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INTEGRATED METHODOLOGY FOR ENERGY PLANNING IN EGYPT

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TABLE OF CONTENTS

List of Tables

List of Figures

PREFACE

Planning for an adequate supply of energy has always been an important component of national planning in Egypt. The dramatic fluctuation of oil prices and the changes in the future energy supply and demand pattern call for a comprehensive approach to energy planning, with special emphasis on the medium and long term. Medium and long-term energy planning require a review of the past and present trends to enable decision makers to evaluate future development of energy demand and the possibilities of fulfilling that demand in various ways. Integrated energy planning centers on the identification of future targets and the procedure of how these targets can be achieved given the premises of consistency and balance among the elements of energy supply-demand, as well as, economy and socio-economy.

It is necessary, and rather essential, for Egypt to have a clear view of its energy policy options. Integrated energy planning has, thus, become a matter of urgency. The Institute of National Planning, therefore, wished to respond to this real need by sponsoring during 1985/1986 the programme of research-work on „Integrated Methodology for Energy Planning in Egypt".

The main objective of this study is to present a conceptual framework for integrated energy analysis and making policy decisions in Egypt. This study gives a detailed guide to the methodology for collecting data on the country's energy system as such, namely the establishment of the national energy balance. In addition, it emphasizes the display of factors that describe the energy system in relation to its environment, both in terms of the economy and socio-economy. It defines in more detail and formulates in a comprehensive and dynamic manner the interrelation among these parameters using different analytical instruments (socio-economic indicators, techno-economic methods, forecasting techniques ... etc). Another basic characteristic which was aimed to obtain for this methodology is that it can be applicable at various levels of geographical aggregation. In other words, such a methodology would be equally suitable for application to disaggregated areas within the country (e.g. rural and urban areas), as well as for the national economy of Egypt or a group of countries within the same region (e.g. Arab countries or North African countries). Therefore, the proposed methodology attempts to identify the analytical approach and the tools to be used, disregarding the development scenarios which might be eventually considered as a particular case study. With this in mind, the approach adopted is one of simplicity and clarity, with preferential treatment being given to the practical aspects.

The main emphasis of this study is to:

i) identify the conceptual framework for integrated energy planning and analysis;

ii) define the data requirements for integrated energy planning and policy analysis, and recommend possible procedures for the procurement of these data,

iii) identify the methodological approach to constructing national energy balance for Egypt;

iv) review the quantitative methods for energy forecasting and discuss briefly the areas of possible application;

v) formulate techno-economic approach to sectoral energy demand analysis;

vi) discuss the unresolved issues on energy planning in Egypt and identify the areas of possible future development.

Finally it must to stressed that, the integrated methodology for energy planning in Egypt is not an end in itself, rather it is justifiable as a tool for the purposes of effective energy analysis and making policy decisions.

This study has been undertaken in the framework of the Institute of Planning research Program. I wish to record our sense of appreciation to the principal investigator of this study Dr. Ragia Abdin kheiralla, Senior Expert in the Institute of National Planning and Prof. Dr. Emad EI Sharkawi, theChairman of the Egyptain Electricity Authority, for his valuable consultation.

I hope that the study, its designations and presentation of the subject, be of interest and a welcome aid to decision makers and energy planners.

Dr. Ragaa A. Rassoul

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Sept. 1986.

CHAPTER 1

METHODOLOGICAL CONSIDERATIONS FOR ENERGY ANALYSIS AND PLANNING

1.1 Interlinkages Between Energy, Economy, Technology and Society

As a result of the significant evolutions of crude oil prices in 1973 and later 1979, a much more precise analysis of the energy sector is required in order to understand the driving forces of energy consumption, the impact on the energy supply and the multi-facetted interrelation of energy with the economy and the socio-economy.

The interfaces of the energy sector with other sectors of the economy are numerous. Energy consumption is ultimately determined by a multitude of influential factors, among which the economic development and the evolution of price are significant parameters. Other groups of exogenous parameters are the population, the availability of resources (capital, manpower, energy, etc.), the social development, technical knowledge and know-how, structural changes in productive sectors, etc.

Energy demand for a specific end use is very much related to levels of economic activity in that end-use sector. This, in turn, is closely related to levels and rates of growth of activity in the whole economy. In addition to such linkages from the economy to the energy sector, there are also feedbacks from energy to the economy, which should be recognized in a fully integrated energy analysis framework. Fig. (1) illustrates such an intersectoral relationship.

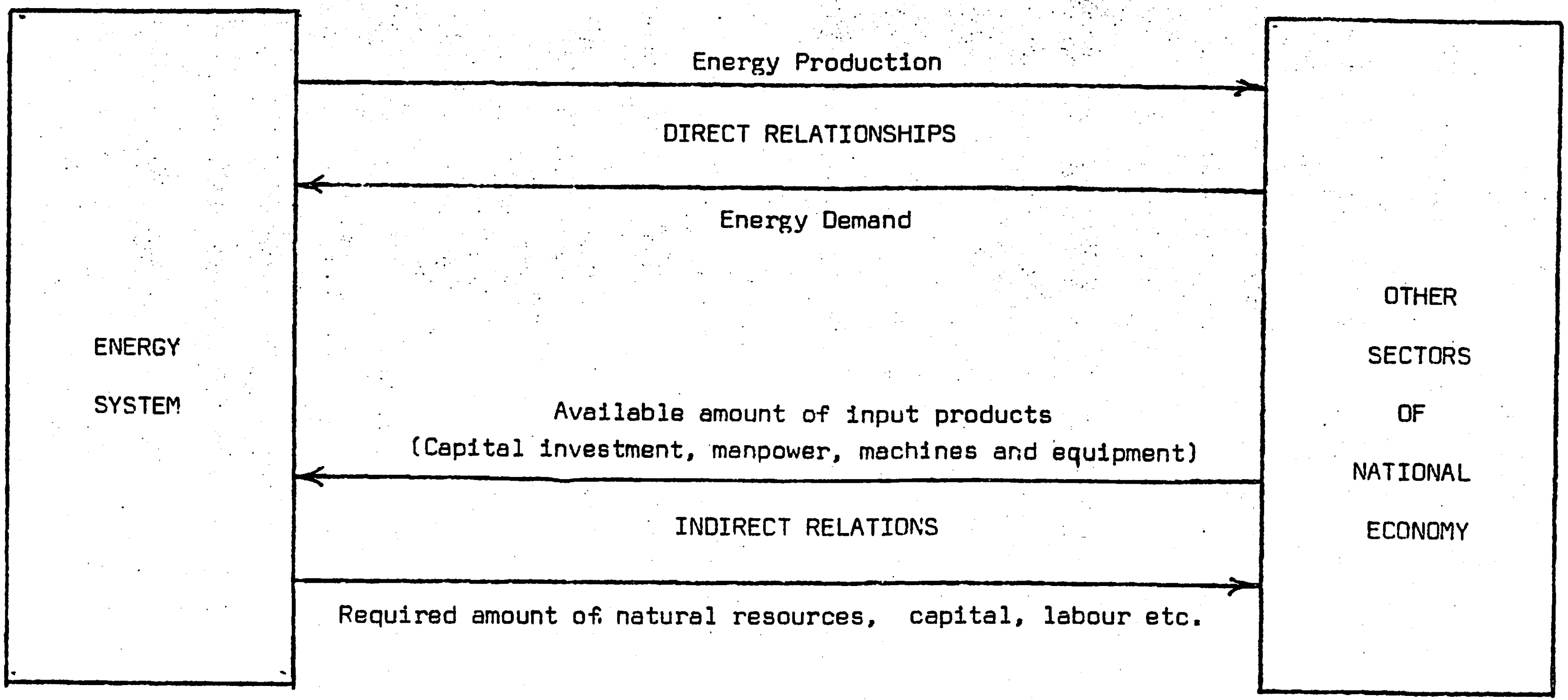


Fig. (1) Intersectoral Relationships

It is noticeable that the interrelationships between the energy system and all sectors of the national economy makes it virtually impossible to try to study the energy system in isolation.

Technology also, of course, contributes directly to a determination of fuel market shares by delimiting the extent of interfuel competition that is possible in any market at any time. It is clear that electricity has virtually insignificant role to play in road transport in Egypt with present state of the used technology. However, it is less clear that this will continue to be true over the next decades (e.g. the subway in Cairo & electrification of railways). Just as changes in technology impinge on energy demand projections by increasing the range of uses for a particular source.

Technological progress may also serve to extend the number of sources available for a particular use, both through the development of new sources and the design of appropriate delivery or conversion systems for existing sources. In addition, the energy intensity of the range of goods and services demanded and produced is a function of the state of technology as it is reflected in production processes.

These types of interconnections between energy, economy, technology and social systems should be taken into account in the process of establishing data base and carrying out energy analyses. Fig (2) illustrates the interrelationships between long-term socio-economic development and

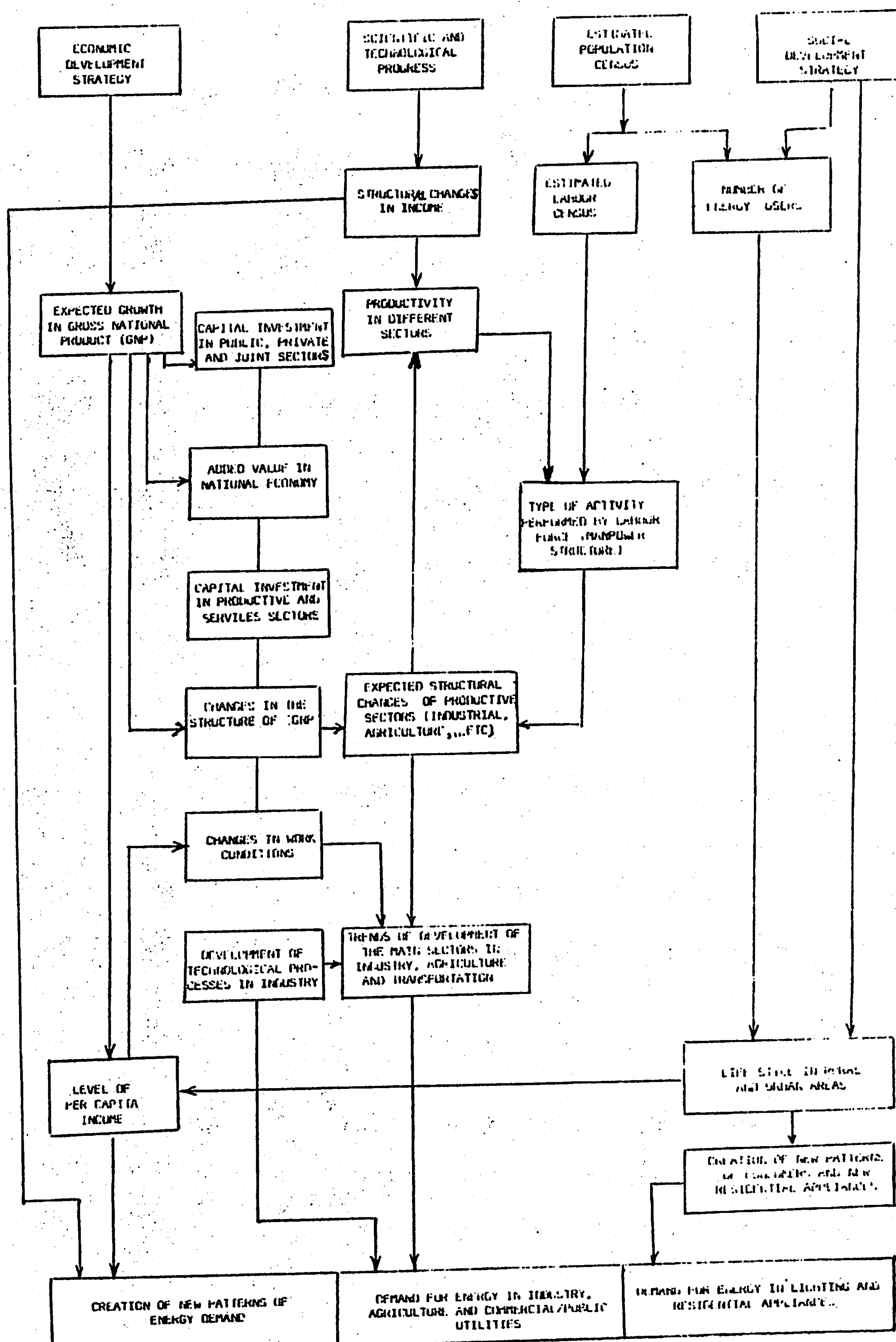


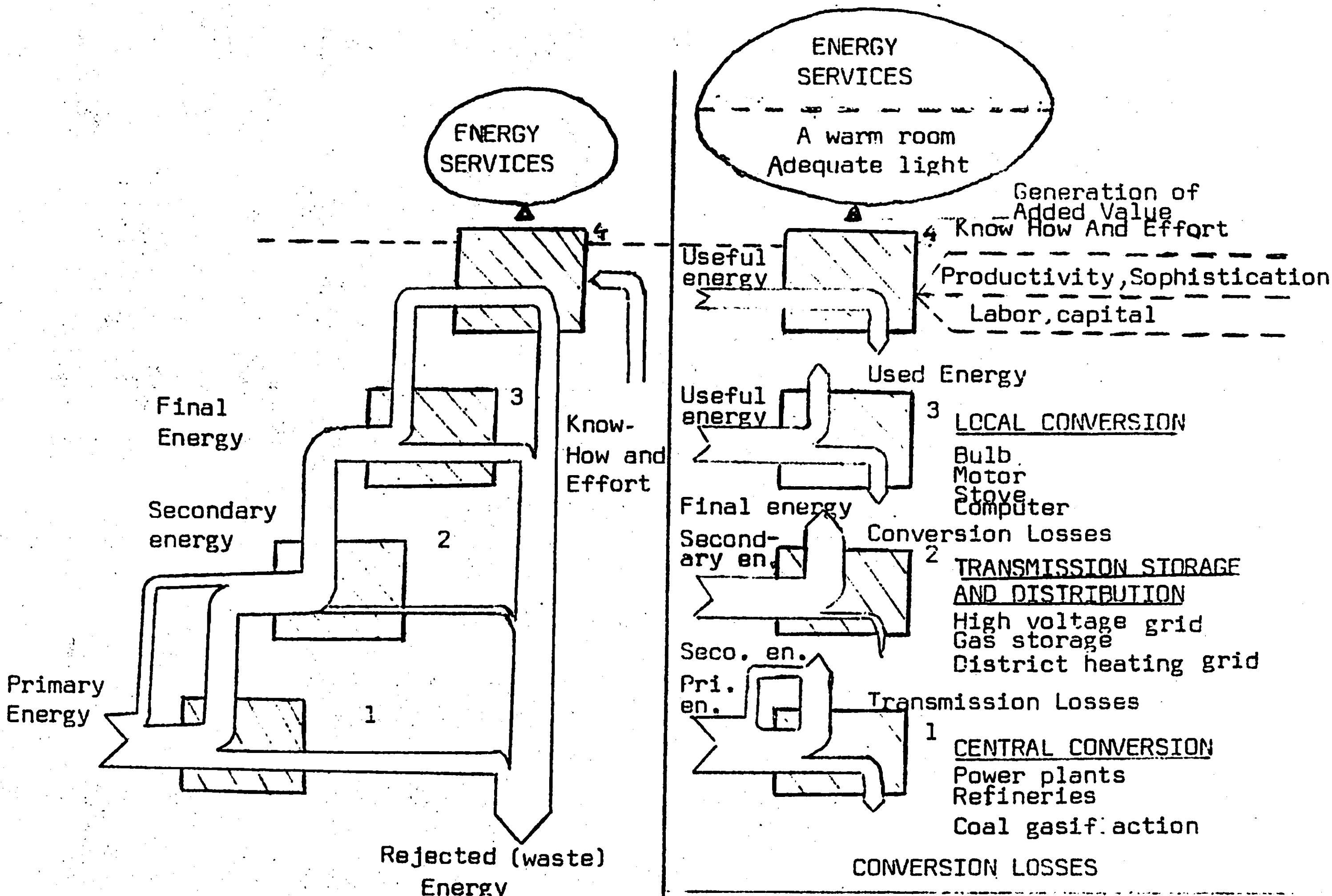
Fig. (2) Interrelationships between the Development of National Economy And The Development of Energy Demand.

the energy demand development. In this respect, it is noteworthy to mention that energy is never an end in itself. It is always one element in the overall situation. In most energy decisions, there will be a trade-off between energy and other elements.

