers are stand alones except ZESCO that has attempted a network link to the Ndola office information system from its main frame VAX 8250 machines. Apart from the Department of Energy, most institutions expressed willingness to the concept of networking. Most of them, however, had only a vague idea when asked to give reasons why they wanted to network.

5.8.7 Computer related Problems

All the institutions reported problems related to unstable electricity, poor maintenance and lack of a wide range of software packages.

On personnel problems, five except ZESCO cited shortage of manpower and inadequate computer training for the staff.

5.8.8 Effectiveness of using Computers

The appreciation of computer technology for effective information handling, processing and utilisation was reported as high. All the six institutions felt that computer applications could improve storage and retrieval, provide better information services, improve working morale and consequently the overall productivity of the institution.

5.9 INFERENCES FROM THE SURVEY OF INSTITUTIONS

The following are the conclusions drawn from the survey of the information systems in the selected six institutions:

- Bibliographic activities are predominant in the information systems surveyed. Although, in some institutions computer technology is used in these services, its application has not gained much ground.

- The survey reveals gaps, lack of co-ordination and collaboration and deficiencies in information flow between the research institution and the planning unit. Researchers interviewed felt that their research findings were not often included in the overall

5.10 ZAMBIA NATIONAL INFORMATION POLICY VIS-A-VIS INFORMATION SUPPORT TO THE ENERGY SECTOR

The Zambia national information policy draft proposal was an initiation of UNESCO in 1987 to try and come up with policy guidelines for the development of a co-ordinated information infrastructure in Zambia. Todate the policy is still in draft form and its revival looks dim. It is, however, important to recognise and appreciate the views expressed in the draft with regard to development on information support system(s) in the energy sector in general and that the energy planning should be considered an integral part of the total national information infrastructure development in Zambia.

The draft proposal highlights the lack of co-ordination and confirms the nature of rudimentary developments of information to support various socio-economic development in the country. It states:

> "Economic sectors such as industry, agriculture, financial, mining, energy, manufacturing, etc., have been emphasized in Zambia's previous national development plans... but every little has been done to

> institutionalise the use of printed, non-print and electronically transmitted information in order to sustain...national economic growth..." (Zambia National Information Policy: a draft proposal, August, 1987).

One interesting characteristic of the draft proposal is the recognition of priority sectors of the national economy and their information requirements (See Figure 4). Particularly for the energy sector, the policy proposal recognises the need for strengthening and maintenance of the existing information support and stresses the application of information technology (especially computer technology) in the processing, management and dissemination of information in the energy sector. It also identifies energy as an area critical to socio-economic development and that information support in the energy sector must focus on:

> "Information for research and development, energy utilisation and conservation, rural energy supply, environmental pollution, appropriate technology; and on energy planning, management and marketing." (Zambia National Information Policy: a draft proposal, August, 1987).

Although the draft proposal does not elaborate further, one notes that initiation of an information support system for energy planning is considered an integral component of the total national information system framework. Since the need for such an information support system is recognised, but no framework for its development has been put in place, the detailed study presented here could be an important step towards achieving the views expressed in the draft proposal. The succeeding chapters, therefore, present proposals and recommendations for the development of such an information support system.

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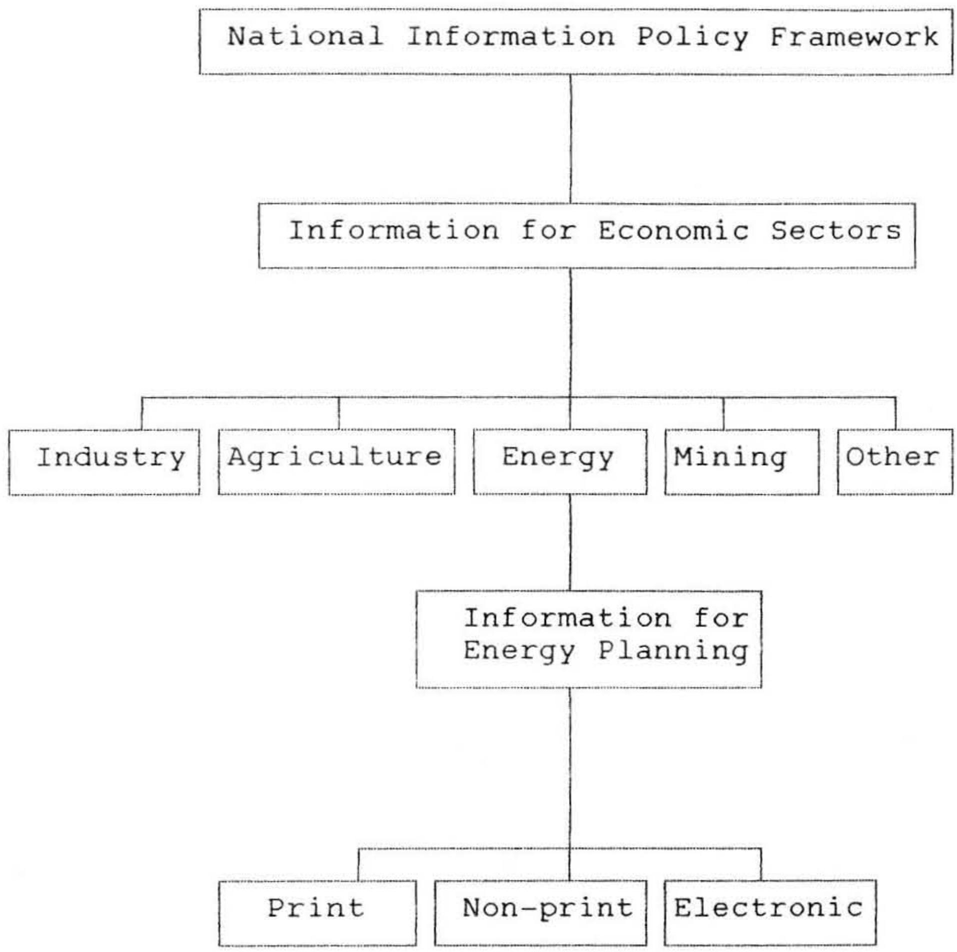
Figure 4: Energy Information Systems in the National Information Policy Framework



Source: Adapted from Zambia National Information Policy: a draft proposal, 1987

CHAPTER SIX

GENERAL SYSTEMS DESIGN

6.1 PROPOSED INFORMATION SUPPORT SYSTEM FOR ENERGY PLANNING IN ZAMBIA

6.1.1 General Overview

The situation presented in chapter 5 exemplifies the inadequacy of the information support for the sectoral energy planning functions in Zambia. This calls for the redesign and modification of the information support system for it to be strengthened so as to meet the requirements of the energy planners and decision makers. Such modifications must, however, take into account that the new information services and products must complement the existing information infrastructure at the Energy Planning Unit.

It was earlier observed that in responding to planning functions, there is need for critical selection of information since the authority structures of any planning process have to adapt to the dynamism and time constraints of such a process. This means the information support system must also respond to this challenge if the users have to appreciate its role in the execution of their various tasks. Admittedly, this can be realised through the application of Information Technology (IT), more especially computer technology in information processing, management and dissemination.

The information support system proposed in this study considers this as a critical factor. The design of various databases will help to overcome the inadequacies in the present system and enable the provision of reliable and comprehensive information support to the energy planners and decision makers. The following databases are proposed in the light of the above:-

1. Object-oriented or mission-oriented

2. Referral databases

- Bibliographic
- Institutional profiles
- Expert profiles
- Project profiles
- Information systems profiles

The importance of these databases to the energy planning process is discussed in the following sections. For illustrative purposes, three referral databases i.e profiles of institutions, experts and information systems, and object-oriented databases are designed using Micro CDS/ISIS (outputs are shown in the appendix).

6.1.2 The Database Approach

It will be helpful to discuss the database approach prior to the actual description of the databases proposed in this study.

Data consists of conventional symbols that represent, describe or record real world objects; but data symbols are not the same as reality. In other words, a **name** may be used to identify a **person**. Data symbols can never be a complete representation of reality; they describe objects and events and their characteristics incompletely. Decisions about what to extract from reality and how to represent it using symbols should, therefore, reflect the needs and the views of the users of the system.

Data items are not stored as individual items; they are categorised and related to other data items already stored. The collection of all the relevant data about a single person, for example, constitutes a **record** and one data type (e.g. sex) in a record constitutes a **field** or **data item.** When two or more related records are put together, usually in the form of a table, it makes up a **file.** The collection of all related files constitute a **database.** In a more descriptive sense, a database is a mechanised, formally defined, centrally controlled collection of data (Olson and Davis 1985,502).

The database approach is made operational by a data base management system (DBMS), a software system which performs the functions of defining, creating, revising and controlling. It provides facilities for retrieving data, generating reports, revising data definitions, updating data, and building applications.

The database management system controls the interaction between the database and the application programs prepared by programmers; and between the database and non-programming or adhoc users. Accessing or updating items in the database is only done through the database management system.

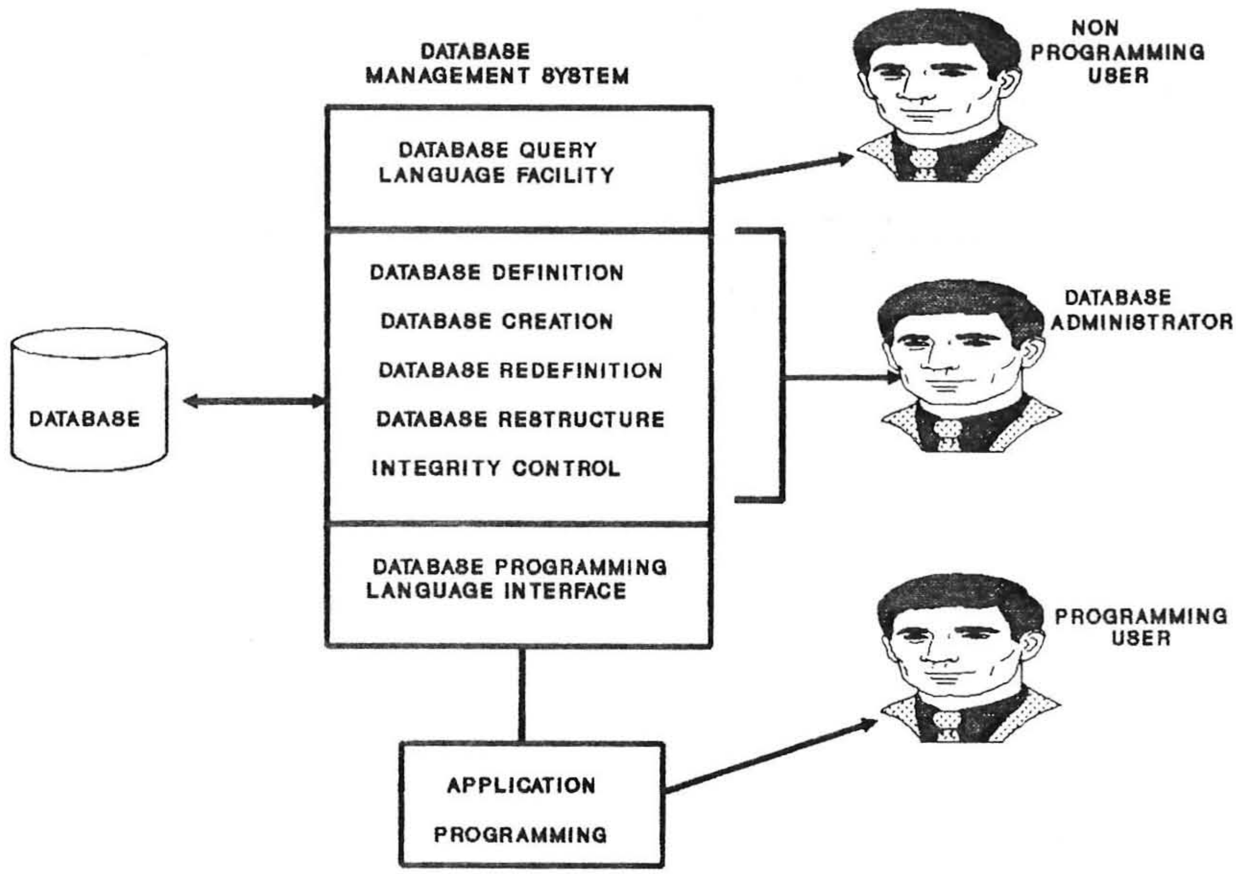
There are three classes of users who interact with the database management systems and there are languages and instruction procedures appropriate for each of them. Their description is given below.

