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# ENERGY INFORMATION IN THE ESCWA REGION

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# INTRODUCTION

Energy statistics in developing countries, including ESCWA member countries, are often sparse and poorly organized permitting only aggregated and imprecise analysis. Hence, efforts should be made to improve the database for estimating more detailed and reliable relations. Energy balances are one form in which statistics can be organized, but they do not yield any analytical results by themselves. At the aggregate level, energy demand is a function of the gross domestic product (GDP), but since the energy-GDP elasticity depends on many factors, elasticities can be used as indicators only and not for predictive purposes. Input-output models provide a detailed portrayal of the relation between production and consumption on the one hand, and energy use on the other hand, and they can be used in developing countries for demand forecasting. However, the large-scale computation and the enormous amount of data required by these models are major impediments to their application in developing countries. Thus, many countries rely more on simple technical models where the final energy consumption can be derived from the specific energy consumption, efficiency of energy utilization and the level of production.

Reliable, disaggregated information on energy consumption and supply is essential to the use of energy planning tools and the formulation of sound energy strategies. The energy industry faces long lead times and the necessity of raising significant financial resources for investment in such projects. Planning for capacity and network expansion is critical if the allocation of resources is to be optimized. In addition, the consequences of inadequate supply are detrimental to the economies of countries and regions. Effective management of the energy sector calls for the formulation of a comprehensive national energy plan and its efficient implementation. The complexity of energy planning stems from: (a) the long planning periods usually required for energy projects; (b) the high capital intensity of the industry; (c) the economic trade-offs between producing or importing additional energy supplies; (d) lowering the current consumption of energy; and (e) reducing the energy intensity of economic activities over time. Such efforts require reliable disaggregated data on energy supply and demand. Unfortunately, institutions and individuals concerned with data collection and management in most developing countries, including many ESCWA member countries, are unaware of the importance of acquiring reliable data for ensuring the success of their plans.

Thus, there is a serious need for a carefully developed and maintained database on energy demand and supply so that planners and policy-makers can identify, quantify and address the key issues related to the energy sector. Solid information on energy prices, quantities consumed and consumer preferences is necessary for inter-fuel substitution analysis and pricing policies.

Data on consumption patterns, energy supply systems and consumer attitudes towards the natural resource base are essential to the development of a sound supply-management strategy. Reliance on non-representative statistics and theoretical extrapolations to create energy policies may result in ineffective energy policies.

Energy planning is a process that incorporates a number of steps at various levels of energy and macroeconomic data gathering and analysis. Below is a step-by-step introduction to this process:

(a) Energy planning starts with macroeconomic projections and targets. The departure point for energy planning is when growth and demographic patterns are determined. These will partially determine energy demand and therefore the required investment;

(b) Energy planning without sufficiently comprehensive and reliable data may result in improper advice to policy makers. A permanent means of gathering energy data is critical for proper analysis and demand projections;

(c) Data should be fed into a permanent energy database designed to serve the needs of its users and maintained by full-time specialists;

(d) Information on the technological and physical options for energy supply must be kept current and combined with data on domestic resource assessment. Supply options can also include alternative foreign sources of energy;

(e) Using data from a well-maintained database, including macroeconomic variables, planners will be able to forecast demand and make various projections about future energy needs;

(f) The integration of supply and demand projections will provide insight into the cost of meeting growth targets, which can then be compared with planning targets. If, for example, the first round of integration yields unacceptable future levels of oil imports, planners may be asked to increase their efforts to reduce energy demand growth by improving energy efficiency. The alternative would be for economic planners to allocate more resources to augment the domestic supply;

(g) Projects to meet supply goals are defined in response to demand growth projections;

(h) Conservation policies and programmes play a vital role in the formulation of demand projections. Planners will often analyse a number of scenarios assuming varying levels of conservation;

(i) Final decisions are embodied in an energy plan, which then becomes the basis for implementation by the agencies responsible for the various energy sectors. The plan is then revised at regular intervals so that adjustments can be made according to, *inter alia*, changing macroeconomic conditions and new energy demand patterns.