1.2 Delimitation of Energy System.

The energy system encompasses a wide span of diversities, including the multifacetted occurrence of energy forms, the different discovery techniques for intensive harvesting, the complexity of the consumption system and the speed of the adoption for use of the different fuel types within the system. As these factors are of equal importance for the energy system, owing to their multitude they have to be carefully considered for the system under study.

Fig. (3) illustrates the flow of energy from the point of extraction until the usage by the potential consumer. Energy is mostly not usable in its forms of occurrance. It passes through one or several transformation sectors until it is made available in usable forms for the consumer. The term "consumption" should not be interpreted as an anonymous single nationwide energy-devouring unit, but as the specific energy and fuel type that is consumed by defined groups of individuals in sectors of the economy: industry, transportation, agriculture, households and services.



1. Conversion From Primary to Secondary Energy.
2. Transformation from Secondary to Final Energy.
3. Conversion from Final to Useful Energy
4. Energy Services.

Fig. (3) Energy Flow

Source: Haefele, W; "Energy in a Finite World, A Global Systems Analysis", IIASA, Ballinger Pub. Co., Cambridge, USA, 1981.

Although energy analysis can be performed under different perspectives and for different purposes, it is primarily for Egypt at the national level that energy supply and consumption studies and their relationship to the economy and the society become essential as bases for socio-economic planning purposes. Of course, the greater the disaggregation that can be achieved and the better that their interdependency can be displayed, the more valuable the information is for the planning procedure.

Fig. (4) displays the general scheme of the sectoral energy consumption and supply equilibrium with its main sources of fuel supply. This simple structure conceals the wide-stretched net of interactions and dependancies among the different parameters and elements of both sides.

As indicated in Fig. (3), each energy source is subject to transformations in order to be suitable for its defined purpose that is to render finally a certain energy service.

To visualize in one example the detailed interface of sources of energy supply and patterns of energy-use, the household sector has been chosen arbitrarily. Presenting the appliances being used in the residential purposes, the connection between energy supply and consumption can be presented intelligibly in Fig. (5).

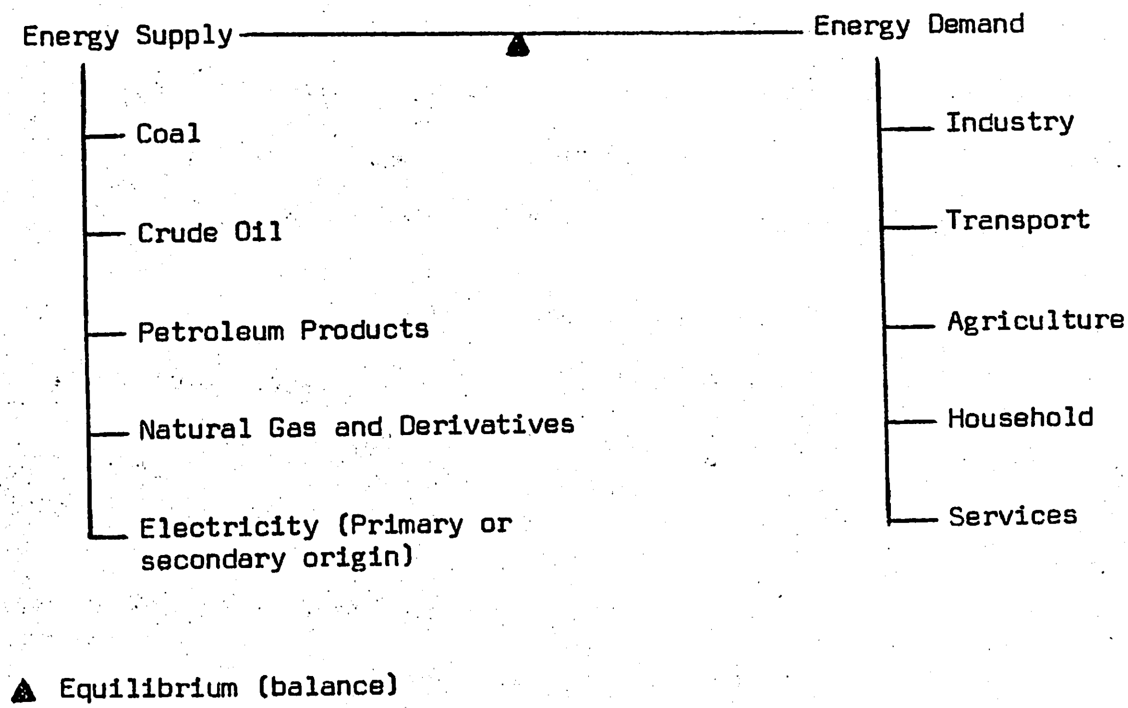


Fig. (4) General Scheme of Energy Supply and Sectoral Energy Demand

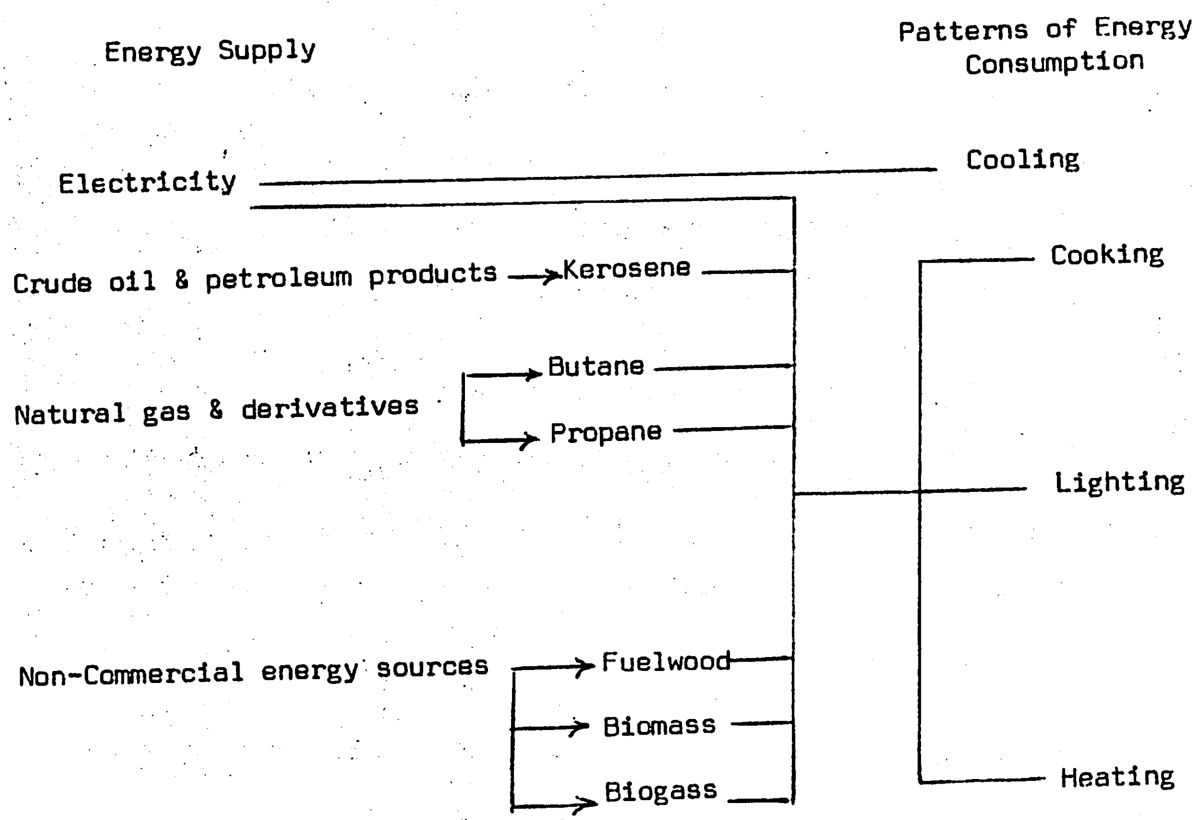


Fig. (5) Energy Supply and Patterns of Energy Consumption in the Household Sector.

1.3 Conceptual Framework for Integrated Energy Planning.

Planning is deciding on a desired future and establishing the ways and means to obtain it. Knowledge about the present situation and the historical evolution is essential to the planning process, since it constitutes the basis for analysis. As pointed out, energy is an important component of the economic activities and therefore energy planning has to be part of the overall socio-economic planning.

The traditional approach to energy planning basically consisted of a global and sectoral analysis of the past and future trends in energy demand and attempted to design a series of major investment projects that supposedly optimized energy supply. Aprogramme of financing based on domestic and international resources was sometimes included.

Virtually previous studies emphasized the relationship between total consumption of primary energy and economic development represented by gross domestic product trends. It was argued that there is a close relationship between the two variables, illustrated by the classic exponential model of constant product elasticity. During the 1960s and 1970s, an attempt was made to explain variations in elasticity by linking them to different stages in the development process. Later, time and socio-economic indicators were introduced in the model by French and Argentinian planners as explanatory variables (9).

Once total demand for primary energy and electricity was determined and broken down by sectors, a series of investment program was proposed for each of the main commercial sources, based on the implementation of specific large-scale projects designed to exploit identified local resources. The resulting gap between demand and supply was covered by imports (mainly crude oil and refined petroleum products) from the world market, which was regarded as an almost limitless sources. A typical example of this kind of planning in developing countries can be seen in the succession of plans prepared in Egypt and India.

The main criticism that can be made of this approach to energy planning is that it is too aggregated to establish relationships between variables that were not really representative of the two phenomena that were being analyzed: energy requirements and economic development. On the one hand, the variable representing energy requirements excluded non-commercial energy sources, and referred to gross primary energy rather than useful energy, that is, energy actually used in the form of heat, mechanical work and light by the final end-use. On the other hand, gross domestic product was used as the only, or ,main indicator of economic development, which is inappropriate, especially when applied to developing countries.Such an approach also disregarded analyses of the structure and level of demand, as well as the impact of prices on demand. While this approach was more or less acceptable in times of price stability, it has clearly ceased to be valid in the circumstances that have been characterized the world energy market since the mid-1970s.

On the question of supply, independent analyses were made for each energy source. These left little room for considering fuel substitution as a possible option. This kind of planning also frequently overlooked factors relating to the financial resources, in local and foreign currency, and the human resources needed to implement all the envisaged projects.

To sum up, current planning systems are essentially technocratic in nature. They are dominated by a set of energy models that were developed by engineers and economists connected with modern, centralized energy supply systems and do not enable proper account to be taken of the needs and interests of the final users, either in productive activities or in activities connected with the livelihood and comfort of people.

To propose an appropriate approach to energy planning, it is important to take the following into account: the socio-economic characteristics of the country(especially the rural-urban dichotomy), the availability of socio-economic and energy data; all the energy sources used by the system, commercial or non-commercial; the contribution of nonrenewable sources of energy; the specific ecological and climatic conditions of the country, the socio-cultural factors of energy supply and demand; and energy needs, not just demand, expressed in terms of useful energy rather than net or gross energy.

Integrated energy planning must start from an understanding of national goals. It must take into account the political, social and financial constraints under which the country must function. Integrated energy planning can provide the means to carry out a systematic evaluation of the country's energy-related policy alternatives and relate them to the performance of the economy. The energy planner's objective is to secure a least-cost option to satisfy future energy needs. In addition, it it is necessary to consider broader objectives including such aspects as the trade balance (exports and imports), development of industry intensively associated with the energy sector, research and development, technological progress, manpower, etc.

The major components of integrated energy planning process include:

- the assessment of available energy resources and the rates at which they can be developed;
- the examination of the improved technologies that can be employed in the energy supply cycle, from extraction to end-use;
- the identification of energy demand, for all energy resources and products, consistent with projected rates of economic growth;
- the balancing of energy supplies with demand;
- the evaluation of the economic, social and environmental impacts of energy development alternatives; and

- an action plan, a series of actions and programs, which must be formulated to meet energy requirements for a specified period in the future.

This integrated analytical approach to energy planning provides decision-makers with a broad base of information that can help them define and evaluate policy options for allocating energy resources in line with overall economic objectives.

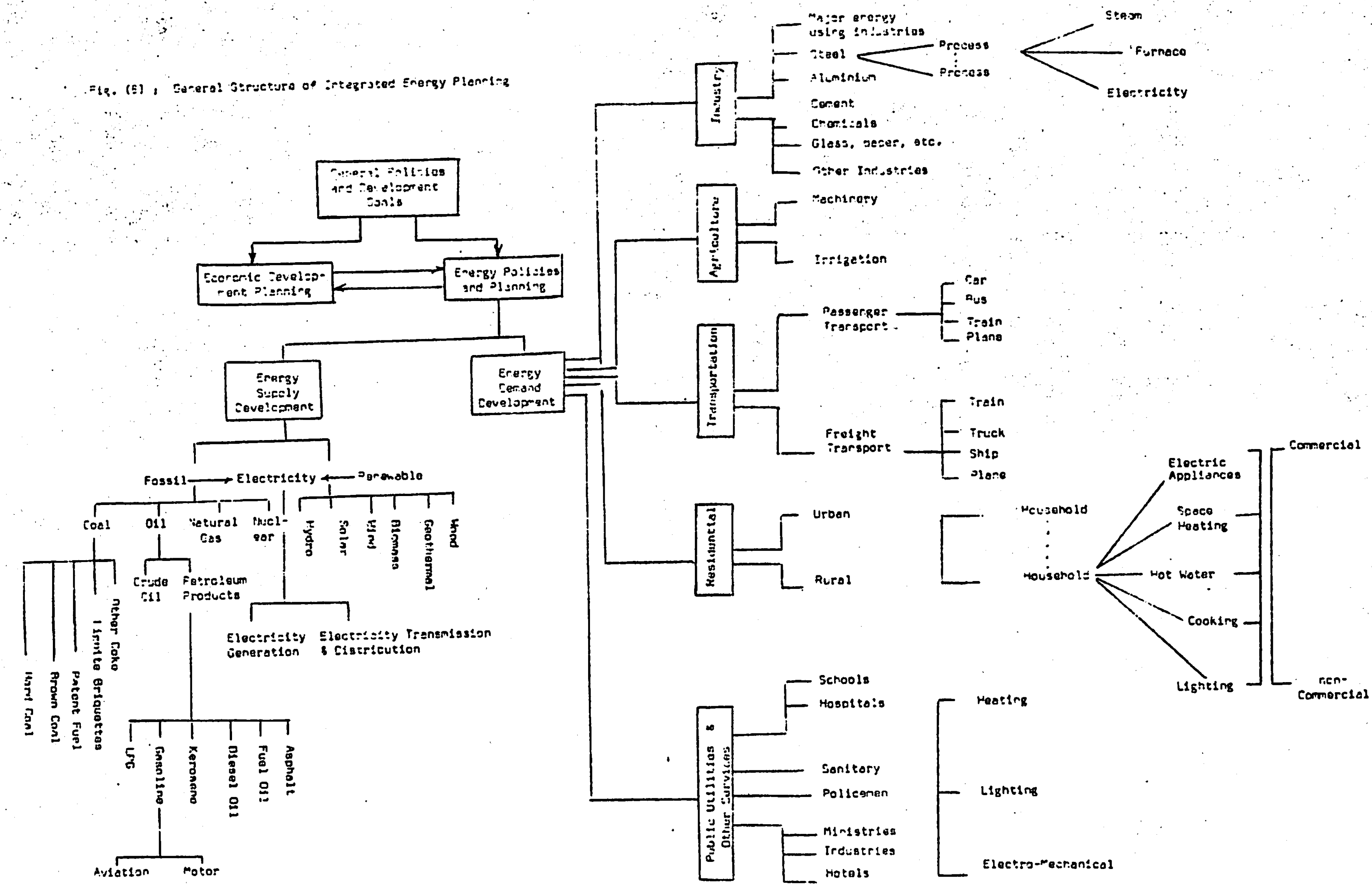
In this respect, it is perhaps useful to distinguish three categories of planning:

- short-term, corresponding to specific projects;
- medium-term, corresponding to development programmes; and
- long- term pertaining to policy guidelines and strategies.