1. The **non-programming user** does not write programs in order to use the database. Usually it is an analyst or the end users with special training. Such a user programs adhoc queries and reports using a database query language.

2. The **programming user** is usually an applications programmer who does the analysis and programming applications. Such a user uses special interface instructions to programm applications to access the database through the data management system. The instructions call the DBMS to request data, perform updates etc. The programming user can also use the database query language for special assignment.

3. The **database administrator (DBA)** uses special instructions and facilities of the data management system i.e a data definition language or DDL to define, create and redefine and restructure the database and implement integrity controls. Figure 5 gives an illustration.

Figure 6: CONCEPTUAL MODEL OF DATABASE MANAGEMENT SYSTEM



SOURCE: ADAPTED FROM DAVIS and OSLON, 1985.

As many different end users and a variety of application programs can access the database, it is desirable to have an organisational function to exercise control over the database i.e database administration carried out by a database administrator to maintain quality of data according to stipulated standards and ensure overall data security.

6.1.3 Objectives of the Database Approach

The data records are physically organised and stored so as to promote shareability, availability, evolvability and integrity. Everest (1984) identified the following objectives (Table IX).

Table IX: Objectives of Database Approach

Database objective	Description
Availability	Data should be available for use by applications both current and future and by queries
Shareability	Data items prepared by one application should be available to all applications or queries. No data items should be exclusively "owned" by an application
Evolvability	The database can evolve as application usage and query needs evolve

Data independence	The users of the database should be able to establish their views of data and its structure without regard to the actual physical storage of data
Data integrity	The database should establish a uniform high level of accuracy and consistency, validation rules being applied by the DBMS.

The objectives listed above underlie the advantages of adopting the database approach over the traditional file organisation in information storage and retrieval in that, space, maintenance and access time are optimised.

6.1.4 The Data Dictionary

A data dictionary is a repository of information about data. In some database systems, the stored definition of data (called schemas) provides all necessary data dictionary information; in others, the data dictionary is maintained supplementally.

Although, it is possible in a very small database to prepare a manual dictionary, the term normally refers to a dictionary maintained by a special data dictionary software (Davis and Olson, 1985).

The information in a data dictionary is about both types of data and uses of data. A complete data dictionary maintains information about data elements (Davis, 1983):

General

Name

Aliases or synonyms

Description

Format

Data type

Length

Usage Characteristics

Range of values

Frequency of use

Input and Output

Conditional values

Control Information

Source

Data origin

Users

Programs in which used

Change authorization

Access authorization

Group Information

Parent structure

Subsidiary structure

Repetitive structure

Physical location

Record

File

Database

For documentation of data elements for a system, a simulated data dictionary is used as illustration in this study. The information recorded for each data element is **name, description, aliases, format, security and location.** The **description** is used to maintain information about the meaning of data elements in the system. Some data may have more than one name and all the synonym words are recorded in the **aliases**. The **format,** on other hand, indicates the data type whether it is numeric or alphanumeric and also records its maximum length. For example, "9" is used for numeric and "X" for alphanumeric data type. To protect data from intentional or unintentional actions or cause of damage, only named persons are authorized to modify the data and this is indicated in **security.** The information maintained by **location** tells the user where the data is available such as in a file or database in the system so that duplicate data are not maintained. Figure 6 shows a simulated data dictionary.

Figure 6: Simulated Data Dictionary

Name:
Description:
Aliases:
Format:
Security:
Location:

In the proposed design in the following sections, a detailed data dictionary is not given but an illustration is given below.

Figure 7: Data Dictionary for ENECO database

Name: Coal Consumption

Description: Type of energy as consumed by sectors of economy and social groups in the country

Aliases: Energy consumption, Energy demand, Energy distribution

Format: "X" (Alphanumeric)

Security: Information Specialist

Location: ENECO Database

6.1.5 Data Models

An important step in the database design is to construct data models that represent the logical structure of the database to be created. It is usually necessary to understand the structure of the data items as they relate to the organisation's activities and data users. A data model is an abstract representation of data one wishes to collect or has collected. The model can use a variety of representations. Examples include graphs, mathematical formulas, and tables. The objective is to represent the essential element of the data without detail (Olson and Davis 1985,97).

There are three major classes of data model-conceptual data models, logical data models and physical data models. These classes reflect the fact that efficient physical storage and retrieval of data must be designed around physical characteristics of storage media and devices; but users of data should be able to describe, think about, and use data without being concerned about its physical storage.

The user-oriented ways of describing and understanding data are called **conceptual and logical data models** or **users views**; and the models that describe physical storage of data are **physical data models** or **physical views**. These data models indicate an ideal separation of how data is used and from how data is stored and accessed (Olson and Davis 1985,97).

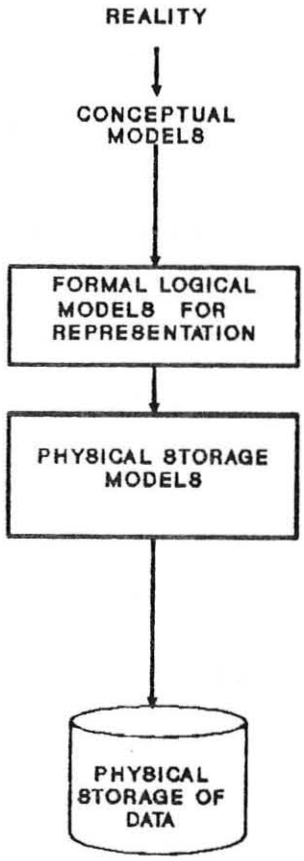
Ideally changes in storage technology should be possible without affecting applications using data; changes in the logical data model should also be allowed without affecting physical storage. This separation is called **data independence.**

The logical data model helps users, analysts and designers to specify data requirements and relationships among data items. The logical model is also conceptual in that it "mirrors" the way users of data describe reality. The users and analyst is responsible for defining logical data requirements; the developer of the database system is responsible for defining the physical storage of data in such a way that the logical requirements can be met. The design of databases, therefore takes the following order or steps:

- **Conceptual model;**
- **Logical model;** and
- **Physical model.**

Our major concern in the study is the building of the conceptual and logical models. The physical model will be implemented by the DBMS package used.
An illustration is given in Figure 8.

FIGURE 8: STEPS IN DATABASE DESIGN



A description of the three phases is given in Table X.

Table X: The Three Phases of Database Design.

Phase	Description
Requirement determination	Determination of the data requirements (views) of individual user and application
Conceptual(logical)	Integration of the design and application views into an overall conceptual view that resolves view conflicts. There are two parts to this phase: an unconstrained or natural conceptual design and a constrained design for a particular DBMS
Physical design	Translating the conceptual design into physical storage structure

There are three different types of data models. The three main ones widely used are hierarchical, network and relational models. Most commercially available DBMS are designed based on these models. In the design of the databases in this study, the relational model has been used largely because of the advantages discussed in the following sections.

It is, however, appropriate to clarify three major concepts that would appear frequently in our discussions:

- **Entity;**
- **Attribute, and**
- **Relationship**

6.1.5.1 Entities

Entities are a set of objects that share one or more attributes in common amongst themselves and about which an organisation or individual may be interested in collecting descriptive data for use. The descriptive data about the entity is termed as **attributive data.** In our study, for example the energy planning unit may collect descriptive data about the energy entity on such aspects as energy consumption, energy demand, energy end-uses etc. A group of similar entities form an **entity set.** For example, all energy sources form an entity set. Similarly, all towns, all houses, all persons etc. are entity sets. A database design requires identification of all the organisations' entities, since it enables one to incorporate all desirable data in a database. Besides, it is easier to identify relationships between entities rather between data. Consequently, in the database approach data is essentially considered as an entity in its own right.

6.1.5.2 Attributes

Entities are represented by their attributes. Attributes are characteristics that describe or characterise an entity. The values of the attributes describe a particular entity. A **value** is the specific data for the attribute of an entity. For example, the entity Addis Ababa can have as an attribute population and a specific value say two million.

Attributes have specific **domains** from which they take **values.** The domain for the attribute **sex** is **male** and **female.** Any entity in the entity set person has value of either male or female for the attribute sex. A value outside this domain is not acceptable for this attribute. Usually, domains are a set of numbers (e.g the domain for age) or string of characters or a combination.

There is also a distinction between the entity type and entity set. An entity type refers to the aggregation of an entity set. For example, from the attributes of person-name, sex, age, birth place etc, one may aggregate a new concept i.e population. Thus, the entity type is name and list of all attributes in the entity set. The entity type for the entity set **person** may be population (name, sex, age, ethnicity, religion, birth place).

6.1.5.3 Relationships

When the data model is designed, relations must be identified between entity types. A relationship is a "logical connection or dependency between occurrences of one entity type and the occurrences of another" (Downe, 1989). There are three types of relationships, among entities. These are recorded during the conceptual data modelling and they also affect physical database design. They include:

- **one-to-one**
- **one-to-many or many-to-one; and**
- **many-to-many relationships.**

One-to-one relationship gives rise to a flat file. The occurrences of one entity causes the occurrence of the other. The relationship between entity type **person** and **birth place** exemplifies this relation. A person can only have one birth place.

In a one-to-many relationship, the occurrence of one entity in the entity type causes the occurrence of zero, one or many entities in the other. For instance, the relationship between **birth place** and **persons** could be one-to-many in that many people can have one and the same birth place. The occurrence of one entity may cause the occurrence of zero, one or many entities in another and at the same time the occurrence of a single entity in the other also brings the same result in the former entity type. The relationship takes the form of many to many. For example, a book may be used by none, by one or by many. Some users may not use a book at all, or use one book or may use many books.

6.1.6 Hierarchical Model

A hierarchical model employs hierarchical or tree structure to represent the relationships among entities. A record may have multiple records subordinate to it, which in turn may have multiple records subordinate to each of them. Put in another way, multiple records of a particular type "belongs to" (are subordinate to) a single record of another type higher in the hierarchy. "Parent" records can have several "children" records, but a "child" can only have one "parent." Figure 9 shows a simple schematic of a hierarchical tree structure.

Figure 9.

COURSE RECORD

Course	Section	Teacher	Room
INST 690	1	Neelameghan	2A

STUDENT RECORD

Student ID #	Name	Major
002/92	Trywell	Info.Sci.
002/92	Dick	Lib.Sci.
002/92	James	Comp. Sci.

Many natural relationship among entities can be represented adequately in a hierarchical structure and processing efficiency is often high. However, there are some major disadvantages with the hierarchical structure:

Insertion: In the above illustration, a student cannot be added unless (or until) it is assigned to a course and then it is added to every course for which it is assigned.

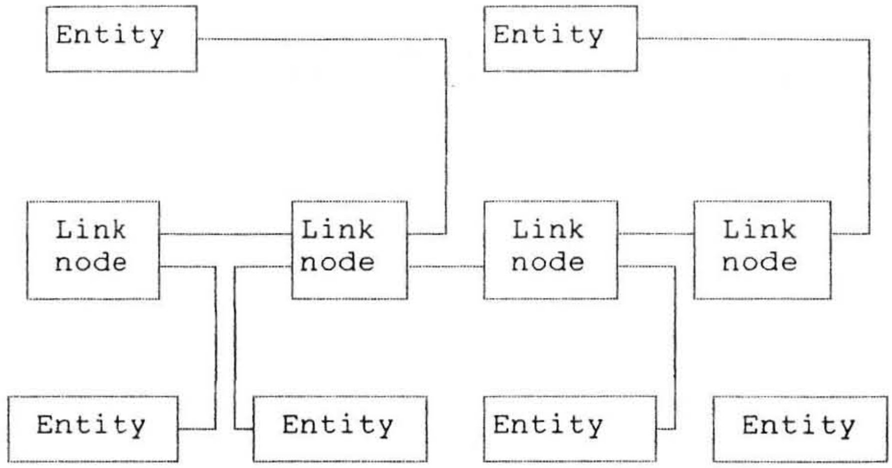
Deletion: If a student drops a course say in section 1; this can be handled by searching all subordinates to the course record for the occurrence of the course dropped. When the student record for this course is deleted, all the information about that student is deleted in the database.

Updating: If a student changes his course the entire database must be searched for every occurrence of the course to be updated, thus a hierarchical model maintains redundant data due to update inconsistencies.