This study reviews some of the important methodological, theoretical and practical issues that should be considered by organizations and institutions in the ESCWA region involved in the collection of data on energy supply and demand.

# I. DATA-COLLECTION METHODOLOGIES

It is important for the examination of a country's energy system to begin with the collection of data and information. When making forecasts, analyses or plans, the first phase is always devoted to describing and quantifying the situation. This can be done by listing existing surveys or case-studies, taking stock of accessible information and examining records kept by ministries, firms or agencies.

The scarcity of available data is a subject of complaint, especially by those countries where even a minimal base has not been established, where no energy surveys have been carried out and there are no detailed energy balances or time series covering even a few years. In other countries the available information may be only partially used or not used at all, owing either to inaccessibility or difficulty of access. Data collection involves a wide variety of activities ranging from the individual who goes to a library and extracts information from reports of national and international agencies to a team of hundreds of people carrying out a survey. However, the choice of methodology and the scope of data-gathering will be significantly influenced by a variety of factors, including the level of detail and accuracy of the data required, the precision and breadth of coverage required, the number of agencies involved and the geographical area to be covered.

Regardless of the methodology chosen, collection of energy data should not be undertaken once. It should be a long-term process undertaken at regular intervals, which requires effort, patience and financial resources. Scarce resources should not be squandered on collecting data that will not be useful over time, especially in developing countries where many development needs must be met. Hence, the choice of methodology for collection of the required data is of great importance.

The most common methodologies that can be used for data collection are discussed in the sections that follow. Special emphasis is placed on those data collection methods that are most appropriate for the ESCWA region. In addition, the sample survey receives due attention since it is often the most appropriate way to collect energy-consumption data.

## A. Examination of reports

Primary supply data such as proven reserves, domestic production, exports and stocks are usually available locally and presented with a reasonable degree of accuracy. They can often be obtained by examining the periodic reports of national enterprises such as national oil companies, refineries and electric utilities. The ministries of energy may also have disaggregated data for the country. Conversion data and utilities' own use and conversion losses are also available in the annual reports of the refineries and electric utilities. General economic and demographic data which are relevant to the energy sector, such as demographic growth, population, GDP growth, rate of inflation, investment in the productive sector, balance of trade and the government budget, can be obtained by examining the reports of the national statistical offices, the central banks and the ministries of finance in each individual country.

Data on imports of oil and oil products can also often be obtained by examining the reports of customs departments or ministries of trade.

## B. Case-study

The case-study involves detailed questioning or examination of relatively few persons or items and is undertaken as an example from which general conclusions can be drawn. The essential methodological feature of a case-study is that it provides an in-depth, detailed analysis of a certain subject. The case-study should always be carried out by a professional, sometimes with qualified assistants. A case-study is not limited by the implied urgency of rapid appraisal methods and is particularly appropriate when a high analytical content is required for a problem. The case-study utilizes a combination of methods: personal observation (which for some periods or events may develop into participation); questionnaires for current and historical data; straightforward interviewing; and the tracing and study of relevant documents and records.

The case-study is a valuable method of enquiry, which may be particularly appropriate in the context of a wider study. It requires great effort by a professional of all-round ability and specialized knowledge. The method also provides an effective way in which academics and officials can work to improve the framework for policies aimed at change and development. Unfortunately, resources for high-level studies are limited in many developing countries, including those in the ESCWA region, which means that a great effort is needed for coordination of resources. In the management of developmental activities, particularly in the context of specific project preparation and implementation, there is a frequent need to carry out a quick diagnostic study of a problem that is identified as a constraint to the successful implementation of a project or activity by the Government or the local community. Speed in execution and flexibility of approach are crucial to such a study. Examples of data or information that may be collected when carrying out a case-study are: (a) the utilization of gas for power generation in a certain country; (b) energy consumption in agriculture; and (c) determining the efficiency of energy consumption in the transport sector.