For these three categories, the uncertainties grow with the range one want to cover. Short-term energy planning, for instance, incorporates certain demand uncertainties but practically no supply uncertainties. Whereas long-range planning concerned with uncertainties in both demand and supply.

Fig. (6) illustrates the general structure of integrated energy planning. It shows the disaggregation of energy supply and demand categories. It covers the various forms of energy sources (coal, oil, natural gas, nuclear energy, electricity, renewable sources of energy, etc.)

Fig. (5) : General Structure of Integrated Energy Planning



and the final energy use categories (industry, transport, agriculture, residential, public utilities and other services) up to the useful energy used by various devices and equipments. In addition, Fig. (6) shcws that energy sector development and planning are also closely tied to the overall national policies and development goals.

1.4 Analytical Approach to Integrated Energy Planning and Its Major Elements

Table (1) and Fig. (7) show the major areas for energy analyses, their objectives, the type of personnel existing (or must exist) in the energy planning community, and the typical organizations that might be involved.

1.4.1 Demand analysis

The analysis of energy demand can be carried out at two levels, as indicated in Table (1), The development analysis focuses on the overall growth and development plans of the country, while the sectoral demand analysis deals with the details of the energy consumption pattern in the major energy-using sectors.

1) Development analysis

The principal objective of development analysis is to prepare a representative set of national economic growth and development scenarios. These scenarios are formulated to describe the alternative targets that

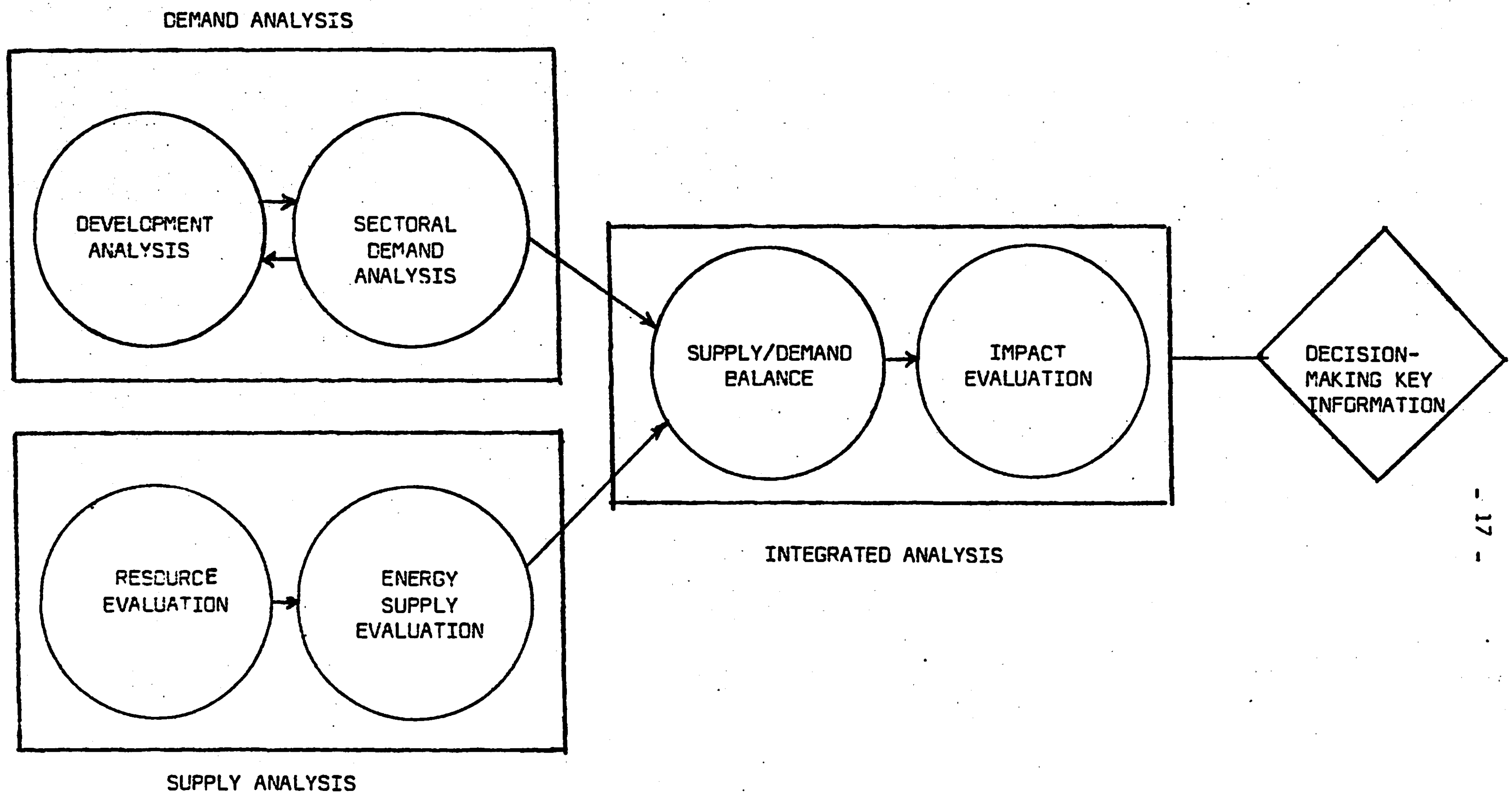


Fig. (7): Major AREAS FOR INTEGRATED ENERGY PLANNING

Table (1): Major Areas for Integrated Energy Analysis

Major Elements of Integrated Energy Analysis	Data Base Area	To Measure/ Analyze	Objective	Typical Expertise of Personnel Involved	Typical Government & Private Organizations Involved
Demand Analysis	Development Analysis Sectoral Demand Analysis	- Economic Growth - Sectoral Composition - End-Use Energy - Options for Change - Alternative Scenarios	To provide projections of end-use energy demand for a number of scenarios.	Planning, Engineers, Economists, Demographers, Financial Specialists.	National Planning Committees Councils, Ministries of Planning, Finance, Economy, Industry, Agriculture, Housing, Transportation, Rural Development, Industrial Enterprises (Public & Private), National Banks.
Supply Analysis	Resource Evaluation	- Resource Availability - Technology Alternatives (energy conversion technologies) - System Performance - Costs - Production Constraints - Environmental Conditions - Alternative Configurations	To provide the possible structure of the energy supply system	Geologists, Geophysicists, Hydrologists, Engineers.	Ministries of Natural Resources, Mining, Energy, Geological Survey.
	Fossil Energy Evaluation			Engineers, Economists	Ministries of Energy, Coal, Oil, Gas Companies, Refinery Companies.
	Renewable Energy Evaluation			Engineers, Economists, Researchers.	Ministries of Energy, Water Supply, Research Organizations, Universities, Nuclear Power Authority.
	Electric Energy Evaluation			Engineers, Economists, Planners	Ministries of Energy, Electricity, Electric Utilities, Rural Electrification Organization.
Integrated Energy Analysis	Supply/Demand Balance	- Fuel Mix - Technologies Available - Resource Production Rates - Fuel Pricing - Import/Export Levels - Energy Policy Considerations - Costs	To structure the data base into a consistent framework to supply decision-making information.	Engineers, Economists, Planners,	Ministries of Planning, Energy, Electricity, National Banks.
	Impact Evaluation	- Energy Resources Requirements - Indigenous Resource Use - Energy System Efficiency - Capital Investment Requirements & availability - Manpower Requirements & Availability - Material Needs & Availability - Local Construction Capability - Balance of Payments - Environmental Impacts - Socio-economic, Cultural & Institutional Constraints	To compute the Impact of a particular supply/ demand balance for a series of alternative scenarios.	Planners, Engineers, Economists, System Analysists.	Ministries of Planning, Energy, National Planning Councils & Committee.

the country might achieve in the course of its growth given certain assumptions. Because of the uncertainties inherent in forecasting, the projections are interpreted as a set of alternative scenarios that are intended to braket the future, rather than predictions of more specific future events. In this respect, the set of assumptions that are used to develop the scenerios must be clearly defined.

An example of possible alternative scenarios is presented below:

Development Scenarios:

- High economic growth rate.
- Moderate economic growth rate.
- Business as usual (historical trend).
- Emphasis on agriculture and land reclamation (food security).
- Emphasis on industry.
- Emphasis on infrastructure.

Energy System Scenarios

- System as usual (historical development).
- Emphasis on coal.
- Emphasis on renewables.
- Diversified supply system.
- Emphasis on nuclear energy.
- Intensive electrification.

In addition to formulating the development scenarios, the development data task must also provide insight into other aspects of the general economic picture. Assembly of data on historical energy use patterns, economic and social factors affecting energy consumption, demographic characteristics, labour availability, and financial resources is also included in this task area.

2) Sectoral demand analysis

The principal objective of this analysis is to identify opportunities for changing the energy use patterns in the major sectors; industry, transport, agriculture, residential, commercial, public utilities and other services. These changes can have significant impact on the energy requirements of the country and include actions such as reducing total energy demand through improved efficiency, fuel switching, substituting industrial processes which are less energy intensive, and others. These energy demand modifying actions can become part of an overall country plan to meet growth and development objectives.

In order to carry out this analysis, the energy demand should be expressed in terms of "end-use energy" rather than fuel type. Table (2) shows the kinds of end-use categories used. By expressing demand in this format it is possible to identify opportunities for fuel substitution. The integrated analysis will evaluate the alternatives on the basis of overall cost competitiveness, among other factors.

Table (2): End-Use Energy Demand Categories

Sector	End-use Demand Category	Additional Disaggregations
Industry	Direct Heat High Temperature Medium Temperature Low Temperature Indirect Heat High Temperature Medium Temperature Low Temperature Electro-Mechanical Feedstocks	By Industrial Sub-sectors Steel & Iron Industries Cement Industries Chemical Industries Textile Industries Food Industries By Enterprise, by Technology/process
Transportation	Auto Bus Truck Railway Aircraft Waterway	By Passenger/Freight, By Technology
Agriculture	Machinery (Tractors, Combines, etc.) Irrigation	By major crop
Residential/Commercial	Heat (Electric appliances, Space heating, Hot water, Cooking, etc.) Lighting Electro-Mechanical	By Urban/Rural Areas By Commercial/Non-commercial By Household

In addition to identifying means of changing energy use, this task provides more detail to the very aggregated scenarios of the development analysis.

1.4.2 Supply analysis

The supply analysis is carried out in four areas, as indicated in Table (1). This division reflects the different aspects of the energy supply system.

1) Energy resources evaluation

Resource evaluation addresses the availability of energy resources in the country. The resource evaluation includes fossil fuels (coal, oil, natural gas, etc.), nuclear materials (uranium, thorium) and hydro-electric potential.

For the fossil fuels and nuclear materials, the intent is to estimate reserves and to identify possible constraints to the exploitation of those reserves. These evaluations will determine what the practical limits are on the use of indigenous resources.

2) Fossil fuel evaluation

The primary objective of this evaluation is to review the means by which fossil fuels are currently used and to identify alternative ways that may be used in the future. This activity provides the information necessary to determine the most cost-effective way in which fossil fuels can be used to meet end-use energy demand.

Data are to be collected on the existing fossil fuel supply system (e.g. oil and gas wells, coal mines, refineries, fuel processing plants, pipelines, etc.) in terms of availability, costs, technical performance parameters, and prices for the various fuels. Plans for the expansion of the fossil fuel system are reviewed, and the set of alternative fossil fuel supply system configurations that might be considered are identified.

The purpose of this evaluation is not to project fossil fuel demand, which will be done when the supply system is matched to the demand requirements in the integrated analysis. Rather, this review establishes the bounds and constraints under which the fossil fuel supply system must operate. For example, it will identify maximum possible coal production from a given mine or the maximum petroleum product outputs from the country's refineries.

The details of how much of these maximum amounts will actually be required will be determind in supply/demand balance.

3. Renewable resource evaluation

The evaluation of renewable energy resources (solar, wind, biomass, hydro-electric, geothermal, etc.) includes not only the estimation of the resource base potential, technology applications, and system capital and operating costs, but also the examination of factors that may hinder or enhance the implementation of the technology. The types of technologies considered are shown in Table (3).

Table (3): Renewable Resource Evaluation Parameters

Technology	Resource Base Definitions	Typical Potential Applications
Direct Solar	Solar Insolation	Water Heating
Thermal		Space Conditioning
Photovoltaic		Electricity Generation
Wind	Wind Velocity	Electricity Generation
	Profile	Motive Power
Biomass	Crop Residues	Gas Generation and
	Animal Wastes	Combustion
	Urban Wastes	Direct Combustion
Geothermal	Temperature Profile	Space Heating
		Process Heating
		Electricity Generation
Hydroelectric	Flow Rates	Electricity Generation
& Mini-hydro	Hydraulic Head	Motive Power

The penetration of these renewable technologies into the market is based on a comparison of their costs to conventional systems and on policies that may be adopted to accelerate this penetration. This part of the analysis establishes the limits to which the technologies can be employed.

4. Electric sector evaluation

This area of analysis encompasses a review of the existing electrical system (including electric generation, transmission and distribution) and an evaluation of future electric system expansion. The electric sector evaluation includes all types of generation plants (steam, diesel, hydro-electric) and reviews both interconnected and isolated systems.

The matching of supply and demand in the integrated analysis may result in different electrical requirements under various scenarios. The country's electric power system plan is used as the starting point, and modifications to that plan that would be needed to meet the alternative future scenarios can be developed.