6.1.7 Network Data Model

Some of the problems cited in the hierarchical model can be avoided in a network model. A hierarchical structure has one superior record for one or more subordinates, while a network structure allows a given entity to have any number of superiors as well as subordinates. A common approach is multiple pointers, usually with a link node record representing the connection between the two entities as shown in Figure 10.

Figure 10: Simple schematic view of a Network model.



Advantages of the network model over the hierarchical model include:

Insertion: In the example cited, a student record can be added without requiring it to be assigned to a course. The link may be added later.

Deletion: If a student drops a course, a simple readjustment of the pointer chains is required. No other information about the student is affected.

Updating: If a student changes his course, the change can easily be done without introducing update inconsistencies since the information about his course is located in one place.

Although many problems inherent in a hierarchical structure do not exist with a network data model, a major disadvantage is its complexity. One need to have explicit knowledge of the relationship represented, including how links are physically represented, for efficient use of the network.

6.1.8 Relational Data Model

The relational model is relatively new compared to the hierarchical and network models. It was first developed by Edgar F. Codd of IBM in 1970.

A relational structure consists of a set of tables. In each table, the rows called **tuples** represent unique entities or records and columns represent attributes. Each table is a relation and so a relational database can be thought of as a collection of tables. Relationships are represented by common data value in different relation (tables). Relational data structures are based on a formal theory of relational algebra which uses very specific terms to refer to other concepts underlying the structure. Details of the relational system is beyond the scope of this study. An illustration is given in Figure 11.

Figure 11

Table 1: COURSE-SECTION

Course no.	Section	Teacher	Room
INST 690	1	Neelameghan	2A
INST 663	2	Tesfaye	2B

Table 2

STUDENT

Student ID	Name	Major
001/92	Trywell	Info.Science
002/92	Dick	Lib. Science
003/92	James	Comp.Science

There are two sets of relations. The COURSE-SECTION table contains value of attributes pertaining only to courses and section: Teacher, Room. The first two columns (attributes), COURSE NUMBER and SECTION, uniquely identify each row in the table; they can, therefore, be thought of as the key for this relation. The STUDENT relation (Table 2) has as its key the first column, STUDENT ID#, which is also unique to each row. The attributes in Table 2 refer only to students.

In processing tables there three fundamental operations:

Projection: Select specified columns from a table to create a new table.

Selection: Create a new table by selecting rows that satisfy given conditions.

Join: Create a new table from the rows in two tables that have attributes satisfying a condition.

Advantages of relational model over the other models:

(a) the relational database does not require to establish paths between entity sets. Relationships between entity types are established by replicating attributes in different relations. In a relational database, relationship is established at the time of retrieval. As a result, a new relationship can be established without the need to reorganise the database. On the contrary, in a hierarchical and a network database, new relationships require reorganisation of the database, hence are not user-friendly.

(b) Since links are not established in the relational database, the relational database requires less space for the same data stored in the hierarchical or network database. In the latter two, database links occupy more storage space than the actual data required.

(c) The relational database has its base in mathematical set theory. Thus, the concepts of relational data model such as the relation are provable.

(d) Techniques, such as, normalisation used in the relational database model are the same for the design of a small or large database.

The main problem of relational database is slower retrieval of data/records.

6.2 DESIGN OF PROTOTYPE DATABASES

6.2.1 Object-oriented databases (OODBs)

6.2.1.1 General Considerations

It has been argued in this thesis that the energy planning process needs the critical selection of information if the requirements of this dynamic process are to be met. It has also been made clear that our target users are mainly energy planners and decision makers. In order to strengthen the information system at the energy planning unit, it is also important to consider the activity of information analysis and consolidation (IA+C) in the redesign of information systems by way of developing object-oriented databases (OODBs).

The design of these databases is based on the view that in planning and decision making, value/quality of information in relation to the users' needs progressively increases with the selection of relevant information that reduce information overload in terms of quantity since the process of planning and decision making is time-bound. Information from various sources, documentary and non-documentary, including people i.e experts, consultants, should be analyzed, consolidated and repackaged to respond to users' needs (See Figure 12).

The rationale behind object-oriented databases is that they arise out of IA+C and thus provide all types of value-added information products and services. An information service providing repackaged text in the energy planning process can be a time saver; a selective and systematic sorter of useful information; a means for more extensive information transmission and delivery; a translation tool; an opportunity for practical application of research results; and a means for the delivery of relevant information (Neelameghan, 1992).

consumption will be different from those for energy demand database.

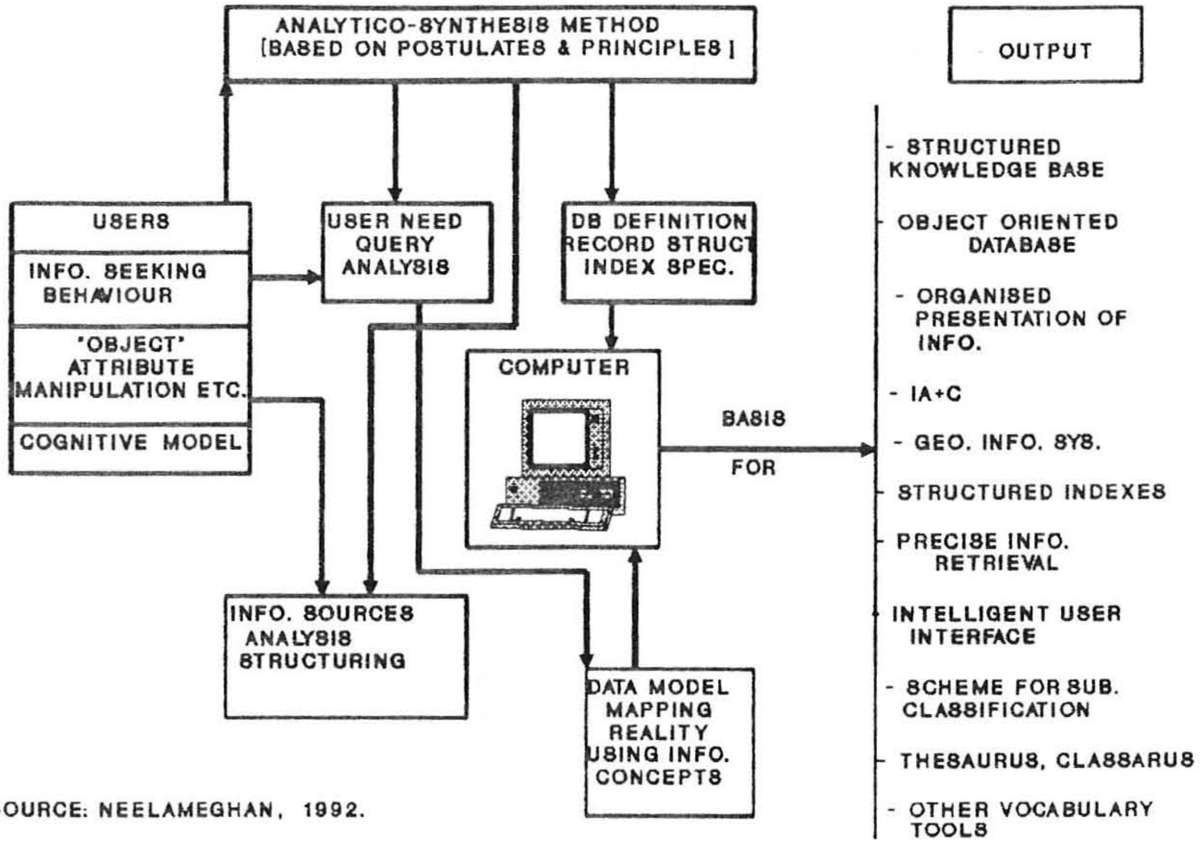
Sources of information for input to most of the fields in the bibliographic record is mainly the document to be catalogued. On the other hand, for a record in a non-bibliographic OODB, the input data may be obtained from different sources including remarks from individuals, even for a single field, and the data may already be in an analyzed, evaluated, and organised form.

OODBs attempt to give information/data themselves rather than just reference to other sources unlike the bibliographic and referral databases. The output from bibliographic databases follow a standardised format (e.g. AACR2 format). In specialized OODB, end-users may be provided with different types of output formats on the basis on their specific needs.

The information provided by specialised OODBs is mostly of local interest and use (e.g a database on energy consumption by sector) and may not be sourced in abstracting services at national and international levels. Such OODBs are usually home grown at institutional or specialised geographical level (Neelameghan, 1992).

Figure 13 illustrates the application of analytico-synthetic facet approach in the design of OODBs.

Figure 13: OODB DESIGN PROCESS



SOURCE: NEELAMEGHAN, 1992.

6.2.1.2 Design of OODBs for Energy Planners and Decision Makers in Zambia.

The energy planning process in Zambia is diverse and covers a wide range of activities and multiple audiences as indicated in Chapters 4 and 5. The type of data and information must be selected, analyzed, consolidated and repackaged for effective and convenient use by the different user groups concerned. As earlier noted, this calls for the close interaction and collaboration between the information system designer (information specialist-IS) and the users of the information system i.e. energy planners (EP) and decision makers.

Neelameghan (1992) observed the same when he identified the points on which such interaction will be helpful. They include among others:

- determining the data and subject content of the database (EP and IS);
- determining the content of the records in the files (EP and IS);
- identification of data/information source collection and provision of input data (EP and IS);
- data rating (EP-see also section 6.2.1.7 for parameters which can be used for data rating);
- designing display and output formats (IS);

- designing of the information storage, organisation, indexing, retrieval and dissemination components of the system (EP and IS);
- information analysis, consolidation and repackaging (EP and IS);
- input preparations and operations and services (EP and IS);
- on-line use of the system (EP and IS as intermediary when neccesary);
- feed back, updating and modifying the system (EP and IS).

The interviews and on-site observations (Chapter 5) enabled a close interaction with the energy planners at the energy planning unit in Zambia. The systems analysis undertaken also helped in input specifications, rating of data in terms of quality of information and determine the specifications for the output formats desired.

It is important to note that the design of the OODBs for energy planners like any database design, must be approached from the broader view of information needs (as obtained from the survey) for the energy planning process. As earlier observed, this is based on the principle of building a conceptual and logical model as separated from the physical model taken care of by the DBMS.

6.2.1.3 Conceptual Framework for Data Structuring

It is helpful to draw a reference framework for data structuring. In order to determine the data elements in each of the OODBs proposed in this study, a model or reference framework according to the energy planning programme explained in Chapter 4 was conceptually analyzed into phases, subtasks and activities and the data needed identified for each of them. Chapter 5 gives details of the areas the energy planners and decision makers were interested in and the type of data to be collected. Such analysis was helpful in selecting, extracting pertinent and precise information and data from various sources, and repackaging into appropriate bodies of knowledge for convenient use by the different users at different stages in the energy planning process. Building such a model for nation's energy resource planning in Zambia should indicate the available sources of energy, the portions imported, how the energy is transported, converted, distributed and utilised including exports etc.

Detailed information and data on each of the factors mentioned in Chapter 5 (users requirement analysis section 5.6.2) were categorised. Accordingly, the information and data types identified were categorised by geographical area (e.g state, province, district etc) or classified by end-use (e.g. industry, agriculture, etc.) or by the stage in the energy planning process (e.g energy generation, transport, conversion etc.) in order to specify the boundaries and come up with relevant attributes and data elements to be included in the database.

Another categorization used for the data and information identified was by current situation, forecast, policy issues, operational experience, and impact evaluation within the purview of the energy planning programme. An illustration of the reference framework adopted in the form of a relational table is given in Figure 14.

Figure 14: Relational table for data structuring

Issue/Factor	Current situation	Forecast	Policy issues	Opera tional experi.	Eva lu tion
End-uses of energy	A				
Energy consumption					
Energy supply					
Energy balance					
Energy demand		B			
Energy pricing					E
Energy flow					
Socio-economic data					
Energy research			C		
Information on environ-mental aspects			D		

Source: Adapted from Neelameghan, 1992.

A box formed by a cross section from the relational table of an issue or factor and an aspect represents a specific area of interest of the energy planners and decision makers. For example:

* Box A: Current status on end uses of energy
* Box B: Forecast on energy demand
* Box C: Policy issues on energy research and development
* Box D: Policy issues on enviromental aspects
* Box E: Impact of energy pricing

For illustrative purposes, three prototype OODBs are designed using Micro CDS\ISIS DBMS package version 3.0. The Field Definition Table (FDT) was created from the above analytical framework which helped in determining the fields and the subfields and the concepts to be indexed and arrangement of data in the output of the databases. The issues were used as fields and the aspects and spatial divisions as descriptors (the FDT and the display format and sample outputs are given in the appendix). The three prototype databases designed in this study are:

- **ENECO**;
- **ZENE** and
- **SECTO**.

ENECO database is meant to allow energy planners have trend reports on the consumption patterns of the various categories of energy mainly utilised in Zambia such as coal, petroleum, electricity, non-conventional energy sources including woodfuels.

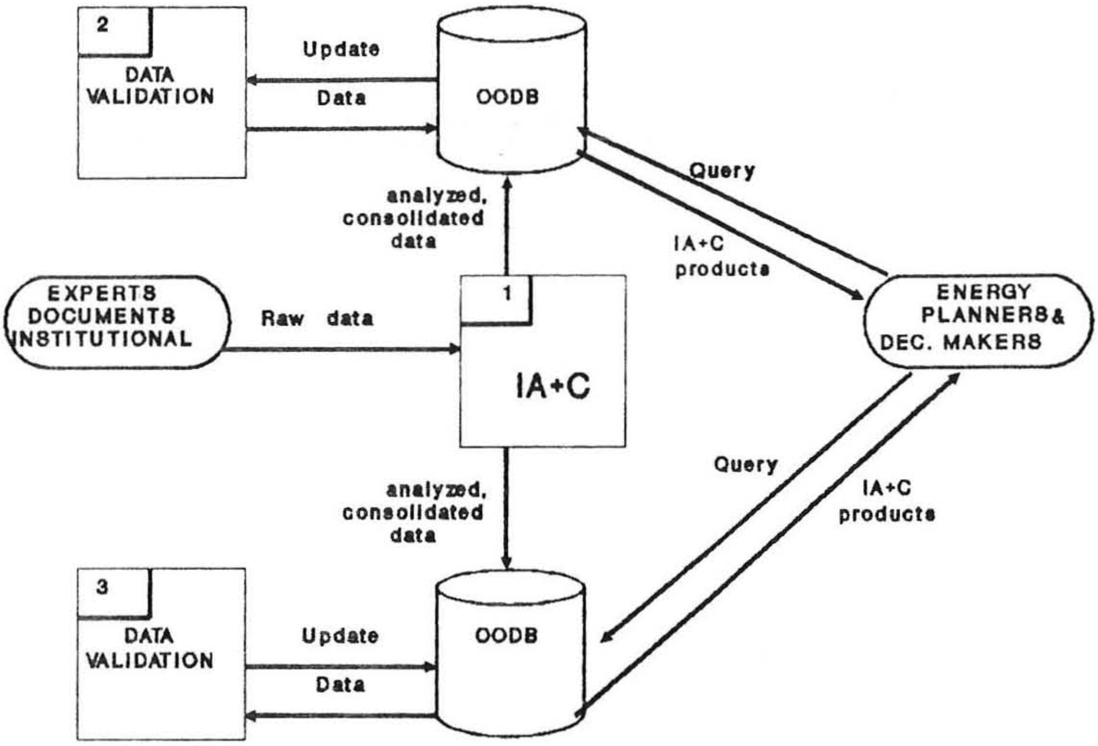
ZENE mainly focuses on the new forms of energy in Zambia and draws experiences from developing countries as well. It also focuses on some trends in energy policies, current situation, forecasts, experiences including impacts of renewable energy sources indicating market trends, technological developments and other projections.

SECTO is a prototype database whose output is in tabular form and shows the consumption patterns of the different types of energy as consumed by various sectors in the national economy in Zambia over stipulated periods of time.

6.2.1.4 Logical Design

Design of the proposed OODBs is logically illustrated by use of a data flow diagram (Figure 15).

Figure 15: DATAFLOW DIAGRAM FOR ENERGY OODBS



6.2.1.5 Input Specifications

Sources of data of the OODBs designed are mainly the institutional, human (experts) and documentary sources of information on energy in the Energy Planning Unit and institutions related to it in the energy sector and outside the sector.

Among documentary sources identified and used include:

- The Energy Statistics Bulletin (1974-1990)
- Indeni Petroleum Refinery Reports
- British Petroleum (Z) Ltd Sales Office (Lusaka) Reports
- ZESCO Reports
- Meteorological Department Reports
- Central Statistics Office (Lusaka) bulletins
- NCSR Reports
- Maamba Collieries Reports
- ZIMOIL Reports
- World Directory of Energy for Africa, Asia and Pacific etc.

6.2.1.6 Output Formats

Various hard copy (printed formats) and on-line outputs may be produced as shown in the samples in the appendix. In the relational table used for illustration in Figure 14, each of the domain marked by letters A,B,C,D or E and which indicate the areas of interest of energy planners and decision makers can be used for provision of information services such as SDI which are not presently offered at the Energy Planning Unit as the survey revealed.

6.2.1.7 Database Maintenance: Quality Assurance Considerations

The survey undertaken revealed the lack of quality assurance pointed out in Chapter 5. It is proposed, therefore, that quality assurance be considered for maintenance of the OODBs vis-a-vis quality of data.

Indiscriminate collection and accumulation of data and information can be wasteful in the long run. Uptodateness, reliability, relevance and timely availability of information are thus important considerations. Even if the best data are not always available, it is necessary to be aware of the attributes of data being input in the system and to use practical methods of filtering out useless data from time to time. Such filtering can be done by assigning relevant parameters for data rating. This is not a one-time exercise, say at the time of selecting data for input only. User needs change; data usefulness too changes. Hence, there should be a planned updating process so as to maintain the database as a whole at optimal level of usefulness.

The following are some examples of the type of parameters which can be used in data rating:

1. Type of data or information collected (whether it is for research, planning, administrative purpose, etc.)

2. Range of the users' interests (whether limited to the originating unit, useful to other units or related fields etc.)

3. Time-frame of use or usefulness (Wheather it is immediate, near future e.g. 1 to 5 years, distant future e.g. 6 to 20, or may not be prdictable.

4. Approximate periodicity of use of the system (per day, week, months, quarterly, rarely or irregularly)

5. End use (e.g. decision making, forecasting, resource allocation, reporting/disemination, SDI, query-answering, etc.)

6. Exhaustiveness of information (items and the period), such as, the necessary coverage, minimum coverage, etc.

7. Coverage of information (e.g.current, past data etc.)

8. Period of validity of data (whether the information valid until next notification, limited in validity, etc.)

9. Accuracy of the information (whether the information is precise, accurate within limits, etc.)

10. Security (whether the information is strictly confidential, accessible to some persons only, open for general use etc.)

11. Barriers (whether there are any barriers or restrictions to information access etc.)

12. Mode of disemination (such as SDI, on request, statistical outputs etc.)

6.2.2 Referral Databases

It is also important to discuss the relevancy of the various referral databases in the energy planning process before the detailed design is spelt out.

6.2.2.1 Bibliographic Database

Such a database is developed with the help of standard bibliographic tools such as AACR2 codes or manuals, ISBD and CCF formats in order to allow for standardization in terms of storage and retrieval and more importantly information exchange. The items recorded are bibliographic descriptions of documentary sources of information; the descriptive elements such as, name of the author, title of the named document etc., conforming to the prescriptions of widely accepted cataloging codes e.g. AACR2, ISBD etc.

Our emphasis is on the information resources on energy. Since the existing information system does not have backup services such as a documentation centre or library service, a bibliographic database would refer the energy planners and decision makers to documentary sources existing in other information systems in the country. National union catalogues of serials (especially has relied on external experts in the execution and management of most energy projects. The referral database of experts will facilitate more productive use of the national expertise and consequently alleviate the dependency on foreign expertise to some extent. The database will indicate the number of experts available in different subject fields related to energy, their areas of interest or specialisation and the institutions they are attached. This would help them make gainful and optimal decisions regarding which experts to utilise on the energy programmes and projects. It also has an implication to the education and development of experts in the energy related subjects.

6.2.2.3 Profiles of Projects

Profiles of projects would help energy planners and decision makers know the ongoing projects, determine their costs and evaluate them in light of the feasibility of implementing them. This would then help them weigh the national development priorities against the ongoing project foci and this will be a basis for making decisions and policy.

In Zambia, like in other developing countries, most of the projects are and have be carried out with little relevancy to the prevailing local needs. Such a profile would, therefore, help change this situation. Furthermore, since ongoing projects would be known, duplication and wastage of scarce resources will be minimised and then such resources would be targeted to other priority areas in the national economy. The database will also indicate who is working on what projects and the allocation of resources.

6.2.2.4 Profiles of Institutions

To enhance the information support system for energy planning in Zambia, a database of profiles of institutions will be useful. Energy planners and decision maker may want to know which institutions are involved in which type of energy. In Zambia, as mentioned Chapter 2, various institutions are assigned from time to time, the responsibility of harnessing, distribution, researching, expanding and developing different types of energy sources. For planning purposes, the statistics on the management, distribution and use of these energy sources from these institutions is important and helpful in developing forecasts and models in the energy flow patterns. This will in turn aid in the allocation of resources to priority areas in the energy sector in terms of production, import and export differentials etc of these energy sources in the country. In this regard, profiles of institutions will show which of these institutions are and help the energy planners and decision makers get the information desired from time to time.

6.2.2.5 Profiles of Information Systems

It has also been indicated that the information system at the energy planning unit depends on secondary data from the institutions in the energy sector and those related to it. Information systems in these institutions are a repository of the data and information generated. A profile of these information systems would strengthen the existing information system at the energy planning unit and consequently, benefit the potential users (i.e energy planners and decision makers).

6.3 DETAILED DESIGN OF PROTOTYPE REFERRAL DATABASES

6.3.1 Input Specifications

In the design of prototype referral databases, ABNCD+ was used. ABNCD is an integrated database developed using UNESCO's Micro CDS/ISIS and Pascal interfaces (1990). Essentially, integration enables the provision of a wider range of information to users and a more efficient use of computer resources.

The ABNCD+ system has three main databases:

1. ABNCD consisting of bibliographic records, profile of institutions, information systems, projects and experts.

The type of the documents included in the bibliographic records of ABNCD include:

- Monographs and collections:books, reports, thesis, conference proceedings etc.
- Part of monograph (analytic/monograph)
- Serial (whole)
- Part of serial (analytic/serial e.g article in the periodical publications)
- Non-book materials such as audio-visual and video cassettes, microforms etc can be catalogued.

2. THES, a thesaurus (e.g Macrothesaurus of OECD)

3. SLRS, a union catalogue of serials. CDS/ISIS PASCAL programs interface the databases.

6.3.2 Database Specifications

As pointed out earlier, although all the referral databases explained are recommended; only three prototype databases are designed (i.e profiles of institutions, information systems and experts). The field definition table (FDT) for ABNCD given the appendix is used as basis for the design of these referral databases.

6.3.3 Database Controls

To ensure that the proposed system performs well and is protected from misuse, the following organisational and procedural control and security should be put in place.

6.3.3.1 Administrative Controls

There is need for qualified personnel for the data base management and overall supervision of the system. These controls include contingent plans for use in the event of a system failure or damage including a backup system for all the files.

6.3.3.2 Input Controls

The input forms used (see appendix for the questionnaires) are used to capture the required data. Each data element should be recorded where it is appropriate to ensure input integrity.

6.3.3.3 Programming Control

Verification of input data is done by the system which checks the corrections and completeness of the data.

6.3.3.4 Data Security

Only authorised personnel will be inputting data. Authorization will be effected through the use of passwords for inputting and updating the data.

6.3.3.5 Output formats

Printed versions of the information products and services and outputs via the terminal screen or copied to diskettes will be generated to suit user requirements from time to time.

6.4 SEARCHES IN THE DATABASES

An advanced search facility-SISA (System Interface Search Assistant), which is a pascal program designed to enhance the user-friendliness of Micro CD\ISIS is used to search the databases designed. SISA lists the databases and allows multiple database search concurrently. It has also on-line help for search language of Micro CD\ISIS and a search facility using a thesaurus.

6.5 USERS-INTERFACE FACILITY

User-system interface is an important aspect of information storage and retrieval. Different types of interface to help users to interact with the information retrieval system may be designed. In the present work, a thesaurus-like assistance facility has been designed to enhance and facilitate retrieval.

One advantage when such a thesaurus is used for searching as vocabulary control is that it helps the users to cope with the problems of semantic and contextual ambiguity (e.g. homographs and false drops) and synonyms. The generic searches are also simplified since the thesaurus shows the user narrow and broader terms to the starting search term. It also points to the other concepts related to the topic of search.