1.4.3 Integrated analysis

Integrated analysis puts all of the data collected and analysed on energy demand and supply sides into a consistent framework to provide means for evaluating alternative energy strategies on a consistent basis. In general the supply/demand balances is set-up first, and then the impact assessment is carried out to evaluate the alternative strategies.

1) Energy supply/demand balance

Energy supply/demand balance is the assembling of information from the data base into the framework prescribed by the computational procedures chosen. This can be done in a matrix form as in „Energy Balance Sheet", or in a network formulation, as known in the „Reference Energy System (RES)". A national energy balance is a supply/demand account that shows for a given time period and for a given territorial area the origins and uses of all energy sources or fuels, all expressed in a single accounting unit. The basic logic of such a balance may be set out in a number of different ways, but one of the most common is as follows.

Energy Production + Imports - Exports ± Stock Changes - Transformation Inputs = Final Energy Use.

The national energy balances are discussed in more detail in chapter III.

2) Impact analysis

A set of impacts of the energy system on the economy can be inferred from the construction of the supply/demand balance. This includes the need to invest capital in the construction of energy facilities, the need to expend operating funds for the import of energy resources and technologies, the need for various categories of manpower to build and operate the energy system, the resulting price of energy to the other sectors of the economy; and the effects of these price changes. The national energy balance must be evaluated in light of these impacts to provide the planners with the necessary information for decision-making.

In addition, the emphasis in impact analysis is on establishing what the current environmental conditions are and on determining where serious environmental impacts could occur from energy system development. The importance of environmental and social factors in national development planning and project appraisal are increasingly appreciated and are, of course, equally relevant in energy planning. Competent technical information and data are required for useful analysis. This area of analysis gained vital importance in Egypt in recent years owing to the possibility of introducing nuclear power plants to the electric power system in 1995 and later on and due to the emphasis on imported coal for electricity generation in the forthcoming years till year 2000.

CHAPTER II

DATA BASE FOR INTEGRATED ENERGY ANALYSIS AND PLANNING

2.1 Reflections on the Role of Energy Data Base in Energy Planning

All planning depends on adequate and relevant information, but information is not an end in itself. Planning and statistics are factors conditioning each other. The collection of data must be based on a clear perception of the energy decisions and issues to be addressed. There is a large range in complexity and time periods. For example, emergency planning, financial resource allocation and pricing require essentially current information, long-range national planning requires a perspective of at least 20 years.

Two stages of energy analysis, and consequently two phases of energy data collection and treatment, can be distinguished in many developing countries (including Egypt). During the first stage, much attention must be given to assembling basic energy supply-demand balances on readily available data. The second stage of energy analysis entails a more ambitious level of energy data collection that require greater commitments of scarce manpower and funds and more careful design of programs. So do refinement in planning techniques call for improved statistical support. The enlargement of the data base enables more detailed analysis of planning aspects. Depending on the scope and objective of the planning process, i.e. energy project or object oriented (single energy form), sectoral or national planning, the relevant statistics of energy and related subjects have to be placed accordingly.

Although energy analysis can be done under different perspectives and for different purposes, it is at the national level that energy supply and demand studies for Egypt and the relationships to the economy and the society became essential as basic for planning purposes. A fundamental requirement for integrated energy planning in Egypt is to develop a data base which enables energy use to be related to all various activities in the national economy.

An appropriate energy data base serves benefitial for any country in performing the task of satisfactory energy planning. But, as the potential inherent in an unsuitable information structure could cause negative biased orientations in planning. The manpower attributed to the provision of information should collect data in a consistent, systematic and dynamic manner.

It is beyond question that apart of comprehensiveness, the internal consistency and comparability are pre-conditions for energy data base. Thus, the general system of basic energy statistics has to include elements such as the framework of classifications and appropriate methodologies, as well as the definition of the interfaces between the energy sector and other sectors-for which plans and policies have to be integrated with energy policy...

2.2 Scope and Requisites of Energy Data

In order to make available a basic set of data concerning energy processes and activities, the following types of statistics are essential on a regular basis. Economic, socio-economic and financial information is a necessary complement to energy data for planning purposes. Although this type of information is not always regarded as energy data, decisions are based on costs and on the economic and social impacts and without them planning is not useful. It is evident that energy data encompass a wide range of parameters. No attempt shall be made to present an exhaustive list, only basic data requirements shall be mentioned, particularly those needed for effective policy making and planning.

All data, available and required, determined to be necessary for integrated energy planning are selectively grouped into the following six major categories:

1. Energy resource data:

This category should include exploration data on all existing domestic energy resources in terms of geological, geographic distribution and economic feasibility information.

- Types, extent and feasible rate of production of domestic energy resources, mainly

    fossil fuels (onshore and offshore),

    nuclear energy,

    renewable energy sources (hydroelectric, solar, wind, biomass)

Data concerned with fossil fuels must distinguish between "known" or "proven" and "inferred" or "interpolated" categories.

- Price thresholds for domestic resource development and production, compared with current supply alternatives, in terms of both technological costs and economic costs and benefits.

- Expected future costs for renewable energy resources.

2. Energy supply data

This category is concerned with data on primary energy production; foreign trade and energy converted or transformed in thermal power stations, oil refineries, NGL plants, gas works, coke ovens, blast furnaces plants, etc. It also includes energy-related technology and cost data.

i- Primary production data

- Rates and costs of production of primary energy commodities.
- Stock changes at producers' facilities, by fuel type.

ii- Trade data

- Quantity and value of imported primary and secondary energy commodities.
- Quantity and value of exported primary and secondary energy commodities.
- Stock changes at importers and exporters, by fuel type.
- Quantity and value of marine and international air bunkers, by fuel type.

iii- Data on energy converted or transformed:

- Generation of electric energy in power stations.
- Production of petroleum products, by fuel type, in oil refineries and NGL plants.
- Output of solid and gaseous products (by fuel type) in gas works, coke ovens, blast furnaces.

iv- Energy - related technology and cost data

This is a vast and complex area covering a set of technical and economic factors which influence the structure of the energy system and its supply patterns.

On the technical side this refers primarily to characteristics of the transformation and extraction sectors.

a. Technical energy-related parameters

Extraction: Primary, secondary or tertiary recovery techniques.

Refineries: capacity, structure, conversion efficiency, self energy consumption and losses, facilities' lifetimes, expected retirements of existing facilities, transportation and distribution losses, non-energy uses of refined products e.g. asphalt and sulphur.

Electric power stations: installed and available capacity, load and capacity factors, availability, utilization factor, conversion efficiency, self energy consumption and losses, specific fuel consumption, lifetimes, expected retirements of existing facilities, transmission and distribution losses.

b. Economic energy-related parameters

- Retail price structure.
- Posted prices.
- Electricity tariffs.
- Subsidies.
- Investment (capital) costs and annual operating costs of transformation centers, both local and foreign currency components.
- Materials and equipment requirements and local availability.
- Labour requirements and local availability.

3. Energy demand data

Two categories of information are needed. The first refers to current energy-using activities and the fuel consumed by these activities. The second concerns projections based on future activities and related energy demand. Energy demand information is concerned with data on:

- Total energy use.
- Total commercial and non-commercial energy use.
- Total commercial energy use by major sectors (industry, transport, agriculture, residential, commercial and other services).
- Fuel breakdown by major consumer groups (subsectors, e.g. aluminium plant, steel mills, fertilizer plants, cement manufacturing, etc.)
- Sectoral energy use parameters; e.g. peak demand, load factor, power factor, loss of supply, percent night use (status during daily peak load).

Forecasts and projections are based largely on historical data, but supplementary economic data and regionalized information are also needed.

Data requirements for key sectors on energy demand are classified in more detail in section 2.3 .

4. Financial data.

- Market prices for domestic, imported and exported energy resources (current and expected future prices).
- Financing sources and repayment terms.
- Discount rates for present worth value computations.
- Cost escalation of energy facilities.
- Inflation rates.
- Currency exchange rates.
- Operating expenses.
- Interest expenses.
- Gross revenue.
- Net operating income.
- Fixed and current assests, investments, long-term debts.

5. Economic data.

- Tariff Schedules.
- Consumer price index - rural and urban.
- whole-sale price index.
- Gross Domestic Product (GDP) at current prices, GDP deflated value by kind of economic activity.

- Gross national product (GNP).
- Expenditures of GNP (GDP).
- Gross capital formation by type of goods.
- Energy cost to the economy or energy revenues.
- Trade balance and balance of payments.
- Industrial production index or value added by major industries.
- Economic indicators: opportunity cost of capital, opportunity cost of labor, shadow prices of foreign currency, official exchange rates.

6. Socio-economic data

The term "socio-economy" comprises all those lifestyle and behaviour parameters of a country that are measurable and directly to energy linkable. This category is concerned with demographic data and encompasses a broad spectrum of parameters. The different behaviour pattern of individuals or groups in Egypt differ remarkably, depending on location, access to facilities, habitation, etc.

However, the minimal data requirements for the economic system with regard to energy consist of:

- Total population and households.
- Urban and rural population and households.
- Per capita income and/or income level.
- Urban and rural incomes.

In anticipation of the detailed analysis in chapter V and in avoidance of duplication, it should be permitted to refer to Table (7) which displays selected socio-economic parameters that meet the conditions of measurability and linkage with the energy system.

2.3 Detailed Data Requirements for Key Sectors on Energy Demand

The provision of useful energy to end-use consumers (devices) opens the second dimension of the energy data base. The central core of the data needed for energy planning is information on energy demand. The higher the disaggregation the more precise the originators of a specific consumption behaviour with regard to the energy-use can be described and analysed. However, due to the lack of information on energy requirements by end-use devices, such detailed presentation is presently difficult to approach for Egyptian energy system.

To determine a trade-off between both extremes, high disaggregation versus high aggregation of information needed for carrying out in-depth analysis of energy demand, the following categories of final energy-use have been defined: industry, transportation, agriculture, households, commerce, public utilities and other services.

In the following, three types of information are distinguished. The first is information regarding current national energy using activities and fuel consumption. Activities are expressed in terms such as steel, cement, ... etc output in tons or households doing cooking or ton-kms freight transport, etc. For each activity information is required on the amount of various types of fuel used to carry out the activity, e.g. the amount of oil, natural gas or other forms of energy used to produce cement and the amount of kerosene and liquified petroleum gas (LPG) used for cooking. Generally a base year can be decided upon and a consistent set of data must be collected for that year.

The second kind of information that must be collected is that required for projections. Projections are usually based on activity levels, so historical data are needed on those activities or plans of those activities or their determinants. A third type of information would include special supplementary data and regionalized information.

1. Industry.

Below is a partial list of major energy using industries:

- Aluminium plant
- Iron and steel mills
- Fertilizer plants (urea as well as natural gas)
- Cement industries
- Metallurgical industries
- Chemical industries
- Engineering industries
- Textile industries
- Food industries

a) Basic data:

- Output of major energy using industries (tons per year and value added).
- Fuel use and electricity use by industrial sectors.
  - Fuel used for production processes or heat requirements
  - Feedstocks
  - Self producing of electricity and steam for heating (feedback)

b) Projections data

- Historical trend of output by industry.
- Historical trend of energy use, by fuel types.
- Plans in each industry for expansion of productive capacity.

c) Supplementary data.

- Regional break-down of data.
- National industrial development plans, policies and strategies.
- Employment by industry.

2. Transportation.

The distinction is made according to the transported object (passengers, goods), the respective mode of transportation (car, bus, truck, train, plane, ship) and the type of fuel used (gasoline, diesel oil, jet fuel, fuel oil, etc).

A) Passenger transportation.

a. Basic data,

- Urban transport: passenger-km travelled by private cars, bus, taxi, etc (using gasoline or diesel oil).
- Rural transport: number of autos (car, bus, taxi, small truck, etc.), gasoline and diesel sales and km/liter.
- Inter-urban: passenger-Km travelled by private cars, bus, taxi, railway (train), waterway (ship), plane (domestic airlines).
- Total number of registered autos (cars, bus, taxi, etc), ownership and/or number of registered drivers.
- Energy efficiency of the transportation fleets (auto, truck, etc.).
- Gasoline and diesel fuel sales.

b. Projection data,

- Historical trend of autos' ownership or registered drivers.
- Historical trend of gasoline and diesel sales.

c. Supplementary data,

- Regional break-down of basic informatoon given in section (a) above.
- Income dependence of the basic data given in section (a) above.

B) Freight transportation,

a. Basic data.

- Ton-km of freight transport broken down by truck, rail, ship and plane.

- Fuel (gasoline, diesel, jet fuel) used for transportation by truck, rail, ship and plane.

b. Projection data.

- Historical data on the aforementioned information.

c. Supplementary data.

- Regional variation of the above data.

3. <u>Agriculture</u>.

a. Basic data.

- Area under cultivation and production in tons.
- Energy use (fuel and electricity) for:

  Farm machinery - soil preparation and cultivations, processing, including drying;

  irrigation.

b. Projection data.

- Historical data on agricultural production.
- National agricultural development plans.
- Land reclamation plans.

c. Supplementary Data.

- Regional breakdown of production and energy use for agriculture.
- Employment by region, by activity.

4. Households.

a. Basic data.

The distinction is made according to location in urban and rural areas.

- Population and number of households in rural and urban areas.
- Appliance ownership (number or fraction of households) according to: kind of stove, kind of lighting, refrigerator, air conditioner, TV, radio, iron and others.
- Hours of use and amount of energy use for each appliance.
- Estimates of devices' efficiencies (relative or absolute).
- Total fuel purchases or use by households.
- Electricity and fuel sales to households.

b. Projection data.

- Historical trends of energy use (fuel and electricity) by households.

c. Supplementary data.

- Fuel prices for residential purposes.
- Fuel and electricity sales by region.
- Information for various income groups.

5. Commerce, public utilities and other services.

a. Basic data.

Energy-use (fuel and electricity) for lighting, air conditioning, heating, cooking and miscellaneous electric uses (e.g. elevators) in:

- Government buildings
- Hospitals
- Hotels and restaurants
- Stores
- Street lighting

Detailed energy-use data for commerce, public utilities and other services are very difficult to acquire in Egypt. Therefore, estimates have to be made by difference between total energy consumption and specific energy uses defined in the previous sectors.

2.4 Sources and Acquisition of Information

From the discussion of the previous sections it is clear that a wide variety of information is required for energy planning and analysis. The collection of basic energy data is a complex and time-consuming process. In many cases it requires adoption of indirect methods and estimation procedures. The complex nature of energy issues involve many ministries, public sectors, organizations and private enterprises. All these organizations are suppliers and users of energy statistics.

Principal existing sources of data in Egypt are:

1. Primary sources, including energy and planning institutions such as Ministries of Planning; Oil; Electricity and Power; Oil Companies; Egyptian Electricity Authority (EEA); Egyptian General Petroleum Authority (EGPA); Electric Distribution Companies; national energy committees, Central Authority for Public Mobilization And Statistics (CAPMAS).

2. Secondary sources, including
   a. Official publications of various national institutions concerned with energy, economics, and finance which include: statistical yearbooks and bulletins; reports and bulletins of central bank; censuses of population, agriculture, industry and transport; budget and expenditure surveys; family survey; publications of the Ministries of Oil, Finance, Electricity and Planning.

   b. Specialized conferences, symposia and workshops held in Egypt and all over the world.

   c. External sources covering publications of specialized agencies or international organizations, e.g. World Bank, United Nations, Organization for Arab Petroleum Exporting Countries (OAPEC) and OPEC .