6.5.1 Thesaurus-Like Search Assistance Facility

A thesaurus-like search facility has been provided to facilitate navigating and browsing into the subject areas into which the OODBs has been divided. It is also possible to search in the subdivisions of information in the referral databases. Searching in the databases is made possible by matching the key terms in the subject divisions with the terms present in the thesaurus using the MTHES facility.

The MTHES pascal program, a modified version of the THES program, has been used to develop the interface in this present work. This pascal interface, suggests in the first screen, (1) to the users who wishes to get an overview of the major division of the subjects/object energy as adopted in the system to key in the term "ENERGY" in the lower or upper case. To this the system will respond with the display of broad categories of the fields into which information on energy is divided or alternatively, (2) the user may key in any term representing his/her interest/need at the moment. The message screen is shown below.

ASSISTED SEARCH FACILITY

A USER INTERFACE SYSTEM FOR ENERGY PLANNING AND RELATED AREAS

1. When you press any key a blank space will be displayed and you will be asked to enter a search term in the rectangular box. Type in the term ENERGY in lower or upper case. A list of the areas into which energy planning information has been divided will be displayed. To position the cursor at the desired term, press the <ENTER> key as many times as required, e.g. "ENERGY DEMAND" and press S key to select the term. Divisions and concepts related to Energy Demand will be displayed. Move the cursor to the desired term and press S key to select the term. Note the options at the bottom of the screen for formulating search queries.

2. You may also key-in the term (or a stem of it) representing your interest and press <ENTER> key; a list of terms beginning with the string you have keyed-in will be displayed. You may move the cursor to the desired term and press S key to select. Then proceed as mentioned at 1.

Press any key

ASSISTED SEARCH FACILITY

A USER INTERFACE SYSTEM FOR ENERGY PLANNING AND RELATED AREAS

1. When you press any key a blank space will be displayed and you will be asked to enter a search term in the rectangular box. Type in the term ENERGY in lower or upper case. A list of the areas into which energy planning information has been divided will be displayed. To position the cursor at the desired term, press the <ENTER> key as many times as required, e.g. "ENERGY DEMAND" and press S key to select the term. Divisions and concepts related to Energy Demand will be displayed. Move the cursor to the desired term and press S key to select the term. Note the options at the bottom of the screen for formulating search queries.

2. You may also key-in the term (or a stem of it) representing your interest and press <ENTER> key; a list of terms beginning with the string you have keyed-in will be displayed. You may move the cursor to the desired term and press S key to select. Then proceed as mentioned at 1.

Press any key

When the user presses any key, the system displays a blank screen with an empty box where he/she may enter the term of interest say "ENERGY" as indicated in the preceding sections. Entering the term "ENERGY" in the empty box will display the following.

Select term

```
ENERGY

     ENERGY
NT   ENERGY CONSUMPTION
NT   ENERGY DEMAND
NT   ENERGY ECONOMICS
NT   ENERGY PLANNING
NT   ENERGY POLICY
NT   ENERGY RESOURCES
NT   ENERGY SOURCES
NT   ENERGY STATISTICS
NT   ENERGY SUPPLY
RT   OECD IEA

[SpB] Next [B]ack [F]irst [P]age  [S]elect [T]erm select[M]ake file
add te[R]m(file) [C]reate term   [A]dd relation [D]elete
[Q]uery sa[V]e [?]display  Query/saVe Search[/]Add e[X]it
```

Moving the cursor further in the displayed list of terms to the term "ENERGY DEMAND", for example, and selecting it by pressing the **'S'** key, will display the following.

If the user is interested in the related concept, "ENERGY CONSUMPTION" in the list displayed, he/she may move the cursor to the term "ENERGY CONSUMPTION", and select it by pressing the **'S'** key which will display the following.

MFN 4

ENERGY CONSUMPTION

```
     ENERGY CONSUMPTION
UF   POWER CONSUMPTION
BT   ENERGY
BT   CONSUMPTION
RT   END-USE EFFICIENCY
RT   ENERGY BALANCE
RT   ENERGY CONSERVATION
RT   ENERGY DEMAND
RT   ENERGY ECONOMICS
RT   ENERGY MIX
RT   ENERGY STATISTICS
RT   ENERGY SUBSTITUTION
RT   ENERGY UTILIZATION
RT   POWER DISTRIBUTION
```

```
[SpB] Next [B]ack [F]irst [P]age  [S]elect [T]erm select[M]ake file
add te[R]m(file) [C]reate term   [A]dd relation [D]elete
[Q]uery sa[V]e [?]display  Query/saVe Search[/]Add e[X]it
```

Options at the bottom of the screen enables the user to select the term(s) of interest to prepare search expressions. Moving the cursor to the term(s) of interest, pressing 'Q', then selecting all the terms representing the information needed, and thereafter pressing 'X' will allow the system to get together all the selected terms in a search expression for a CDS/ISIS database(s). For example, the terms and/or the operators can edited, modified or changed (if necessary) before making the search by pressing the <ENTER> key.

The thesaurus-like search assistance contains terms/concepts selected from appropriate information categories needed for the purpose of energy planning explained in Chapter 5. These were organised in the form of a thesaurus with application of thesaurus construction or development techniques.

Options at the bottom of the screen enables the user to select the term(s) of interest to prepare search expressions. Moving the cursor to the term(s) of interest, pressing 'Q', then selecting all the terms representing the information needed, and thereafter pressing 'X' will allow the system to get together all the selected terms in a search expression for a CDS/ISIS database(s). For example, the terms and/or the operators can edited, modified or changed (if necessary) before making the search by pressing the <ENTER> key.

The thesaurus-like search assistance contains terms/concepts selected from appropriate information categories needed for the purpose of energy planning explained in Chapter 5. These were organised in the form of a thesaurus with application of thesaurus construction or development techniques.

CHAPTER SEVEN

CONCLUSIONS AND RECOMMENDATIONS

7.1 CONCLUSIONS

Energy planning in Zambia like any planning process is knowledge-based and information intensive and also varied. In order that energy planners and decision makers execute their various planning tasks effeciently and effectively, the need for a strong information support is crucial. The information required in such a process should have quality and value. It must, therefore, be precise, reliable, timely and adequate to meet the multiple audiences of the energy planning process. An information support system that processes data and provides information tailored to the needs of the different user groups should be considered as an integral part of the energy planning exercise.

At present the information services in the energy planning unit cannot respond to the energy planning programmes in Zambia as the study findings indicate.

Since the energy planning process is dynamic and constrained by various factors, such as, time, there is need for the provision of a wide range of services to support the planning function.

Application of information technology (IT), especially computer technology has been cited as one such important consideration and particularly the design of various referral and object-oriented databases as a necessary part of information infrastructure. It is expected that this would strengthen the information support for energy planning in Zambia. It, however, calls for a redesign and reorientation of some the existing information systems.

The poor performance of the existing information services for energy planners and decision makers is due at best in part to inadequately trained information professionals, low level IT appreciation on the part of energy planners and decision makers, low level application of information technology (IT), lack of co-ordination with the relevant institutions in the energy sector and those related to it, lack of a coherent information policy to direct information infrastructural development, inadequacies in data collection and input in the system, inhibiting organisational practices such as bureaucracy, etc.

7.2 RECOMMENDATIONS

In the light of the above, the following recommendations are preferred to alleviate the prevailing situation:

1. There is a need to redesign the information system. A detailed study such as the one carried out in this thesis is recommended as a basis for the modification of the existing information system if it has to be strengthened and be of value so that it can provide information that is timely, relevant, accurate, reliable and in desired usable forms.

2. The energy planning unit must attract qualified energy planners that have adequate experience and a wide background in computer applications if the whole energy planning exercise has to be productive.

3. The information specialist, must have further training and more qualified information personnel are needed in order to provide effective information services.

4. There is also an urgent need for closer collaboration between the information personnel and the end users (energy planners) if a better information service

provision has to be achieved. Energy programmes are complex and dynamic and therefore, user needs will change and evolve over time. A close interaction between information professionals and end users should be the basis for the provision of a comprehensive and wide range of information services.

5. The application of IT (especially computer technology) must be stepped up. More hardware and software must be acquired to alleviate the problem of low level computer technology in the planning unit. The acquisition of computer resources must reflect the future requirements such as networking and functional compatibility of the hardware and portability of the software.

6. Bureaucratic tendencies in the implementation of a redesigning of the system must be checked and changed in order for an alternative system proposed to be implemented at an early date on a full scale.

7. The national information policy must be redrafted to reflect the changing needs of the information world and to give guidance to a coherent development of an information infrastructure in the country, particularly the energy sector.

8. The information system at the Energy Planning Unit should also consider linking all the microcomputers in the Energy Planning Unit through a Local Area Network (LAN) in order to share the scarce computer resources.

9. In order that the information system at the Energy Planning Unit is strengthened, the information system in the identified institutions must be effective as well. There is, therefore, a need for co-ordination in terms of data exchange through networking arrangements. Since most information specialists in the selected institutions expressed the desire for such a network even though their experience of IT applications and skills are low, a mutually compatible manual and automated information exchange is proposed.

7.2.1 Proposed ZAENET

ZAENET is the acronym for Zambia Energy Network. The information systems in the energy sector and those related to it should collect, process and organise information resources in a convenient and usable manner. Co-ordination of diverse contributions is, therefore, vital. Resource sharing calls for the application of standards and norms so that information exchange can be facilitated. The co-ordination in network like structure should be arranged in different ways as deemed appropriate to optimize the whole system.

7.2.2 Basic Principles of the Proposed Network

- The network must be built on a decentralised basis. This is because centralisation of information in a single entity and the prevailing bureaucratic organisational practice may hinder the quality of services. Hence, independent nodes each of which serving energy planning and development in Zambia should be strengthened.

- To co-ordinate the contribution of each node in the network, an information coordinating body for the energy sector should be established to manage the network, preferably in the Energy Planning Unit.

- Each organisation (node) should have autonomy to set up its structure and operations to satisfy its own user community within the framework and guidelines of the network. The guidelines should be prepared by a ZAENET Working Group composed of representatives of the network drawn from the energy sector and those related to it.

- The network should conform to international agreed upon norms and standards and practices of information handling such as CCF for bibliographic records, common vocabulary control tools, etc.

- It should also be organised within the national information policy framework in Zambia and should co-ordinate with regional alliances such as PADIS etc to share experiences and expertise etc.

- It must be built on legislative basis to which every participating node should conform.

- The subsystems of the network should be preferably the institutions identified in the study and other relevant ones. These will cover information relevant to the energy sector and particulary relevant to energy planning. For example:

* Information on electricity supply and distribution-ZESCO
* Information on wind and solar energy- Meteorological Department
* Information on Petroleum-ZIMOIL
* Information on Coal management and exploitation-Maamba Collieries etc.

Information services among the participating members in the network would include:

- Database construction e.g. bibliographic and other referral databases according to internationally stipulated norms and standards and record format guidelines;

- Retrospective searches e.g on CD-ROM databases;

- Organising and supporting continuous training of information experts;

- Mounting of user sensitisation programmes and;

- Introduction and development of standards in information systems towards harmonization of data exchange e.g adoption of common standards.

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ANNEX 1

OUTPUTS OF SAMPLE RECORDS

FROM

SECTO DATABASE

....