It is noteworthy to mention that, although information collected in specialized surveys (e.g. expenditure and family surveys) are for special purposes quite separate from those of energy planning, these sources often contain information that is basic to energy planning as well. Secondary sources do require critical examination because their energy information may not have been carefully evaluated.

Given the cost and personnel requirements of detailed data collection efforts it is most important:

i- to make use of all existing sources of information before initiating primary collection efforts and

ii- design collection efforts or surveys around real information needs for planning.

From our previous experience it was found that the weakest area of existing energy information in Egypt is for sectoral energy consumption, and particularly for household sector. This is partly true because non-commercial fuels (such as animal and agricultural waste (biomass) dominate in the mix of fuels used for households in rural areas and partly because of the decentralized or atomized nature of energy consumption. Where different forms of energy such as kerosene, electricity and LPG are used in rural areas, little is known about the pattern of consumption and the relationship between fuel demand and income or the interrelationship between fuels or the role of relative prices and the mechanism of fuel switching. In this respect, a need has been recognized to collect detailed information (using energy surveys and questionnaires) on energy consumption in Egypt.

While the fundamental rationale for energy surveys in the household sector is the design of beneficial and acceptable national supply and pricing policies, energy surveys in the industrial sector can have a practical action-oriented goal. Significant savings in industrial energy consumption can be attained by well dsigned, low cost energy management programs. Well designed programs of industrial energy audits can accomplish two important functions: they can add important information to national energy planning and also form the basis for practical energy conserving actions to be taken by industry. As one moves from industrial energy surveys to detailed plant audits, the requirements for specialized skills increase as do the costs and the benefits to the national energy balance and balance of payments, Clearly such a program is of potentially great national interest and requires careful planning and design.

2.5 Energy Information System And Decision-Making.

The previous exposition gives some thought to the kinds of information that are useful to national energy planning and to the most effective ways in which that information can be collected and used in analysis. Energy information is not an end in itself, it is required as a basis for making policy decisions. At the same time, the decision process may reveal inadequacies in that information. Some of policy decisions are clearly recognized as energy decisions, such as the construction of a new power plant or oil refinery. Others may be viewed as economic, social, transport or industrial development decisions, but they may also have a large energy component. Although we cannot identify national issues in general, there is, in fact, a remarkable degree of uniformity in the important energy issues facing Egypt and we can at least categorize these types of energy decisions as follows:

1. <u>Energy pricing.</u>

Pricing decisions are perhaps the most sensitive of all the energy policies and continue to be one of the most important energy issues between government and lending institutions (e.g. World Bank and International Monetary Fund (IMF)). Considerable information is required to evaluate the social costs and benefits of alternative pricing policies. This includes: amounts of various forms of energy (fuels and electricity) consumed by various income groups, availability of alternative fuels for final energy use and their prices (e.g. Kerosene Vs. LPG and LPG versus electricity ... etc), macroeconomic impacts of fuel prices and subsidies, and the econcmc costs of supplying fuels.

2. <u>Energy Investment.</u>

Energy investment decisions typically have the highest economic visibility since most of the energy projects are capital-intensive. Decisions on investment in new oil refineries, power plants or transmission lines require an understanding of the evolution of energy demand. A wide variety of alternatives often must be considered and various types of impacts (e.g. on regional development).

3. Energy resources allocation.

An effective allocation plan for petroleum products, crude oil, natural gas, electric energy, ... etc requires knowledge of the profile of energy supply, conversion, distribution and consumption. The economic and social impacts of energy resources' allocation must also be considered.

4. The choice of appropriate technology.

The formulation of a national energy plan requires information on: energy resources of various kinds, the current and future costs of various kinds of energy production technologies and the creation of new patterns of energy demand. It also requires an analysis of the economic costs and benefits of investment in energy research, development and demonstration activities particularly in new and renewable sources of energy.

5. Energy system management.

Depending on the institutional structures of the energy sector, the government has various degrees of involvement with the management of the energy system. There is also a need for a central view of consumption patterns and energy conservation in order that the consumption of energy can be made more efficient. This requires a detailed information not only on the quantities of various kinds of energy used at all sectors of the national economy but also the technical efficiency with which that energy is utilized compared to alternatives or international standards.

6. Long-term energy planning.

Long-term energy planning requires a view of the possible energy demand forecasting and the possibilities of fulfilling that demand in various ways. This future view must be based on the analysis of the current supply-demand relationships and the recent evolution of energy demand. It also requires an appraisal of the energy consuming activities rather than fuel consumption. In the industrial sector, analysis and projections should be based on physical outputs and the fuel requirements for that production taking into account the processes to be used.

7. Sectoral development strategies.

Energy information is required also for decisions in other sectors such as industrial development, transportation, housing and rural development. Policy-makers in these sectors must be informed by data on energy availability and costs and the energy implications of alternative sectoral development strategies.

CHAPTER III

METHODOLOGICAL APPROACH TO CONSTRUCTING NATIONAL ENERGY BALANCE

3.1 Introduction

Different energy sources (e.g. coal, oil, natural gas, electricity, water, firewood, wind, etc) have their own particular physical, heat content and other characteristics. Some sources are solid, others liquid or gaseous. Some are primary energy sources (e.g. coal, crude oil, natural gas), others secondary energy forms (e.g. electricity). Each energy source has its own usual unit of measurement, which may differ from country to country.

For some analytical and policy purposes, each energy source may be studied on its own. Whilst for integrated energy planning an overall assessment of energy supply and demand is required, where all these energy sources need to be fitted into a comprehensive and internally consistent statistical framework.

The energy balance is a supply-and-consumption (or demand) account that shows for a given time period and for a given territorial area the origins, conversions and uses of all energy sources, all expressed in a single accounting unit. The time period is most commonly a year, but it may sometimes be a quarter or half-year. The area is usually a country but it may be a region within a large country (e.g. rural area) or it may group more countries together (e.g. Arab countries).

The energy balance is a methodological instrument, which presents in a clear manner the static equilibrium and the complex relationships between the various energy sectors and between energy supplies (producers) and the various socio-economic activities which consume energy. It is a conceptual framework, providing a concise summary of the main features of countries' energy profiles in a specified year. Apart from the fact that the energy balance provides a very concentrated summary of information, it also places emphasis on an area which is relatively neglected in other forms of presentation, namely final energy consumption by sectors and its relationship to primary energy supply. The concise form of the energy balances, allowing the user to see at a glance the data of importance to energy policy, has resulted in wide international acceptance of the energy balances and their use as models in some countries.

The national energy balance may be relatively simple or quite complex. It depends on how many different kinds of energy sources are used, in how many different ways, how much statistical data are available on the various energy operations (i.e. supply, transformation or use of a source) and on how much detail is needed in order to answer a particular question.

The first step in establishing the energy balances consists of collecting both energy data and socio-economic data.

Whilst, the second involves arranging the data into a coherent whole, In order to proceed from the first step to the second, the following points need to be specified:

- Energy flows and operations.
- Energy accounting systems.
- Conversion and equivalence coefficients.
- Sign conventions.

3.2 Energy Flows and Operations

The energy flows illustrate the energy operations taking place between the production stage and the final energy-use.

The energy operations can be classified into four main groups:

1. The availability of energy supplies, which covers all energy operations relating to the extraction of primary resources, energy imports and exports, refuelling at sea bunkers, stock movements.

2. Energy transformation and conversion, which traces the input and output from conversion processes where there is physical or chemical modific-ation of the energy sources in oil refineries, gas plants, electric power stations, etc.

3. Own uses by energy producing industries and other losses which traces the consumption of the energy sector, the transportation and distribution losses and the non-energy end uses (bitumen, oil lubricants, etc..).

4. Final energy use in various socio-economic activities: industry, transport, agriculture, households, commerce, public utilities and other services.

The aforementioned classification is not universal, but it does correspond in its general outline to that proposed by the majority of international organizations(*).

These energy operations constitute the rows of the energy balance sheet, as illustrated in the following Table (4). The various forms of energy, which constitute the columns of energy balance is given in Table (5).

Appendix I on "Glossary of Terms" gives the scope and constituent compenents of the energy operations, and identifies the different forms of energy used in structuring the energy supply utilisation balance.

3.3 Energy Accounting Systems

Quantitative analysis of the energy flows from production to utilisation is not an easy matter. Energy sources are not usually consumed in their primary forms in which they are produced. They undergo one or more conversion operations, which not only change their energy form, but also their energy content. An example is the transformation operation of a

(*) The United Nations Statistical Office, the International Atomic Energy Agency (IAEA), World Bank, European Economic Community (EEC).

Table (4) Rows of Energy Balances
(Energy Operations)

Net primary production
Imports
Exports
Sea & air bunkers
Stock changes
Availability of energy supplies

Energy transformation
  Oil refineries
  Gas manufacture
  Electricity generation
    Public
    self-producers

Energy sector's own use & loss
  Refineries
  Power Stations

Other losses (transportation & distribution)

Non-energy use

Final energy use
  Industry
  Transport
  Households
  Agriculture, Commercial & other services

Statistical differences.

Table (5) Columns of Energy Balances
(Forms of energy)

Solid fuels
Crude oil
Natural gas
LPG
Gasoline
Jet fuel
Kerosene
Diesel / Gas oil
Fuel oil
Bitumen & other petroleum products
Electricity

Total commercial energy

Firewood *

Biomass *
Agricultural residues *
Dung (Livestock) *

Biogas *

Solar *

Wind *

Total non-commercial energy

Total

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* Non-commercial energy can be included when the data would be available.

primary source (e.g. coal, oil, natural gas, etc.) into a secondary source (e.g. electricity). Another example is the transformation of crude oil into different petroleum products (gasoline, kerosene, diesel/gas oil, aviation fuel, LPG, residual fuel oil, bitumen, etc.). As a result, it becomes more complex to describe the flows on the energy balance, since energy conversion operations are expressed as an intermediate stage between production and utilisation. In the energy balance sheet two items are required to represent the energy conversion process-one to indicate the energy inputs into conversion plants, and the other to give the energy output. The difference between the two items is known as the conversion discrepancy, and generally corresponds to the losses incurred in energy conversion.

For establishing the energy balance there are, in principal, three concepts for accounting:

i. The Final Energy Balance:where all energy flows (production, foreign trade, bunkers, stock changes, input and output from conversion, consumption) are expressed on the basis of the real energy content (net calorific value) of each source. This balance indicates the energy supply situation in real terms expressing the quantities of energy that are effectively available, and allowance is made for the losses incurred during conversion operations.

Despite the practical drawbacks relating to the degree of precision required in data collection, this accounting system provides a satisfactory framework for a complete and homogenous description of all the energy operations.

ii. The Primary Fuel Equivalent Balance: expresses the quantities of energy required to satisfy final energy uses on the basis of their primary fuel equivalent. As a result, all the items on the balance sheet are accounted in terms of the volume of primary energy required to produce the supply, Consequently, all secondary energy sources (e.g. petroleum products, electricity, .. etc) have to be accounted in terms of their primary fuel equivalent, i.e. in terms of the quantities of primary energy required to produce them.

Conversion operations do not show any discripancy, i.e. any loss, since only the conversion input is taken into account. However, a suitable conversion coefficient is used to align energy output to input. For new and renewable sources of energy (nuclear, solar, hydro, goethermal energy) used for electric energy generation, a substitution hypothesis is used. The quantities accounted are that of primary fuel which would have had to be burned in equivalent classical thermal power stations in order to produce the same quantity of electric energy.

The drawback of this accounting system is that it overestimates the quantities actually necessary for supply. The limitations of its use in Egypt is that different coefficients would be required to convert derived sources into their primary fuel equivalents. This is mainly because of the disparity in installations and hence the disparity in conversion yields.

However, for practical reasons this accounting system is generally only applies on a partial basis. The concept of primary fuel equivalent is applied to electric energy, whilst the other energy source are evaluated on the basis of their real energy content. This is the so-called partial substitution accounting system.

The concept of final energy equivalent balance is recommended for establishing the national energy balance of Egypt.

All calculations, aggregations and loss accounting have been performed on the basis of real energy content (net calorific value).

3.4 Conversion and Equivalence Coefficients

The energy quantities, in standard practice, are expressed in the following units of measurements:

Coal products: Metric tonnes (t)

Crude oil, petroleum products: barrels (b) or metric tons (t)

Natural gas, gas products: cubic meter (m^3) or Teracalories (Tcal)

Electric energy: Gigawatthour (GWH), ... etc.

In the energy balances, it is necessary to aggregate several forms of energy. In this respect, the problem of equivalence between the various sources of energy arises. The conversion coefficients serve to convert the data, expressed in specific units of measurements, into a common unit, so that aggregations could be performed.

For secondary forms of energy, in particular electricity, these conversion coefficients are governed by the methodological approach adopted towards the energy balance. On other words, these coefficients depend on the energy accounting system used: primary fual equivalent or final energy balance or a mixture of both. The common unit of measurement can be joule, KWh, ton coal equivalent (tce), ton oil equivalent (toe).

One ton oil equivalent (toe) corresponds to the energy obtained by burning one virtual ton of petroleum, of a net calorific value of 10 million Kcal. The ton of oil equivalent is the most appropriate common unit of measurement, given that petroleum is the dominant form of energy in Egypt. It is chosen because it is defined precisely in terms of heat content (10^7 Kcal), thus permitting easy conversion from other specific units of measurement for various forms of energy. Moreover, it is a unit actually used in everyday buisness. It has the added practical advantage that a single table shows both Kcals and tons of oil equivalent, eliminating the need for double system of tables. Therefore, using the unit of toe in the energy balances does provide an easily assimilated summary of the main features of the Egyptian energy profiles expressed in actual terms.

This approach is particularly suitable to the analysis of policy problems relating to oil-saving through conservation and substitution.

As a result, the energy policy decisions can be taken more effectively by energy planners.

In the case of final energy balance, based on the real energy content of the different forms of energy, there is no difficulty in establishing a series of conversion coefficients. All the specific units of measuring the various forms of energy are clearly defined on the basis of the calorie. The heat content (net calorific value) of the different fuels varies according to local specifications and qualities (e.g. specific gravity, water content, sulphur content and other inert matter content) in different countries.

As far as electric energy is concerned, the coefficient of equivalence is defined according to the basis regarding the system of accounting for final energy balance: 1 GWh=86 toe.

Hydro-electric energy and other new and renewable sources of energy (nuclear, solar, wind) are expressed in terms of the hypothetical amount of oil which would be needed to produce the same amount of electricity in conventional thermal power plants.

3.5 Sign Conventions

In the formulation of energy balances, it is necessary to introduce sign conventions to illustrate the direction of energy flows for the various energy operations (production, imports, exports, refuelling at sea bunkers, stock changes, transformation inputs and outputs, losses ..., etc). Sign conventions for additions and withdrawals are designed to facilitate aggregation and to avoid double counting. In this respect, the following sign conventions are adopted:

i. + sign for: primary energy production, imports and output from conversion industries (i.e. coke, briquettes, petroleum products, gaseous products, electricity, ... etc).

ii. - sign for exports, sea bunkers, primary and secondary forms of energy input into conversion industries (crude oil, coal, fuel inputs to thermal power stations), own uses and losses in the energy sector, and losses in transportation and distribution.

iii. In energy balance, the "sense" of the stock-changes sign needs to be clearly defined. It is more logical on the supply side to show a stock change that causes an increase in supplies (namely, a stock decrease) with a positive sign, and one that causes a decrease in supplies (namely, a stock increase) with a negative sign.

iv. In some cases (e.g. in energy sub-aggregates), where additions and withdrawals of energy take place, the net value should be indicated.

3.6 National Energy Balances

The methodological approach to constructing the energy balances is illustrated in brief in Table (6) and Fig. (8), which outlines the general procedure for drawing up the balance.

As shown in Fig (8), three levels are considered in the national energy balance, mainly:

i. Balance of energy supplies: at this level, the main emphasis is to idenfify the quantity of energy that was made available to the economy before passing through the transformation plants. It is noteworthy to mention that energy production excludes the flared gases and re-injection in the oil wells. The balance of energy supplies is calculated by the following equation:

Availability of energy supplies=net energy production + imports - exports - bunkers ± changes in stocks. (3.1)

The value of this aggregate may be either positive or negative. A negative figure for some energy sources is stem primarily from export and/or sea bunkers, aviation bunkers credits or from stock increase.

ii. Balance of transformation processes: at this level, the objective is to identify the effectiveness of the energy conversion plants installed in the country. This balance is calculated by the following equation.

Table (6)

Specifications of the Main Concepts in
Building the Energy Balances

1. Energy Accounting Systems:

- The final energy balance
- The primary fuel equivalent balance.
- Partial substitution balance.

2. Common Accounting unit:

- International unit: Joule, and multiples of it (e.g. terajoules).
- Conventional units: ton of coal equivalent (tce), ton of oil equivalent (toe), kilocalorie (Kcal), British thermal unit (BTU).
- Common accounting unit which is used in Arab countries-toe. toe = 10^7 Kcal.

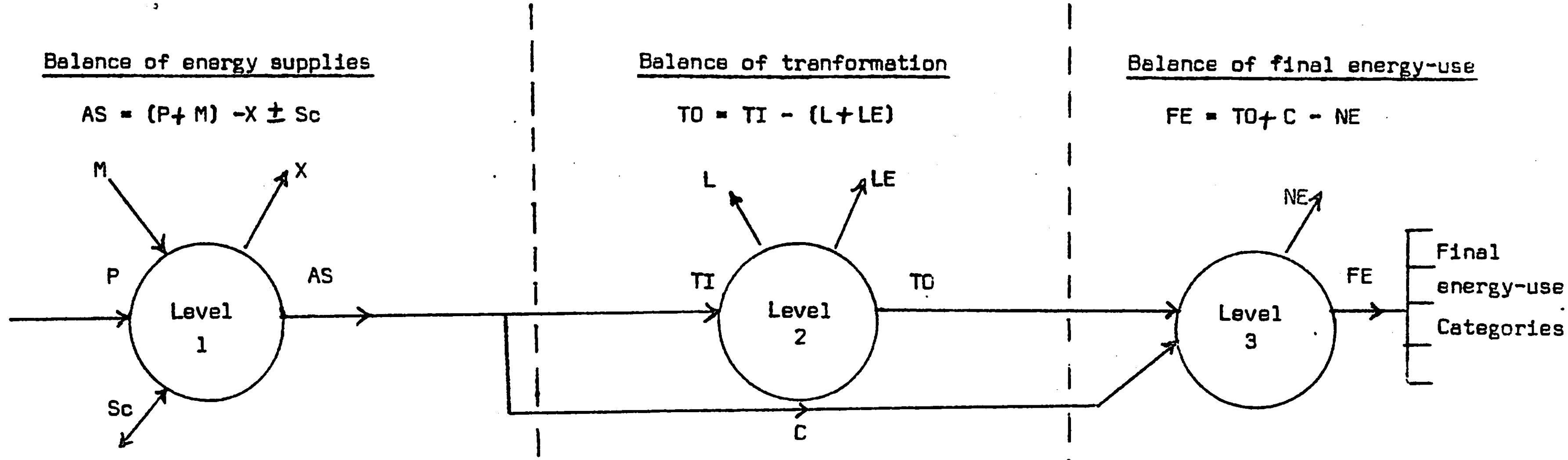
3. Conversion and Equivalence Coefficients:

- Heat content (Net Calorific Value) of various forms of energy.
- Particular case of electricity, and new and renewable sources of energy.

4. Sign Conventions:

\+ sign: Primary energy production, imports, decrease in stocks on the supply side, transformation outputs.

\- sign: exports, bunkers, increase in stocks on the supply side, transformation inputs.



P- Net national production

M- Imports

X- Exports

Sc- Stock changes

AS- Availability of supplies

TI- Transformation inputs

C- Final energy-use of unconverted supplies

To- Net output from transformation processes

LE- Own uses of the energy sector

L- Losses

FE- Availability of final energy-use.

NE- Non-energy uses

→ arrows indicate the energy flow sense.

○ nodes indicate the levels of balance.

Fig. (8) General Structure of the National Energy Balance.

Net Transformation output (derived energies) = Transformation inputs—self consumption of the energy sector — Losses in transportation and distribution. (3.2)

This method of accounting, which allows a distinction between inputs and outputs, has the advantage of showing up conversion losses.

iii. Balance of final energy: At this level, the objective is to identify the quantity of energy that was made available to the economic and social systems (i.e. the pattern of energy consumption) in the country, exculding the non-energy uses. The balance equation is; Availability of final energy-use=Availability of primary energy sources for final use + availability of secondary energies for final use — non-energy uses. (3.3)

These three levels trace the energy flows from various primary sources of energy through transformation processes till the different final energy-use categories. Another level of energy balance, namely the useful energy balance cannot be considered at present in Egypt, mainly due to the limited availability of data and the difficulties regarding the determination of end-use technologies, technical and socio-economic parameters. These difficulties hinder the energy analysis on the useful-energy level. However, the balance of useful energy level can be included in the national energy balance, using the same adopted approach, whenever the required data (given in chapter II) would be available.

The format adopted for national energy balance in Egypt is presented in Appendix II. Energy balance is constructed in matrix form with the following characteristics:

a. The columns of the matrix format relate to the commercial primary and secondary forms of energy (coal, crude oil, petroleum products, natural gas, electricity, etc.). Due to unavailability of data, the non-commercial fuels(firewood, agricultural and animal wastes, solar, wind ... etc) are not included.

b. In the rows, the different energy operations are presented in three sets:
   - supplies of various forms of energy;
   - transformation inputs and outputs, energy industries;
   - own uses, transmission and other losses;
   - final energy-uses (energy consumption).

c. The energy aggregates are presented in the rows to show the availability of supplies, the availability of energy for final energy-use.

d. In the last row, the statistical differences are presented to show the difference between the availability of final energy-use and the total energy consumption of various sectors (industry, transport, households, commerce and services).

e. In the last column are presented the net total of each energy operations (net primary production, exports, imports, bunkers, ... transformation processes, energy consumption in various sectors, ... etc.) and the net total of the energy aggregates.

f. The common unit used in the energy balance is ton of oil equivalent (toe = 10^7 Kcal).

The choice of energy operations and aggregates to be specified in the rows, and the various energy sources to be identified in the columns, result from an arbitration between the availability of data and the usefulness of these data for assessing the energetic dynamics of the socio-economic environment in Egypt.

In this way, the proposed structure of the national energy balances for Egypt does provide an easily assimilated summary of the main features of the energy profile in a specified year. The matrix form of energy balance is of three dimensions-year, transactional energy flow and energy commodities. It shows relationships between the various energy sectors and between end-use and energy requirements. It enables overall conclusions about energy policy requirements to be drawn, e.g. energy conservation and management, interfuel substitution ... etc.

CHAPTER IV

QUANTITATIVE METHODS FOR ENERGY FORECASTING

Quantitive methods for energy analysis and forecasting have to concentrate on the determination of a consistent set of equations that endeavours to capture mathematically the interrelation between energy, economy and socio-economy. Methods used for energy analysis are developed using numerous techniques and approaches which are often dictated by the sort of decision problems we wish to answer, the system under study and the amount of available data.

Some of these methods and approaches are econometric methods, techno-economic methods, optimization models, accounting models, trend analysis, normative approach, ..., etc. This delineation of the energy forecasting approaches is artificial because a particular forecast may be based on combination of these methods.

This is not the place to repeat in-depth the methods and techniques as they are well known. Instead, reference will be made to them only broadly and the areas of possible application briefly discussed.

4.1 Econometric Models

They use macro-economic indicators (GDP, GNP, value added for each sector, energy prices, .. etc) to calculate the level of energy demand, overall or for each sector of consumption, and for each form of energy or for all forms combined.

The most generally used models are "Statistical models" in which the energy demand (total or sectoral) is calculated using the levels of activity or of incomes and sometimes energy prices and demand elasticities. These models are simple and of very high consistency. They provide reliable answers in situations of regular economic growth and stable energy prices.

However, econometric models turned out to be unsuitable for representing the relationship between energy demand and economic growth in Egypt, where economic and social development can cause major structural changes. The limitations of the econometric methods are basically due to the insufficient level of disaggregation and the heavy dependence of these models on the past. In addition, demand elasticities are difficult to measure and the "past elasticities" cannot satisfactorily be used for forecasting purposes.

4.2 Trend Analysis

The trend analysis, or extrapolation method, is the simplest technique to forecast the future, requiring minimal data. The projections are made based on a continuation of historical trends of consumption patterns. These trends often have to be adjusted to take account of current and expected changes in the economic, social and energy environment.

Therefore, this method is inflexible towards structural changes, either inherent of, or imposed on the system under study, which therefore might lead consequently to an inconsistent projected structure.

4.3 Normative Approach

The normative approach has an opposed attitude towards the future. As the evolution of a system is uncertain in anyway, because many factors undefinable today, appear and affect the system in the long-run, it is better to decide on the future, to set goals and objectives and to analyse and then identify steps required to fulfill these objectives. Such analysis requires very little historical data and therefore is suitable in cases where data are limited.

The normative approach to energy forecasting might be more appropriate for the determination of energy demand in household sector, which is subject to rapid changes, thus, do not follow a certain trend. In this case, it seems more suitable to use the normative approach to fix arbitrarily a social level and along with it the respective energy needs. However, even for the normative approach the basic data should be reliable enough to prevent serious mistakes from occuring.

4.4 Optimization Models

This type of optimisation model is useful from the micro-, sectoral and macro level in determining how best a country can utilise its resources. Such models integrate supply and demand based on assumptions as to maximum and minimum fuel preferences levels by various sectors coupled with maximum and minimum available fuel supplies.

However, due to the large required data base and the difficulties of regarding life style parameters in the analysis renders this type of models unsuitable at present for national energy planning in Egypt. It might be, however, applicable for certain planning purposes, e.g. to calculate energy sources allocations on a least-cost basis.

4.5 Techno-economic Methods

These methods based on the following general approach:

a. Detailed representation of energy end-use categories (e.g. cooking and lighting for households, etc).

b. Calculation of the demand for useful and final energy on the basis of technical, economic and social indicators.

c. Use of a scenario approach to account for the development of all factors which depend on policy options both in the energy field and elsewhere.

d. Use of a model to translate the scenarios in terms of useful energy and final energy demand.

These methods distinguish two components in the energy demand. On the one hand, "the useful energy" directly related to the level of development of the country. On the other hand, the transformation of useful energy into final energy, which is related to the type of energy and equipment used (end-use efficiency). Thus techno-economic approach requires a complete statement of the assumptions concerning future changes in the technological factors as well as in the style of economic and social development.

The definition of "scenario" used here is that "the scenario method is a synthetic approach which, on the one hand simulates, step by step and in a plausible and consistent way, a series of events leading a system to a future situation. On the other hand, it presents an overall picture of this situation".

The different techno-economic approaches may be classified according to the type of model and scenario used.

i. Econometric models, in which the progression of most of the social and economic indicators, the choices between alternative equipment or processes, and the substitutions between different forms of energy are endogenous and essentially based on econometric relationships. These models have the advantage of making energy projections more consistent at the macroeconomic level. Their limitations are that they are over-dependent on the past.

ii. Accounting models, in which the changes in the social and economic structures, in the technology, and in the energy mix are exogenous and specified within the framework of the scenario. Thus the scenario plays a key role. The main function of the model is to perform rapidly a whole series of multiplications and additions. Thus these models are accounting tools rather than real models. Therefore, users of these models must have accurate knowledge of the social, economic and technical problems linked to energy.

iii. Systematic models, in which the progression of most social and economic factors and the technological options are endogenous to the model and simulated on the basis of relationships aimed at sticking as closely as possible to real phenomena. Thus, these models require previous analysis to be made.of the mechanisms by which energy demand develops, and of its determinants. Then, this analysis is formalized into the model.

Techno-economic methods have several advantages. They provide simple, transparent answers to a number of questions concerning the long-term development of energy matters. In addition, these methods allow in-depth analysis of the supply of final energy by investigating the balance of supply and demand at a more detailed level. Moreover, with these methods the major demand determinants are made explicit.

Some problems arise in application. These methods require a highly developed data base. They rely heavily on scenarios, which must be designed carefully to avoid inconsistencies, especially in the interface between macro-economic development and technological changes. The consistency problem may be solved by using complementary economic models and structured scenario method.

The previous exposure of forecasting techniques and approaches emphasizes the need to exercise caution and selectivity in applying these techniques. Because different models are required for various purposes, energy planners stressed the need of relying on more than one forecasting technique. It is essential for the purpose of energy forecasting and planning in Egypt that more highly developed data be obtained, particularly for the industrial, transport and household sectors.

CHAPTER V

TECHNO-ECONOMIC METHOD FOR SECTORAL ENERGY DEMAND ANALYSIS

The focus of this chapter centers on the display of the socio-economic and economic parameters that determine the energy demand in different sectors: transport, industry, agriculture, household and services. The conceptual framework presented endeavours to amalgamate parameters of energy, economy and socio-economy on the useful demand level comprehensive, but nevertheless simple and transparent.

A selection of technical, economic and socio-economic parameters used for the methodology is presented in Table (7). However, as the energy balances' lowest determination level is the final energy level, the matching of the formal interrelation and the balance will take place on that level.

The presented methodology considers only the pattern of commercial fuels, i.e. crude oil and its derivatives, natural gas, coal and its products and electricity. Supply and usage of traditional or non-commercial fuels has been presently disregarded due to the difficulties of measurement and allocation. The economy has not been treated as an agglomerate. The breakdown of economic activities at least in the main contributing sectors has been undertaken.

Table (7) PARAMETERS USED FOR THE METHODOLOGY

LIFESTYLE PARAMETERS

HOUSEHOLD

- Room per unit
- Degree days
- Number of occupied unit
- Power installed
- Hours of power used
- Demand for water
- Warm water fraction
- Number of people per family

TRANSPORTATION

- Passengers/mode of transportation
- Average Kilometrage per road vehicle by type of object.

AGRICULTURE

- Calories and/or proteins intake per capita

TECHNICAL PARAMETERS

HOUSEHOLD

- Insulation coefficient
- Capacity of installed air conditioning

TRANSPORTATION

- Energy intensiveness per passenger transported: car, bus, rail, plane
- Energy intensiveness per good transported: truck, rail, plane
- Average fuel consumption per vehicle by type of object.