Field Definition Table (FDT) Data Base: SECTO

?	Tag	Name	Len	Typ	Rep	Delimiters/Pattern
	10	Sources	50	X	R	
	15	Year	10	N		
	20	Conversions	10	X		
	30	Agriculture & Forestry	50	X		abcde
	40	Industry & Commerce	100	X		abcde
	50	Mining	100	X		abcde
	60	Transport	100	X		abcde
	70	Household	100	X		abcde
	80	Govt.	100	X		abcde
	90	Total	100	X		abcde
	91	Notes	500	X		

A - Insert (after)	B - Insert (before)	C - Change line	D - Delete line
P - Previous page	N - Next page	T - Top	E - Bottom
		X - Exit	┘ - Next line

Data Base Name: SECTO Format name: SECTO

```
'SECTORAL ENERGY CONSUMPTION PATTERN IN ZAMBIA (000TOE)'/#'SOURCES:'(c10,v10^a(2
5,24)/)/#'CONVERSION:'v20/#'YEAR:'v15/#'TYPE OF ENERGY',c20,'PETROLEUM',c32,'ELE
CTRICITY'c47,'COAL',c53,'WOODFUELS',c66,'TOTAL'/#'AGRIC & FORESTRY:',c23,f(val(v
30^a),6,2),c34,f(val(v30^b),6,2),c46,f(val(v30^c),6,2),c54,f(val(v30^d),6,2),c66
,f(rsum(v30),6,2)/#'INDUSTRY:',c23,f(val(v40^a),6,2),c34,f(val(v40^b),6,2),c46,f
(val(v40^c),6,2),c54,f(val(v40^d),6,2),c66,f(rsum(v40),6,2)/#'MINING:',c23,f(val
(v50^a),6,2),c34,f(val(v50^b),6,2),c46,f(val(v50^c),6,2),c54,f(val(v50^d),6,2),c
66,f(rsum(v50),6,2)/#'TRANSPORT:',c23,f(val(v60^a),6,2),c34,f(val(v60^b),6,2),c4
6,f(val(v60^c),6,2),c54,f(val(v60^d),6,2),c66,f(rsum(v60),6,2)/#'HOUSEHOLD:',c23
,f(val(v70^a),6,2),c34,f(val(v70^b),6,2),c46,f(val(v70^c),6,2),c54,f(val(v70^d),
6,2),c66,f(rsum(v70),6,2)/#'GOVT.:',c23,f(val(v80^a),6,2),c34,f(val(v80^b),6,2),
c46f(val(v80^c),6,2),c54,f(val(v80^d),6,2),c66,f(rsum(v80),6,2)/#'TOTAL:',c23,f(
val(v90^a),6,2),c34,f(val(v90^b),6,2),c46,f(val(v90^c),6,2),c54,f(val(v90^d),6,2
),c66,f(rsum(v90),6,2)/##'NOTES:',Mhl,v91/#
```

EDIT: Replace

SECTORAL ENERGY CONSUMPTION PATTERN IN ZAMBIA (000TOE)

SOURCES: 1.Indeni Refinery, 1990
2.ZIMOIL, 1990
3.BP(Zambia Ltd)
4.Energy Department, 1991

CONVERSION:1 tonne = 1000kg; 1 TOE = 41.9 gigajoules

YEAR:1991

TYPE OF ENERGY	PETROLEUM	ELECTRICITY	COAL	WOODFUELS	TOTAL
AGRIC & FORESTRY:	24.10	8.60	0.00	141.50	174.20
INDUSTRY:	52.30	86.80	126.90	299.40	565.40
MINING:	146.40	464.40	140.10	0.10	751.00
TRANSPORT:	373.70	0.00	0.00	0.00	373.70
HOUSEHOLD:	18.70	65.00	0.00	2443.10	2526.80
GOVT.:	10.10	31.20	11.10	0.00	52.40
TOTAL:	625.30	656.00	278.10	2884.10	4443.50

NOTES: Petroleum products' consumption was recorded high in the transpor sector; followed by the mining sector in 1991. The Government services indicated a low consumption. Woodfuels was the largest consumed energy s in the household sector. Coal was mostly consumed by the industrial and mining sectors. Since the mining sector (more especially ZCCM) has streamlined its operations and has been using alternative energy sources other than coal and given the low exports, it is anticipated that coal production is likely to decrease. The mining sector also consumed the la portion of electricity in the same year. In order of decreasing trend, t national consumption of the energy was: woodfuel, electricity, petroleum coal.

SECTO DATABASE

SECTORAL ENERGY CONSUMPTION PATTERN IN ZAMBIA (000TOE)

SOURCES: 1.Energy Statistics, 1990
2.NCDP
3.Energy Department
4.Central Statistics Office(Lusaka)

CONVERSION:1 tonne = 1000kg; 1TOE = 41.9 gigajoules

YEAR:1988

TYPE OF ENERGY	PETROLEUM	ELECTRICITY	COAL	WOODFUELS	TOTAL
AGRIC & FORESTRY:	13.50	10.10	0.00	129.50	153.10
INDUSTRY:	71.80	79.00	194.70	239.00	584.50
MINING:	145.20	396.70	102.50	1.90	646.30
TRANSPORT:	308.20	1.10	0.00	0.00	309.30
HOUSEHOLD:	25.60	60.00	0.00	2480.00	2565.60
GOVT.:	0.10	63.10	29.50	0.00	92.70
TOTAL:	564.40	610.00	326.00	2850.40	4350.80

NOTES:In 1988, woodfuel still dominated the national energy consumption, seconded by electricity, petroleum products and then coal. There was an increase in tha national consumption levels of all these energy sources as compared to 1986 and 1987. Large consumption of energy sources such as petroleum and electricity could be attributed to the growth of the industrial and transport sectors. It is important to note that the large consumption of woodfuels has had an impact on the envirionment in general and environmental policies in particular.

SECTO DATABASE

SECTORAL ENERGY CONSUMPTION PATTERN IN ZAMBIA (000TOE)

SOURCES: 1.Department of Energy
2.Indeni Reports
3.Zesco Reports
4.Natural Resources Department

CONVERSION:1 tonne = 1000kg; 1TOE = 41.9 gigajoules

YEAR:1987

TYPE OF ENERGY	PETROLEUM	ELECTRICITY	COAL	WOODFUELS	TOTAL
AGRIC & FORESTRY:	18.90	12.80	0.00	162.20	193.90
INDUSTRY:	59.20	67.90	65.70	27.70	220.50
MINING:	153.80	404.60	105.90	2.20	666.50
TRANSPORT:	296.00	0.00	0.00	0.00	296.00
HOUSEHOLD:	15.20	46.10	0.00	2530.40	2591.70
GOVT.:	1.10	29.00	15.20	0.00	45.30
TOTAL:	545.00	560.30	286.80	2922.50	4314.60

NOTES:Like in 1988, the national consumption of coal was restricted to the mining and industrial sectors. Efforts to reduce dependency on woodfuel in the household sector have not materialised todate. A pilot project initiated by the NCSR to make a coal briquette from coal slurries as an alternative energy source for the household sector has proved unattractive;present market trends indicate lack of appreciation form the household sector.

SECTO DATABASE

SECTORAL ENERGY CONSUMPTION PATTERN IN ZAMBIA (000TOE)

SOURCES: 1.Energy Department
2.Natural Resources Department

CONVERSION:1 tonne = 1000Kg; 1TOE = 41.9 gigajoules

YEAR:1986

TYPE OF ENERGY	PETROLEUM	ELECTRICITY	COAL	WOODFUELS	TOTAL
AGRIC & FORESTRY:	15.60	8.40	0.00	203.30	227.30
INDUSTRY:	51.10	76.60	141.50	216.80	486.00
MINING:	152.30	398.90	181.20	0.30	732.70
TRANSPORT:	273.70	0.00	0.00	0.00	273.70
HOUSEHOLD:	15.90	42.80	0.00	2456.30	2515.00
GOVT.:	9.30	26.60	16.10	0.00	52.00
TOTAL:	517.20	553.40	338.80	2879.00	4288.40

NOTES:As compared to 1987, except for coal; the national consumption of petroleum, electricity was lower. Socio-economic indicators show that the general national economy in this year experienced low growth resulting from a stifled industry, low agricultural production, operational constraints in the mining sector and a shrinking transport sector.

Field Defin

?|	Tag|
	5 Cov
	10 Top
	20 Cur
	30 Fore
	40 Pol
	50 Oper
	60 Eval
	70 Sour

A - Insert (
P - Previous

ANNEX 2

OUTPUTS OF SAMPLE RECORDS

FROM

ZENE DATABASE

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ANNEX 2

OUTPUTS OF SAMPLE RECORDS

FROM

ZENE DATABASE

....

Field Definition Table (FDT) Data Base: ZENE

?	Tag	Name	Len	Typ	Rep	Delimiters/Pattern
	5	Coverage	60	X		
	10	Topic	100	X		
	20	Current Situation	500	X		
	30	Forecast	500	X		
	40	Policy issues	500	X		
	50	Operational experiences	500	X		
	60	Evaluation	500	X		
	70	Sources Information	200	X	R	

A - Insert (after)	B - Insert (before)	C - Change line	D - Delete line
P - Previous page	N - Next page	T - Top	E - Bottom
		X - Exit	┘ - Next line

Data Base Name: ZENE Format name: ZENE

```
'COVERAGE:'v5/#'TOPIC:'mhl,v10/##'CURRENT SITUATION:'mhl,v20/##'FORECAST:'mhl,v
0/##'POLICY ISSUES:'mhl,v40/##'OPERATIONAL EXPERIENCES:'mhl,v50/##"EVALUATION:'
hl,v60/##'SOURCES OF INFORMATION:'(c25,v70^a(25,24)/)##
```

EDIT: Replace

ZENE DATABASE

COVERAGE: ZAMBIA

TOPIC: BIOGAS UTILISATION

CURRENT SITUATION: The National Council for Scientific Research(NCSR) has finalised a pilot project on the production of biogas initiated four years ago and now face implementation problems. NCSR has challenged individuals, government and NGOs to help harness and promote the utilisation of biogas as an alternative source of energy. Little response and interest has been shown.

FORECAST: World energy trends show most countries are mobilising their resources towards the global issues of energy conservation by initiating projects on harnesing alternative sources of energy such as biogas. Reducing dependance on imported energy source(such as oil) that takes a larger part of national budgets has activated this trend too.

POLICY ISSUES: The previous government initiated and materially supported such projects. Today there is no clear energy policy as to the exploitation of biogas. Neither the government nor any other quarter has shown policy commitment.

OPERATIONAL EXPERIENCES: Biogas can be used for cooking, lighting, refrigeration and can be helpful in rural schools for perfoming science experiments in the laboratories since it is useful in bunsen burners. Currently, most schools fail to conduct practical science programmes. Biogas has proved a success at Kasisi Orphanage school for cooking, refrigeration and lighting and has reduced the problems of hydropower failures.

EVALUATION: Biogas is cheaper source of energy and an economically viable alternative source of energy. It can help in terms of energy conservation and reduce dependence on oil, hydroelectric and woodfuels in the rural and urban areas.

SOURCES OF INFORMATION:
1. NCSR Annual Report, 1990
2. Zambia Daily Mail, October 2, 1993
3. World Energy Trends, African Business, Jan. 1993.

ZENE DATABASE

COVERAGE: ZAMBIA

TOPIC: SOLAR AND WIND ENERGY UTILISATION

CURRENT SITUATION: Vast potential of renewable sources of energy exist in Zambia. Wind and Solar energy exploitation look promising. Wind pumps utilise an average of 2.5m per second which is used for irrigation. Solar installation is about 4kwh/m squared per day with peak hours recorded in October and November when a lot of sunshine converts about 450 colories with a record of sunshine hours between 2600 to 3000 per year.

FORECAST: The use of solar and wind energy shows an upward trend in fish and crop drying. Although, this cannot be easily quantified; increasingly use of solar and wind energy for the purpose of lighting, refrigeration and water pumping is becoming common through such technologies as photovoltaic especially for the rural farming community.

POLICY ISSUES: There is a political commitment by the government to institute measures to reduce the imported fuel consumption and the dependance on hydropower even though concrete policy on energy does not exist. The energy policy is still in draft form.

OPERATIONAL EXPERIENCES: Recent summaries of the the industrial energy audit on 14 industries showed that a total of about K1.6 bn was spent on energy alone. There is potential of reducing this figure to about 30 percent by emphasing efficient utilisation of new technologies that stress on energy services rather than simply increasing supplies of oil, coal or electricity. China in the 1980s intiated such a programme and by 1990 had reduced energy consumption by 50 percent thus directing their trade-off in investment to other priority areas.

EVALUATION: With the constraints on the national budget and a marginalised rural community in terms of energy supply; use of efficient technologies that service both the industry and rural farming community must be enhanced. Research activities must also be supported in the development of these technologies.

SOURCES OF INFORMATION:

1. BP Solar Ltd Sales Office, Lusaka
2. Energy Statistics Bulletin, 1974-90
3. Meteorological Department, Lusaka
4. African Business, January, 1993.p43.

ZENE DATABASE

COVERAGE: DEVELOPING COUNTRIES

TOPIC: ENERGY POLICIES.

CURRENT SITUATION: The developing countries current energy path leads them deeper in debt and marginalised life of million of people. Plans for expansion of conventional energy use stand at over $4 trillion over the next 35 years, triple the Third World debt of $1.35 trillion. This is because most developing countries still emphasize increased supplies of conventional energy such as oil, coal, electricity using obsolete infrastracture with inefficient energy technologies.