INDUSTRY

- Energy intensiveness per product output of major producing categories

AGRICULTURE

- Average fuel consumption per category of machinery park

ECONOMIC PARAMETERS

HOUSEHOLD

- Rural-urban population distribution
- GNP distribution

INDUSTRY

- Distribution for dollar of value added/producing sector
- Energy intensiveness per dollar of value added per producing sector
- Activity level of industries

SERVICES

- Energy intensiveness per dollar of value added

5.1 Transport

The need to travel varies greatly from one region of the country to another and so does energy demand. However, the structure of the transport sector in Egypt can be identified according to the transported objects (passengers and goods), the respective mode of transportation (car, ship, train, ... etc), and the fuel usage (gasoline, diesel, ..etc), as shown in Fig. (9).

Depending on the availability of data, the following two approaches can be performed.

i. The advanced approach

At the useful energy demand level, the socio-economic parameter "passenger-kilometers per mode of passenger transportation" and the economic indicator "ton-kilometers per mode of freight transportation" influence the energy consumption. The eggregated level of these two variables is obtained through a correlation to the gross national product, which serves as a proxy for consumer income and for the level of economic activities. The amalgamation of these parameters in relation to useful energy consumption leads to the following formal equation:

$$ET_{ij} = f\ (KM(GNP)_{ij},\ XS_{ij},\ E_{ij}) \qquad (5.1)$$

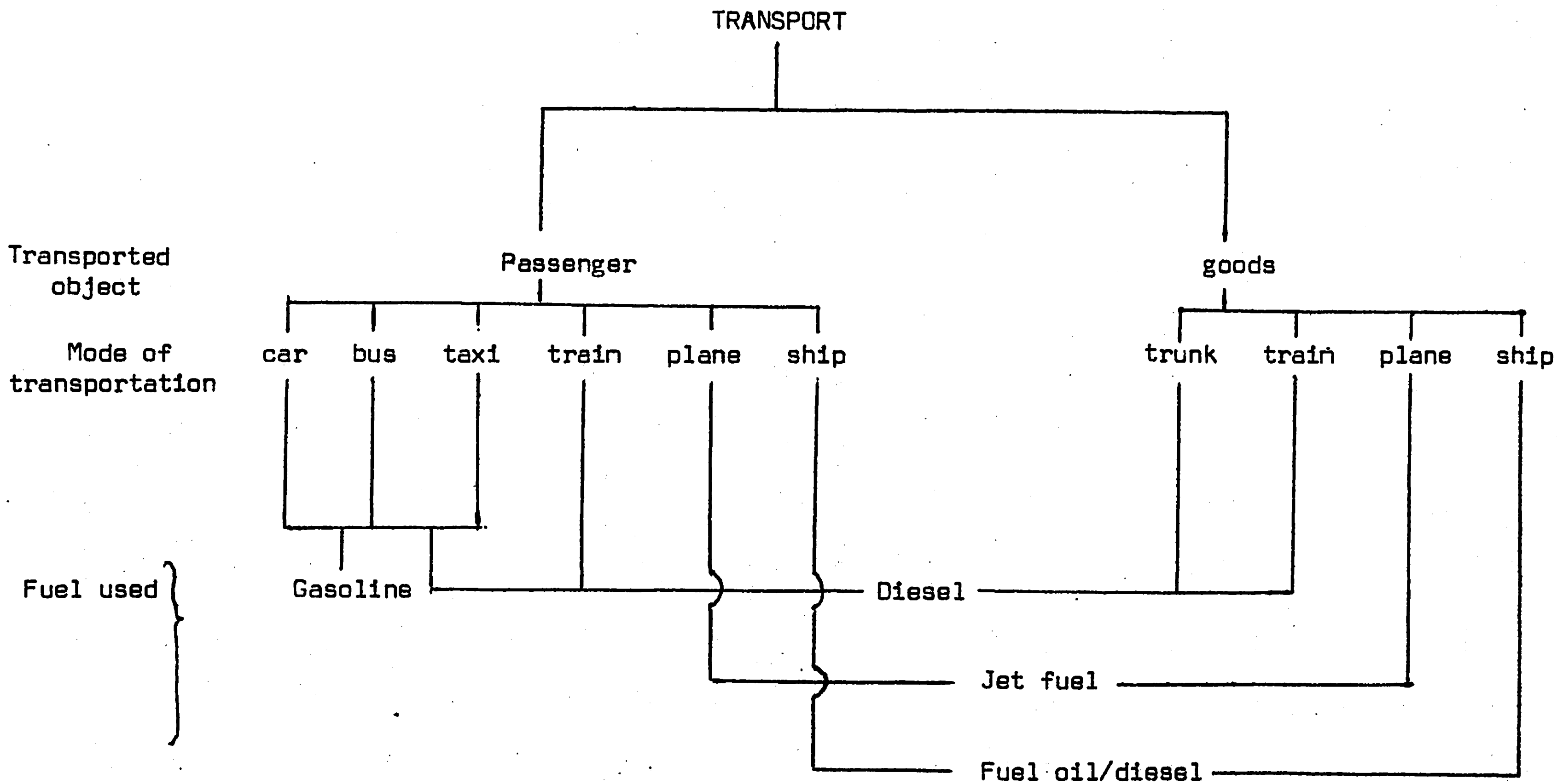


Fig. (9) Transported Objects, Mode of Transport and Fuel Usage.

			Unit
Where	ET_{ij}	is the useful energy consumption of transportation object i and transportation mode j,	toe
$KM(GNP)_{ij}$		reflects the amount of driven kilometres of object i as a function of Gross National (Domestic) product,	pkm or tkm
XS_{ij}		the share of mode j for the object i, and	dimensionless
E_{ij}		the energy intensiveness per mode j of object i,	kgoe/pkm of (kgoe/tkm)

transported objects:
i = 1 passenger
i = 2 goods

transportation mode:

j / i	1	2	3	4	5
1	car	bus	train	plane	ship
2	-	truck	train	plane	ship

It might be appropriate in certain cases to use the term 'seat'-or place-kilometre-i.e. for internal aviation or rail transportation of passengers-as this parameter might be more easily available.

To derive at the level of final energy consumption, the thermal efficiencies of each power machine (EFF) have to be applied on the various transportation mode. Furthermore, for each transportation mode the share of the specific fuel used (SF) has to be determined. In a more sophisticated approach, the relative price structure and the price elasticities for the determination of each transportation mode could be incorporated. The final energy demand in the transportation sector given the aforementioned calculus would be derived by

$$F = f(ET_{ij}, EFF, SF) \qquad (5.2)$$

ii. The basic approach

For road transportation - goods as well as passengers-the parameters: number of vehicles registered (NV), average kilometrage (AK), ard average consumption of fuel per kilometer driven (AF) deliver a crude approximation on the fuel consumption of this sector on the level of final energy.

$$F = f(NV, AK, AF) \qquad (5.3)$$

Final energy used for good transportation by railways can be approximated by relating the quantities transported (Q) and the energy requirement for one unit of good transported (EQG).

$$F = (Q, EQG) \qquad (5.4)$$

5.2 Industry

Depending on the availability of data, the following two approaches can be performed.

i. The oil/non oil dichotomic approach:

The approach that considers economic and technical parameters relates for the minimal superior disaggregation, i.e. two sectors: oil and non-oil, the gross domestic product (GDP), the activity level of each industry (SI), the structure of captive end-use categories (AV), the energy intensiveness of each sector (KW), the fuel mix for the end-use market (FM) and the efficiencies of fuels for each specific end-use (EFF).

$$F_{oil/non-oil} = f(GDP, SI, AV, KW, FM, EFF) \qquad (5.5)$$

In a more sophisticated approach, the relative price structure and the price elasticities could be incorporated.

ii. The quantity based approach.

In cases where data are available on energy-intensive industries with a limited production palette, this approach is appropriate. The amount of energy consumed per productive sector can be determined by weighting the quantities produced with the respective energy content. This serve as a reasonable proxy.

5.3 Agriculture.

The determination point in the economic system for the energy use in the agricultural sector is the farm gate. This implies that transportation of agricultural products:- grains, vegetable products, meat, fish, .. etc., and the originating fuel consumption thereby is taken care of in the transport sector. Additionally and to avoid double counting, consumption in the farm house is considered in the respective household sector; food preparation and processing, in its broadest sense, belongs to the industry sector. What remains is the cultivation of agricultural land, meat production and fish catches and farming and the energy required for these processes.

The main consumer of energy for agricultural purposes are the machinery parts (M) and irrigation pumps (P). Given the average consumption of fuel per machinery input and pumps (AC), energy consumption in the agricultural sector could be derived by:

$$F = f(M, P, AC) \qquad (5.6)$$

5.4 Household

Energy is disposed of in the household sector to render four major categories of services, namely: room heating and cooling both to render a desirable indoor temperature, water heating for cooking and the use of electricity to operate various electrical appliances. The structure of this concept is presented in Fig. (10).

i. The advanced approach

As this approach is rather detailed, it might not be applicable in the near future in Egypt. However, it has been presented based on the intention to draw now attention on this subject so that the data collection is already oriented towards that goal. Final energy consumption required for space heating or air conditioning can be calculated by:

$$F_{room/air} = f(MS, DG, C, SF_r, EFF) \qquad (5.7)$$

Where:		Unit
MS	represents the floor area,	m^2
DG	degree-days,	°C-day
C	the insulation coefficient,	Kgoe/m^2 C-day
SF_r	the fuel share, and	dimensionless
EFF	the efficiency ratio of the process	dimensionless

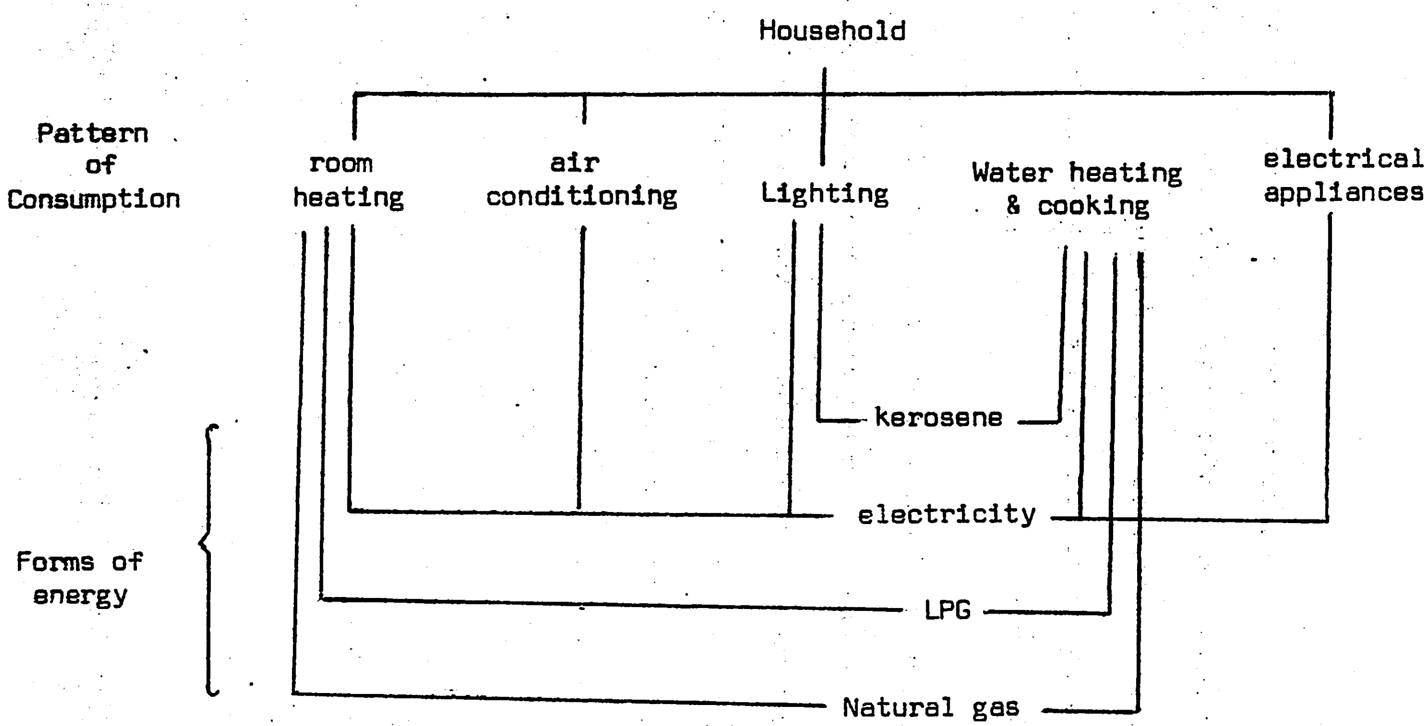


Fig. (10) Major Categories of Services and Energy Use in the Household Sector.

Final energy consumption required for water heating and cooking can be calculated by:

$$F_{water} = f(WC, SW, WE, SF_W, EFF) \qquad (5.8)$$

Where:		Unit
WC	represents the amount of water consumed,	liter
SW	the fraction that has to be heated to render a service,	dimensionless
WE	the energy requirement for heating one unit of water,	kgoe/liter
SF_W	the share of fuel, and	dimensionless
EFF	the efficiency ratio of the process	dimensionless

There is a fraction of the energy consumption in the household sector that is devoted to the usage of household appliances and lighting. This type of energy mostly consist of electricity unsubstitutable by other fuels. One approach of determining the electricity consumption on final energy level could be by its relation to per capita income:

$$F = f(GNP/Cap) \qquad (5.9)$$

ii. <u>The basic approach</u>

For cases when no distinction according to the use of energy is possible, the energy consumption per fuel in the household sector can be derived by the number (NH) and size (SH) of households, the disposable income (DC), and the share of commercial fuels (SFH),

$$F = f(NH, SH, DC, SFH) \qquad (5.10)$$

5.5 Services

Until appropriate measures to determine final energy consumption in the service sector are developed, the consumption might be determined according to:

$$F = f(SS, GNP, SF, EFF) \qquad (5.11)$$

Where:		Unit
SS	reflects the share of the service activities in the total GNP,	dimensionless
GNP	the Gross National Product,	currency unit
SF	the fuel share, and	dimensionless
EFF	the energy ratio of energy consumption per unit of vale added.	kgoe/currency unit

CHAPTER VI

UNRESOLVED ISSUES ON ENERGY PLANNING IN EGYPT AND AREAS OF POSSIBLE FUTURE DEVELOPMENT

6.1 Complexity and Uncertainty of Energy Policy Issues

In order to make clear which demands and problems planners and policy makers are confronted with and what contribution energy methods and models can have, we consider it necessary to combine an overview of the development and present state of energy models with the description of some details of the energy problem itself.

The central problem for energy planning in Egypt over the short-and-medium term consists in coping with the dramatic fluctuation of oil prices and the existing dependency on crude oil exports and the impact of oil foreign trade on the economy and balance of payment. In the long-term, the presistent and dominant question is, which energy sources can and should guarantee the energy supply in the light of the foreseeable exhaustion of crude oil and natural gas reserves.