FORECAST: Projections indicate that the emphasy on energy service efficiency can revitalise stalled economic development in the Third World. Misdirected investments in the older technology could also be saved if advanced, newer and simpler technologies are adopted. It is estimated that each $1 invested in improving energy efficiency leads to an average saving of $5 in energy supply. Over the next 35 years $350 bn invested in efficient energy use would eliminate the need for $1.75 trillion worth of power plants, oil refineries etc.

POLICY ISSUES: Developing countries need to institute policies that emphasise the need for efficient energy utilisation. This can save misdirected investments. These policies must be supported by national programmes if such goals are to be realised. In 1980, for example, China launched an ambitious efficiency programme to improve energy use in industry. Efficiency gains were estimated at one-third less expensive than comparable investments in coal supplies.

OPERATIONAL EXPERIENCES: Experience of developing countries like Brazil indicate gains in the adoption of efficient policies. The National Electricity Conservation programme invested $20m in improving efficiency. This investment reduced the nation's need for new power plants and transmission lines by roughly $1bn in the late 1980s.

SOURCES OF INFORMATION: 1.African Business, Jan. 1993 p43
2.World Watch Institute Report, Nov.1992.

ZENE DATABASE

COVERAGE: DEVELOPING COUNTRIES

TOPIC: MARKET TRENDS ON NON CONVENTIONAL ENERGY EQUIPMENT.

CURRENT SITUATION: Considerable potential exist for expanding trade among developing countries in non conventional energy producing equipment. Demand for wind pumps, wind generators, water turbines and solar panels is expected to grow rapidly during the remainder of the next century and into the next. International trade in such equipment is steadily growing. It is an attractive market which the countries need to consider.

FORECAST: Demand already exist in some developing countries in which non conventional energy generating technologies are being applied. Examples include Brazil, China, India, Mexico and South Korea. Future sales products are expected to increase if there will be changes in the oil price along with overall expansion of long term energy needs. In the industrialised countries, an upward trend is expected. The USA's emphasy on use of solar energy could offer sales opportunities. Although the market is difficult to determine future demands look significant

POLICY ISSUES: The viability and extent of the application of energy systems depend greatly on government policy.One of the reasons for developing a market for non conventional energy technologies in the USA,for example, was the very favourable policy to set a national goal to obtain 20 per cent of the national energy supplies from solar energy by 2000 AD which was supported by a tax reduction for solarenergy installations. Other countries have adopted national policies on energy. The energy substitution project in Cape Verde is another reference.

OPERATIONAL EXPERIENCES: Industrialised countries especially in Europe are also active in the trade of non conventional energy equipment. Almost all exports of wind and water turbines and about two-third of such imports over the past years have been accounted for by the developed countries. Developing countries have been importing about one-third of the world total non conventional equipment and they export about 2 percent of the total trade. This export is small given the relatively simple technology required to produce low-powered non conventional energy equipment.

SOURCES OF INFORMATION: 1.Asia-Pacific Technical Monitor(APCTT) Market Prospects for non-conventional energy equipment Sept-Oct. 1987.

Field Definition Table (FDT)　　　　Data Base: ENECO

?	Tag	Name	Len	Typ	Rep	Delimiters/Pattern
	10	Subject	50	X		
	20	Coverage	100	X		
	30	Current Consumption rate	500	X		
	40	Production forecast	500	X		
	50	market trends	500	X		
	60	Sources of information	500	X		

A - Insert (after)	B - Insert (before)	C - Change line	D - Delete line
P - Previous page	N - Next page	T - Top	E - Bottom
		X - Exit	┘ - Next line

ANNEX 3

OUTPUTS OF SAMPLE RECORDS

FROM

ENECO DATABASE

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```
'SUBJECT:'mhl,v10/##'COVERAGE:'mhl,v20/##'CURRENT CONSUMPTION RATE:'mhl,v30/##'
RODUCTION FORECAST:'mhl,v40/##'MARKET TRENDS:'mhl,v50/##'SOURCES OF INFORMATION
'(c25,v60^a(25,24)/)/##
```

EDIT: Replace

ENECO DATABASE

SUBJECT: COAL CONSUMPTION PATTERN

COVERAGE: ZAMBIA

CURRENT CONSUMPTION RATE: Almost all coal consumed in the country is mined at Maamba Collieries Ltd. Its consumption declined from about 742,000 tonnes in 1975 to about 374,000 tonnes in 1990. The consumption pattern of coal is dominated by the copper mines accounting for 61, 64 and 56 percent of the total coal sales in 1977, 1979 and 1989 respectively. As of 1990 statistics, the industrial consumption was about 37 percent of the total sales, while the household sector consumed a rate of only 9 percent.

PRODUCTION FORECAST: The reflected reduction in coal reduction is due to production constraints resulting from the use of old technologies. In 1985 a rehabilitation programme was initiated to restore the production capacity. The Collieries can now at least satisfy local demands and it is anticipated to increase export to countries within the PTA. Its production is expected to be hampered by the decline in copper production (where it is largely consumed) due to the closure of some of the mines and other energy substitution and conservation practices being introduced in the country and the region.

MARKET TRENDS: The local demand is showing a decline with the sole and largest consumer, ZCCM changing its reliance on coal by introducing energy cost effective measures. Coal exports have generally been a small scale accounting for only a fraction of the total production. The pricing of coal has been changing since 1986. Today the pricing is based on quality which takes into account the energy content rather than based on the grade quantified in terms of size in diameter as was the case prior to 1986.

SOURCES OF INFORMATION:
1. ZCCM Reports, 1990
2. Maamba Collieries Reports, 1990
3. Energy Statstics Bulletin, 1974-1990.

ENECO DATABASE

SUBJECT: PETROLEUM CONSUMPTION PATTERN

COVERAGE: ZAMBIA

CURRENT CONSUMPTION RATE: All petroleum products consumed are imported, largely from the Middle East, as stockfeed which constitutes crude and refined spiked oil. The volume of imported oil declined from about 870,000 tonnes in 1975 to 575,000 tonnes in 1985. There is now an upward import trend of about 90 percent. Mining and transport have been the dominant consumers with a record of 80 percent consumption over the past years. The industry consumes 20 percent which it converts into end petroleum products.

PRODUCTION FORECAST: The economic cost of the oil dependance represent a strain on the national resources. Efforts to explore prospective oil reserves in Eastern and Western parts of the country has proved a costly venture. Refinery production trends at the Ndola Refinery plant are expected to rise given that high industrial growth rate are likely to be recorded with more foreign industrial investment in the next few years.

MARKET TRENDS: Refinery of petroleum products are handled by ZIMOIL and marketed by AGIP, BP,CALTEX, MOBIL and TOTAL and account for 70 percent of the marketed oil in the country; with BP and AGIP marketing 50 and 20 percent respectively. The export market of the refined products to the neighbouring countries in on small scale. The retail prices indicates an upward trend activated by the depriciation of the national currency (Kwacha) and increased import costs.

SOURCES OF INFORMATION: 1.ZIMOIL Report, 1990
2.Indeni Refinery Report, 1990
3.Central Statistics Office, 1990

ENECO DATABASE

SUBJECT: ELECTRICITY

COVERAGE: ZAMBIA

CURRENT CONSUMPTION RATE: The total capacity of electricity generated is 1,778 MW of which 1,640 MW is transmitted by and distributed buy ZESCO. ZCCM is the largest consumer of electricity, followed by the Industrial and Commercial sectors. In 1990, for example, ZCCM consumed 71 percent of the total electricity generated in the country. The consumption of the industrial and commercial sectors accounted for 10 percent; Household (9 percent); Government service (7 percent), Agriculture and Forestry (3 percent); while the transport sector recorded a consumption rate of zero percent.

PRODUCTION FORECAST: Hydropower generation accounts for about 90 percent of the total electricity produced; with the reminder power being produced by a small network of diesel supply stations. Although, the 1989 fire that gutted the Kafue gorge power station reduced hydropower generation, trends in the past years has shown that power generation has stabilised and is on the increase. It is anticipated that the whole network (diesel stations) would be connected to hydropower by the year 2000 AD.

MARKET TRENDS: Electricity exports had increased significantly from 1977 to a peak in 1982 of 37 percent exports; but has of late declined considerably. the major importor, Zimbabwe brought on the stream new thermal power stations and along with the 1989 fire reduced the exports to almost zero. The next five years show a promising trend since power generation has stabilised and is able to satisfy most of the local needs.

SOURCES OF INFORMATION:
1. Zesco Reports
2. Energy Statistics Bulletin, 1990
3. Experts at Kafue Gorge Power Station

ENECO DATABASE

SUBJECT: WOODFUELS

COVERAGE: ZAMBIA

CURRENT CONSUMPTION RATE: Woodfuel is the principal household fuel and nation's largest source of energy. Woodfuel consumption is in form of firewood and charcoal in the rural and urban areas respectively. Estimates on woodfuel are scanty but FAO/Forest Department estimates in 1990 showed that it accounts for over 66 percent of the total national energy consumption.

PRODUCTION FORECAST: Woodfuel, though the largest consumed energy source especially in the household sector, presents problems in terms of environmental degradation, since it leads deforestation. The rate of woodfuel is expected to increase if alternative measures are not put in place by the government. The need for increased efforts in funding research in order to provide alternative energy sources for the household sector is thus paramount.

MARKET TRENDS: The pricing of woodfuel, especially charcoal can be derived from the market prices in the urban areas. Survey of most prices in the urban areas indicate an upward trend which is necessited by the slow economic growth of the national economy. The liberal market nature of the national economy has for the most part dictated the price patterns of charcoal over the past few years. Details of pricing of firewood are, however, very difficult to obtained in the energy market.

SOURCES OF INFORMATION:
1. FAO Study, 1990
2. World Bank/Dept of Energy Urban Household Survey, 1988
3. Sectoral Energy Planning Unit-NCDP
4. Central Statitics, Lusaka.

ANNEX 4

OUTPUTS OF SAMPLE RECORDS FROM REFERRAL DATABASES

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SAMPLE RECORDS FROM ABNCD DATABASE

*** PROFILE OF INSTITUTION ***

INSTITUTION	National Council for Scientific Research
START DT	1967
LOCATION	Zambia
ADDRESS	P.O.Box CH 158,Lusaka.
TELEX	ZA40005
PHONE	281081-6
HEAD	Director
INST. TYPE	National Research Institution
ASSOC.ENTITIES	Energy Department; Forestry Department; Ministry of Science and Technology
OBJECTIVES	To conduct Research and consultancy in matters related to science and technology

SAMPLE RECORDS FROM ABNCD DATABASE

*** PROFILE OF INSTITUTION ***

INSTITUTION	Zambia Electricity and Supply Corporation
START DT	1967
LOCATION	Zambia
ADDRESS	P.O Box 33304,Lusaka.
TELEX	ZA40150
FAX	(01)222753
PHONE	228084-9
WORK.LANG.	English
HEAD	Managing Director
INST. TYPE	Parastatal
ASSOC.ENTITIES	Energy Department; Ministry of Power, Transport and Communication
OBJECTIVES	To facilitate the supply and distribution of electricity in the country.
ACTIVITIES	Provision of electricity in the country.

SAMPLE RECORDS FROM ABNCD DATABASE

*** PROFILE OF EXPERT ***

NAME	MWANZA,CLOTILDA, ENERGY PLANNER
BIRTH	1960
QUALIFIC.	University of Zambia. B.A. Public Adminstration and Social Work.
SPECIALIZATION:	Energy Planning.
WORK. LANG.	English.
OTHER LANG.	Njanja.

Employment Record

CURR. EMPLOY.	Energy Planner, GRZ, 1989-.
ASSIGNMENTS	Research on Cookstoves and Biogas, Lusaka, 1989-1990.

SAMPLE RECORDS FROM ABNCD DATABASE

*** PROFILE OF EXPERT ***

NAME	MPOROKOSO, ABEL, ENERGY ECONOMIST
BIRTH	1959
NATIONALITY	Zambian
QUALIFIC.	University of Zambia. B.A.
SPECIALIZATION:	Economics.
WORK. LANG.	English.
OTHER LANG.	Bemba.
	Employment Record
CURR. EMPLOY.	Energy Economist, Depatment of Energy.

SAMPLE RECORDS FROM ABNCD DATABASE

*** PROFILE OF EXPERT ***

NAME	CHIMPONDA,P.M, CHEMIST
BIRTH	1947
NATIONALITY	Zambian
QUALIFIC.	HND(Occupational Safety and Health).
SPECIALIZATION:	Enviromental Assessment and Pollution and Waste.
WORK. LANG.	English.
OTHER LANG.	Bemba.
	Employment Record
CURR. EMPLOY.	Safety Superintendent, NCZ-Kafue.
LAST EMPLOY.	GRZ.
ASSIGNMENTS	Safety Superintendant, NCZ, 1982. Senior Mining Technician, Mines Safety GRZ, 1979-1982.

SAMPLE RECORDS FROM ABNCD DATABASE

*** INFORMATION SYSTEM ***

INSTITUTION	Zesco Information System
START DT	1967
LOCATION	Zambia
ADDRESS	P.O. Box 33304,Lusaka
TELEX	ZA40150
FAX	(01)222753
PHONE	228084-9
WORK.LANG.	English
PERSONNEL	15
HEAD	Data Processing Manager
INST. TYPE	Parastatal
OBJECTIVES	To provide information services related to electricity distribution and supply.
ACTIVITIES	Bibliographic; Documentation; Information services; Data in machine-readible form
INFO. SERVICE	Data Processing; Specialised services
DATABASES	Customer Database; Human Resource Database; Stock Control Database; General Ledger
EQUIPMENT	Mainframe(VAX 8250); Micro VAX II

SAMPLE RECORDS FROM ABNCD DATABASE

*** INFORMATION SYSTEM ***

INSTITUTION	Geological Survey Documentation Centre and Library
START DT	1950
LOCATION	Zambia
ADDRESS	P.O. Box 50135, Lusaka.
TELEX	ZA40107
FAX	2501973
PHONE	227949/52
WORK.LANG.	English
PERSONNEL	4
HEAD	Records Manager
INST. TYPE	Goverment
OBJECTIVES	To act as a national depository for all the information relating to geology and provide information and advisor services to the public.
ACTIVITIES	Bibliographic; Numeric and Statistical
INFO. SERVICE	Reference Services; Current awareness; Abstracting/Indexing services; Documentation Services
CLASSIFIC.	UDC
EQUIPMENT	IBM PC; dBASEIV; WordPerfect; Lotus 1-2-3

ANNEX 5

The University of Zambia,
Department of Lib. Studies
P.O. Box 32379,
LUSAKA.
July, 1993.

Dear Sir/Madam,

I am a Graduate student at the School of Information Studies for Africa (SISA) at Addis Ababa University, Addis Ababa, Ethiopia conducting a research (as part of a Master's thesis requirement) on:

Information support system for Energy Planning in Zambia.

Among other things, the research involves investigating the existing information support facilities in Zambia with the view to proposing plans and recommedations for enhancing them and designing new ones and thereby enabling information flow and data exchange in the Energy sector in Zambia.

Would you please, therefore, assist me by filling in the attached questionnaire as early as possible and before August,15 1993.

Thanking you in anticipation,

Yours faithfully,

Trywell Kalusopa (Mr)

The University of Zambia,
Department of Lib. Studies
P.O. Box 32379,
LUSAKA.
July, 1993.

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Would you please, therefore, assist me by filling in the attached questionnaire as early as possible and before August,15 1993.

Thanking you in anticipation,

Yours faithfully,

Trywell Kalusopa (Mr)

SURVEY OF INSTITUTIONS AND INFORMATION SYSTEMS RELATED TO ENERGY PLANNING IN ZAMBIA.

PART 1.

GENERAL INFORMATION.

1. Name of the institution ------------------------------

----

2. Name of the information system (Library, Documentation or information centre.)------------------------------
----

a. Address --
b. Telephone --------------------------------------
c. Telex --
d. Fax --

3. Parent Organisation (if any) ----------------------
----

a. Objectives --------------------------------------

----

4. Date of establishment ------------------------------

SURVEY OF INSTITUTIONS AND INFORMATION SYSTEMS RELATED TO ENERGY PLANNING IN ZAMBIA.

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GENERAL INFORMATION.

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2. Name of the information system (Library, Documentation or information centre.)----------------------------------
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a. Address ---

b. Telephone ---

c. Telex ---

d. Fax ---

3. Parent Organisation (if any) -----------------------
----

a. Objectives --

----

4. Date of establishment -------------------------------

5. Type of documentation activities (Mark x where appropriate).

a. Bibliographic [ ]
b. Numeric/stastical [ ]
c. Referral [ ]

6. Type of information services offered to the users (mark x where appropriate).

a. Reference services
(eg reference services,
retrospective searches,
or technical inquiry etc) [ ]

b. Current awarenees
(eg selective dissemination of
information (SDI), newsbriefs,
bulletins, research in progress
notifications etc.) [ ]

c. Specialised services
(eg forecasts,trends report,
contract and tender notices,
environment scanning etc.) [ ]

d. Information analysis and
consolidation.
(eg research abstract,digest
for planners, policy maker,
statistical digest, numerical
data services) [ ]

e. Common services
(eg library services,

5. Type of documentation activities (Mark x where appropriate).

a. Bibliographic ☐
b. Numeric/stastical ☐
c. Referral ☐

6. Type of information services offered to the users (mark x where appropriate).

a. Reference services
(eg reference services,
retrospective searches,
or technical inquiry etc) ☐

b. Current awarenees
(eg selective dissemination of information (SDI), newsbriefs, bulletins, research in progress notifications etc.) ☐

c. Specialised services
(eg forecasts,trends report, contract and tender notices, environment scanning etc.) ☐

d. Information analysis and consolidation.
(eg research abstract,digest for planners, policy maker, statistical digest, numerical data services) ☐

e. Common services
(eg library services,

documentary delivery,

document reproduction,
translations, organisation
of exhibits). ☐
f. On-line searches ☐
g. Others (specify)--------------------------------------

6. What classification scheme does your information system use ? (Mark X appropriately)

a. Library of Congress (LC) ☐
b. Dewey Decimal Classification (DDC) ☐
c. Universal Decimal Classification (UDC) ☐
d. Colon ☐
e. Others (specify) ---------------------------------

7. Name the subject heading list use (Mark X)

a. Library of Congress ☐
b. Sear's list ☐
c. Others (specify) ---------------------------------
----

8. Types of indexing (Mark X)

Author	☐	Title	☐
Subject	☐	Description	☐
Keyword	☐	Geographical	☐

Others (specify)
----

9. What kind of thesaurus is used (if any) ------------
----

documentary delivery,

document reproduction,
translations, organisation
of exhibits). [ ]
f. On-line searches [ ]
g. Others (specify)---------------------------------------

6. What classification scheme does your information system use ? (Mark X appropriately)

a. Library of Congress (LC) [ ]
b. Dewey Decimal Classification (DDC) [ ]
c. Universal Decimal Classification (UDC) [ ]
d. Colon [ ]
e. Others (specify) ---------------------------------

7. Name the subject heading list use (Mark X)

a. Library of Congress [ ]
b. Sear's list [ ]
c. Others (specify) ---------------------------------
----

8. Types of indexing (Mark X)

Author [ ]	Title [ ]
Subject [ ]	Description [ ]
Keyword [ ]	Geographical [ ]

Others (specify)
----

9. What kind of thesaurus is used (if any) -----------
----

10. Number of staff

a. Professional (Librarian, Documentalist, information scientist) ------------------------------------

b. Paraprofessional ------------------------------

c. Support staff -------------------------------

d. Others ---

10. Number of staff

a. Professional (Librarian, Documentalist, information scientist) ------------------------------------

b. Paraprofessional -------------------------------

c. Support staff --------------------------------

d. Others ---

PART 2. COMPUTER RESOURCES AND MANAGEMENT.

11. Does your institution have any any computer facilities?
(Mark x appropriately)
YES ⎣__⎦ NO ⎣__⎦

If answer is YES, answer the question below, if NO go to question
27.

12. Indicate the location of the computer resources (Mark x appropriately).
a. Library / Documentation/information centre ⎣__⎦
b. Within the Parent Organisation ⎣__⎦
c. Any Location (specify) ----------------------------
----

13. What are the main uses of the computer resources in the organisation?
a. Word processing ⎣__⎦
b. Financial management
and other management functions ⎣__⎦
c. Bibliograghic/Library or
information system database management ⎣__⎦
d. Numerical/Statistical application ⎣__⎦

14. Please describe the computer facilities used by your information system.

MAINFRAM COMPUTER
Make/Model--
Main memory---
Operating system--------------------------------------
Disk units--

Tape units--

Disk capacity---

Data installed--

MINICOMPUTER

Make/Model--

Main memory---

Operating system--

Disk units--

Tape units--

Disk capacity---

Date installed--

MICROCOMPUTERS

Make/Model ---

Main memory --

Operating system ---------------------------------------

Hard disk ---------------------- Capacity --------------

15. Are the microcomputers

    a. Networked? ⎿⏌

    b. Stand alone? ⎿⏌

16. If networked, what kind of network ?

    a. Local Area Network ⎿⏌

    b. Wide Area Network ⎿⏌

17. Specify department or institution to which networked

----

8. What are the problems related to network ? in terms of data exchange (Explain)

----

19. Does the institution have any CD ROM drives ?

Yes ☐ No ☐

20. If Yes ; Specify which CD ROM Database are used in the remote access ?

----

21. If the computer are used in Database Management, specify the name of the database.

22. Indicate the type of database.

a. Biblographic ☐
b. Profiles(eg expert,instuitional etc.) ☐
c. Object or mission oriented ☐
d. Others(specify) ------------------------------------

PART 3. PROBLEMS.

23. What kind of problems do you encounter in the use of compuetrs in your infomation sytems?

b. Equipment related problems.

- Lack of or inadequate peripherals(eg printers ....) └──┘
- Lack of software └──┘
- Inadequate computer memory └──┘
- Slow processing speed └──┘
- Poor maintanance └──┘
- Envionment conditions (heat, dust, unstable electricity etc.) └──┘

Others (specify)

----

b. Personal related problems.

- Shortage of manpower └──┘
- Lack of training opportunities in hardware and software use └──┘

Others (specify)- ----------------------------------

----

24. How well are the staff trained in the use of computers?

----

25. Where are they trained?

a. Abroad ⎵

b. Locally ⎵

26. Do you think computer have improved your information system operations? (Explain)

----

27. If your institution/information system does not presently have or ultilise the computer facilities, are there plans to install or use them in the near future? (Mark x).

YES ⎵ **NO** ⎵

If YES when you intend to do so? (specify)

----

28. If planned, what type of computer does your infomation system intend to introduce? (Mark x appropriately)

a. Mainframe ⎵

b. Minicomputers ⎵

c. **Microcomputer** ⎵

29. What operations do you intend to use these computers for?

THANKYOU FOR FILLING IN THE QUESTIONNAIRE

ANNEX 6

....

DIRECTORY OF EXPERTS IN THE ENERGY SECTOR IN ZAMBIA.

(QUESTIONAIRRE)

INFORMATION TO THE RESPONDENT.

I am a Graduate student at the School of Information Studies for Africa, Addis Ababa University, Ethiopia. The information you will provide here will be used in the development of prototype databases of profiles of experts in the Energy sector (as part of my requirement for the Master's thesis) focusing on: **Information support system for Energy Planning in Zambia.**

Please, would you kindly fill in this form as early as possible and before August 15, 1993.

Present address: Trywell Kalusopa
University of Zambia
Dept. of Lib. Studies
P.O. Box 32379
LUSAKA, ZAMBIA.

Main publications ------------------------------------

Main working language(s) -----------------------------

3.0 EMPLOYMENT RECORD

(a) Current Employer ---------------------------------

Title of post --

Duration: from:------------------------- to:----------

Description of duties --------------------------------

(b) Last employer ------------------------------------

Title of post --

Duration: from: ----------------------- to:-----------

Description of duties --------------------------------

ANNEX 7

LIST OF QUESTIONS FOR INTERVIEWS

1. What type of information do you frequently require in Energy Planning?

2. What sources do you normally consult for your planning purposes?

3. In type of forms and formats would find the information useful for your planning activities?

4. Does the information system provide all the relevant information and data needed for energy planning in terms of the following characteristics?

- Relevance
- Coverage
- Timeliness
- Accuracy
- Validity

5. What services does the information system offer? (e.g SDI, Referral Services, Digests etc)

6. In your view does the information system provide satis factory services?

7. Suggest ways in which the information system can be modified to meet your energy planning needs.