Although there exists an extensive consensus on the severity of the present energy supply situation in Egypt, opinions and views differ widely as to the appropriate path towards a post-petroleum energy supply system and as to which primary energy carrier should have priority in substituting for crude oil and natural gas. Some anticipate an increased use of coal and building-up of nuclear energy as the solution to the problem, while others support conservation by more effective energy end-use. Still others believe that a decentralized use of renewable energy sources alone can represent a long-term solution capable of bearing the load. Besides technical and economic arguments, there are especially questions of environmental protection, security as well as general political aspects which mark the energy discussion. The emotional and controversial energy discussion is also a reflected image of the problems which confront those active today in the field of energy policy or energy planning. Complexity and uncertainty are its characteristic attributes.

In the field of energy production, conversion, transport, distribution, and end-use technology, there is a wide range of technical constraints and specific features of respective technologies to consider in order to guarantee compatible interaction with the other components of the energy system. A plurality of new technologies, e.g. the use of renewable energy sources, are under development in Egypt today. Their timing of commercial introduction, their costs, and their technical parameters, such as efficiencies, can be stated today only with a large range of uncertainty. Also, the interactions between the energy system of Egypt, the other sectors of the economy, and the general economic growth are complex. The consequences of fluctuation in energy prices or of a limited energy supply on the economic development of Egypt are essentially aspects which must be taken into consideration within the scope of energy policy decisions. Considerable uncertainty also exists with regard to the future development of energy requirements. This arises on the one hand, because a further economic growth is no longer seen automatically as desirable, and on the other hand, because it is hard to anticipate to what extent energy-saving measures and methods will be carried out. Availability and price fluctuation of crude oil and petroleum products, acceptance of nuclear energy, global environmental problems are only several of a number of important issues giving rise to the complexity of the energy problem as well as to the considerable uncertainty, under which energy-policy decisions must be met.

To sum up, the energy planning process in Egypt has entered an era of new complexity. Rather than asking what the energy demand in some future years will be, or what the contribution of different supply options will be, a better question is, "what must an energy policy look like?"

6.2 Capital Requirements and Timing in Developing Energy Policies

The energy production, conversion, and transport facilities require manpower, equipment and financial resources to a degree that justifies a careful evaluation of Egyptian ability to implement its energy supply plans fully. Since these same resources may be required for the development of other economic sectors that create the demand for energy, the evaluation of resources capabilities must include more than the energy supply sector alone. As the energy supply sector involves major facilities and long construction times, early attention to these aspects is essential to ensure the availability of the required resources.

The lumpiness of many energy investments makes energy planning difficult. In Egypt oil supports economic development both as a generator of financial resources for investment projects and programs and as an energy source for activities in industry, transport, agriculture, residential, public utilities and other services. The recent drops in oil prices would challenge the ingenuity and capacity of the financial community, government as well as international. The capital-short would be energy-short. In this respect, the true opportunity cost of scarse resources (particularly capital and energy) must be correctly and fully evaluated, for decisions may be almost irreversible, tying up scarse resources in a way that may distort development.

To sum up, emphasis should be placed on self-reliance and rational use of capital and energy resources.

Timing is the most significant factor in the present historic transition from low to high-cost energy. This obliges the energy planners to reconsider patterns of production, consumption and technology. Difficult choices must be made between competing alternatives in a complex and dynamic environment, and for this integrated energy planning is a first and indispensable step. A second step would be to identify and commit the necessary resources.

6.3 Financial Considerations and Project Analysis

Every energy plan requires funding. Lack of capital is the most serious constraint on the effort to provide an adequate supply of energy. The costs and benefits of the constituent parts of the plan, their interrelations and timing must be carefully evaluated. Project analysis is an indispensable tool for planning itself and for a realistic assessment of the financial implications of the plan. The process of drafting an energy plan becomes a time-consuming and difficult task because of the long lead times of major investments and the many uncertainties.

Special emphasis should be devoted to the following points:

a- A considerable proportion of the capital required in energy sector must come from abroad and repaid in foreign currency. New investments in energy will increase the national debt and the payment interest on that debt. For a long period, the government may have to pay off a loan in foreign currency for an existing plant. If this plant is to be replaced by a new investment, an additional foreign exchange burden will be incurred. In this respect, financial needs for loan redemption, maintenance and expansion of existing plants must be secured by an appropiate pricing policy.

b- Many energy projects, especially in the electricity sector, earn revenue only in local currency. This means that foreign currency must be earned through other forms of export. In the 1970's and the beginning of the 1980's, oil replaced cotton and other agricultural products as the main export in Egypt. The income from oil, Suez Canal revenues and the remittances of Egyptian labour working abroad were the main sources to fund the development plans in Egypt. However, due to the decrease in these revenues in recent years, the planner must be aware of the limitations in foreign currency and make sure that the energy plan is financially viable within the global national economy.

c- Changing the energy mix will usually result in higher investment requirements per unit of output than was the case five or ten years earlier. Potential availability of funds, in foreign as well as local currency, should therefore be carefully investigated during the process of energy planning, since it is nonrealistic to plan for what cannot be implemented. In this context, it is noteworthy to mention that investment costs are strongly influenced by management action.

6.4 Training of Personnel for Energy Planning

In general there are relatively more human resources available for the production, marketing and investment phases of the energy sector in Egypt, while the most acute shortage of manpower is in the areas of overall energy analysis and planning. In Egypt there is a crucial need to have sufficient qualified personnel to analyze the structure and functioning of the national energy system, and on the basis of that analysis, to draw up comprehensive plans and evolve an energy policy geared to the needs and resources of the country.

Given the multidisciplinary nature of energy planning, there is a necessity and importance of the involvement of the existing institutions in the development of personnel for energy planning by initiating an extensive training programme for their staff. The priority in training should be given to public service personnel already involved in policy-making and management in the Egyptian energy sector. This priority is justified because it is necessary that the personnel who prepare policy decisions and manitor their implementation have the required experience to properly carry out these tasks. In this connexion, training programmes for planners should include courses in system analysis, operation research, statistics, the financial and economic evaluation of projects, and information sciences. With this background, more specific training should be provided in: detailed analysis of the economic development aspects of each energy resource and the energy sector as a whole; key techniques for analysis and forecasting of energy demand; supply planning methodologies. In addition to such theoretical training, practical training should be provided using case studies and planning exercises that represent as closely as possible the actual situation in Egypt.

A related subject, which need greater emphasis and careful consideration is the internal migration of skilled personnel within the country from the energy sector to other activities or from the government to the private sector. The main causes of this phenomenon are the inadequacy of salaries, allowances and other fringe benefits and incentives in energy institutions in Egypt.

6.5 Institutional Issues.

The abundance of agencies in the energy sector and the absence of an umbrella energy planning institution have resulted in dispersing Egypt's human, financial and administrative resources. Consequently, the lack of sufficient co-ordination and integration, the prevailing fragmentation of responsibility for energy planning and the shortage of experienced staff in planning throughout the sector are the major constraints for the formulation of comprehensive national energy plan. This points to the necessity of establishing a national energy authority that would have the responsibility for formulating energy policy and strategy and for coordination and monitoring of Egyptian energy plan as it is integrated with the national development plan.

A critical issue, in this respect, is the status and power of the National Energy Authority (NEA) in relation to the entire energy establishment, including Ministry of Petroleum, Egyptian General Petroleum Authority (EGPA), oil companies, Ministry of Electricity and Power, Egyptian Electricity Authority (EEA), Electric distribution companies and other electric power utilities, regardless of whether these are public or private sectors. The question of status is much more complicated in real practice. Therefore, the NEA's status must be made equal to its responsibilities and the key factor in ensuring this is to enable NEA to attract and retain highcalibre staff. One of the most important tasks of the NEA and its full-time professional staff would be to work out criteria for energy investments and the ranking of projects. The difficulty of estimating the future price of oil increases the difficulty of this task.

CONCLUSIONS AND RECOMMENDATIONS

A fundamental requirement for integrated energy planning is to develop a data base which enables energy to be related to all the various activities in the national economy. The conceptual framework as described above provides a systematic structure for conducting energy analyses in Egypt. As such, it provides means for organizing the collection of data into manageable segments and provides means of synthesizing these segments into an integrated analysis based on supply/demand balance.

Energy information and other data needs should be collected in a consistent, systematic and dynamic manner. It is beyond question that apart of comprehensiveness, the internal consistency and external comparability are pre-conditions for energy data base. It is noteworthy to mention that, energy information system is not an end in itself, it is required as a basis for making policy decisions. At the same time, the decision process may reveal inadequacies in that information.

Energy balance is a conceptual framework, providing an easily assimilated summary of the main features of the energy profile of the country in a specified year. The matrix form of energy balances is of three dimensions - year, transactional energy flows and energy commodities. It shows relationships between the various energy sectors and between end-use and energy requirements. It enable overall conclusions about energy policy requirements to be drawn, e.g. energy conservation and management, inter-fuel substitution ... etc.

Methods used for energy analysis are developed using numerous techniques and approaches which are often dictated by the sort of decision problems we wish to answer, the system under study and the amount of available data. Some of these methods and approaches are econometric methods, techno-economic methods, optimization models, accounting models, trend analysis, normative approach. This study emphasizes the need to exercise caution and selectivity in applying these techniques.

Techno-economic methods have several advantages. They provide simple, transparent answers to a number of questions concerning the long-term development of energy matters. In addition these methods allow in-depth analysis of the supply of final energy by investigating the balance of supply and demand at a more detailed level. Moreover, with these methods the major demand determinants are made explicit.

However, techno-economic methods require a highly developed data base. They rely heavily on scenarios, which must be designed carefully to avoid in consistencies, especially in the interface between macro-economic development and technological changes. The consistency problem may be solved by using complementary economic models and structured scenario method.

It is essential for the purpose of integrated energy planning in Egypt that more highly developed data be obtained, particularly for the industrial, transport, agricultural, residential and commercial sectors. An indirect benefit of the application of the proposed methodology for energy planning in Egypt is the bringing together of all institutional agencies that deal with energy problems to focus on an integrated analysis. The integrated methodology provides a mechanism for agencies with varying mandates (e.g. Ministries of oil, Electricity, Industry, Transport, ... etc) to pool their capabilities and focus on a unified approach to energy planning. Such interaction is crucial to effective national energy planning in Egypt.

In this context, the endeavour is to be seen to link the elements: energy, economy and socio-economy in order to cristallize the impetus of energy-use rooting in the socio-economic environment and to visualize clearly that energy is not an element in its own, but embedded in a much more complex interactive system.

Major problematic areas for energy planning in Egypt (e.g. complexity and uncertainty of energy policy issues, capital requirements and timing in developing energy policies, financial constraints, lack of professionals for energy planning and other institutional issues) have been identified to launch more detailed investigations in the future. The following areas have been identified to be the cornerstone in the plans of action to support Egyptian energy policy-makers in their long way for energy planning and analysis:

- improving the energy data base;
- emphasis on self-reliance and rational use of capital and energy resources;
- evaluating correctly and fully the opportunity cost of scare resources (particularly capital and energy) to work out criteria for energy investment and the ranking of projects;
- reviewing the energy institutional arrangements for more effective energy planning and identifying responsibilities for efficient supply and demand management;
- training of energy statisticians and professionals.

APPENDIX I GLOSSARY OF TERMS

APPENDIX II GENERAL STRUCTURE OF THE NATIONAL ENERGY BALANCE SHEET FOR EGYPT.

GLOSSARY OF TERMS

Primary Energy: is the one extracted or provided by natural source, e.g. coal, crude oil, natural gas, hydro-and goethermal electrical energy, solar, wind, etc.

Secondary Energy: is the derived or converted primary energy after physical or chemical transformation, e.g. petroleum products, electricity, etc.

Final energy is the primary and/or secondary energy made available for consumption of the socio-economic sectors (industry, transport, households ... etc).

Useful energy: is the energy in terms of useful heat, light, mechanical power, etc. needed to provide energy services to the final user, e.g. the heat for industrial production processes, space heating etc.

Net primary production: refers to the quantities of energy extracted or produced. In general, it includes the quantities consumed by the producer during production operations as well as supplies to other producers of energy for transformation or other uses. Data for natural gas excludes the amount flared, represured, reinjected and wasted, as well as the shrinkage due to the extraction of natural gas liquids.

Imports refer to the quantities of primary and secondary energy brought in from other countries. Transit trade is excluded from this category.

Exports refer to the amount of primary and secondary energy supplied to other countries. Transit trade is excluded.

Sea and aviation bunkers refer to the quantities of fuels delivered to sea-going ships or aircraft, whatever their flag, engaged in international traffic. Deliveries to ships engaged in transport in inland and coastal waters, or to aircraft engaged in domestic flights, are not included.

Stock changes (at producers, importers, suppliers and large-scale industrial consumers) refer to the difference between stocks of fuels held at the beginning and end of the year under review.

Total availability of energy supplies refer to the inland availability of energy for conversion or consumption purposes.

Consumption by energy sector comprises the quantities of energy (either purchqsed or taken from own output) used by producers and converters for operating their installations. It includes the energy consumption of compressor and pumping stations of pipelines, as well as the station use and loss of electric power plants.

Losses in transport and distribution refer to the losses of electrical energy, natural gas and derived gases which occur outside the utilities or plants.

Consumption for non-energy uses refers to the quantities of energy consumed as raw materials by the chemical industry and that consumed in non-energy applications (buitumen, lubricants, waxes, etc.) in other sectors of concumption for lubrication and road surfacing. The petro-chemical industry is taken as a special case here in that the quantities consumed are net quantities, i. e. after deduction of petroleum products returned to refineries or sold in the market.

APPENDIX (II)

General Structure of the National Energy Balance Sheet For Egypt

Year:
Unit: thousand tons of oil equivalent

Commodities / Transactions	Coal	Crude Oil	LPG	Gasoline	Jet Fuel	Kerosene	Gas/ Diesel oil	Fuel oil	Other petr. products	Natural Gas	Hydro	Electricity	Total
Net primary production													
Imports													
Exports													
Bunkers													
Stock Changes													
Total Availability of energy supplies													
Coal industry													
Gas industry													
Oil industry													
Electric power plants													
Public													
self-producers													
Consumption by energy sector													
Losses in transport & distribution													
Non energy uses													
Final energy available for consumption													
Industry													
Transport													
Households													
Agriculture, Commercial & others													
Statistical differences													

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سلسلة من القضايا صدر منها :

(١) دراسة الهيكل الاقليمى للعماله فى القطاع العام فى جمهورية مصر العربية ديسمبر (١٩٧٧)

(٢) Adverse Economic Effects Resulting from Israeli Aggressions and Continued Occupation of Egyptian Territories April 1978

(٣) الدراسات التفصيليه لمقومات التنمية الاقليميه بمنطقة جنوب مصر . (ابريل ١٩٧٨)

(٤) دراسة تحليلية لمقومات التنمية الاقليمية بمنطقة جنوب مصر . (يونيو ١٩٧٨)

(٥) دراسة اقتصادية فنيه لآفاق صناعة الاسمدة والتنمية الزراعية في جمهورية مصر العربيه حتى عام ١٩٨٥ . (ابريل ١٩٧٨)

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(١٣) تقييم سياسات التجاره الخارجيه والنقد الاجنبى وسبل ترشيدها . (يوليو ١٩٨٠)

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(٣٤) مدى امكانية تحقيق ذاتى من القمـــح ٠ (يوليــو ١٩٨٦)