## C. Sample survey

An appropriate method used by many developed countries to study sectoral energy demand is to conduct surveys among the final consumers. This is often the most appropriate method for acquiring accurate energy data in the developing countries. The methodology of every survey follows a similar pattern, and the typical steps are the following:

(a) To divide the sector in question into subsectors and classes;

(b) To select the sample by determining the appropriate number of establishments to be surveyed;

(c) To extrapolate the results for the entire sector.

The number of establishments to be considered in each class depends mainly on the coherence of the class and on the average consumption of each establishment. The higher the variance of the energy consumption, the greater the number of establishments which must be surveyed. If the average consumption of the establishments is high, each individual establishment becomes more important and the sample should therefore be expanded. In the educational subsector, for example, rural schools should be separated from urban schools so that the variance between energy consumption classes remains as low as possible. It should be noted that the consumption of rural schools will probably be lower than the consumption of urban schools. The number of establishments surveyed in each class from kindergarten up to general secondary school can vary from 5 to 30 establishments, but all vocational schools and universities should be surveyed owing to each one's importance.

1. *How to conduct the survey*

To ensure that undertaking the survey is worthwhile, care should be taken in the overall design so that the appropriate questions are asked and that the right people are queried. The survey should meet two important criteria: it should produce results in a relatively short time and it should include the possibility of introducing future improvements. Consequently, the goals of any survey should be to determine the total energy consumption in the sector quickly and to prepare follow-up plans for future surveys. In this way, continuity of collection procedures will be ensured. Two types of surveys are most appropriate for the ESCWA region:

(a) A **mail survey** of large, well managed establishments in a specific sector which can be reasonably relied on to answer a written questionnaire sent by mail. The postal system allows the institution responsible for energy planning to send a large number of questionnaires without excessive use of resources;

(b) An **interviewer survey** in smaller establishments where face-to-face contact between the interviewer and the energy user may be necessary to determine the level of energy consumption of the establishment.

In the mail survey, the questions should be as precise as possible to achieve better responses and better response rates. They should cover the following areas:

(a) The activity of the establishment, a precise definition of its activity, the type of output or services produced, quantities produced, number of employees and cost of production per unit of output;

(b) The total area of the establishment;

(c) Total energy consumption in terms of physical quantities and total cost. The various ways in which the establishment uses energy should be covered, such as heating, air-conditioning, cooking and lighting.

To obtain a reasonable response rate in a mail survey, those concerned may have to be reminded by telephone. Strict control must be exercised over returned questionnaires, which should be evaluated immediately to ensure coherence between quantities and values, calculation of the rate of consumption by employee or by square metre or by ton of production. When information appears incorrect, a telephone call to the participating establishment may be necessary to verify the information and complete the questionnaire.

In the interviewer survey, the questionnaire may be simpler and can be adapted to those who do not know their annual energy consumption level. The questions would then address the monthly consumption during various seasons. The estimation of consumption can result from the dialogue between the interviewer and the participant from the establishment. A reliable estimate may be obtained by asking several questions such as the following:

"How much energy (or specific energy product such as butagas/solar) do you consume monthly?"
"How many stoves do you have?"
"How many hours is it turned on?"
"What is your average electric bill?"

The interviewer should ask to see the two or three most recent bills, if possible.

### 2. *Sample design*

Sample design is an important procedure which usually makes use of formal probability theory. While it may be necessary to deviate from this process for practical reasons, a non-representative sample can render subsequent results unreliable when the data are extrapolated for the entire sector. Factors which may limit the application of statistical techniques include the lack of a master sample or data on the overall sector from which the sample is to be drawn, physical inaccessibility of certain subsectors, and insufficient financial or human resources.

### 3. *Questionnaire design*

A proper design for the questionnaire involves (a) choosing questions that will generate reliable and usable information for planners and policy makers; (b) understanding the important elements of the questionnaire format; and (c) avoiding common mistakes in phrasing questions. Considerable savings in data-gathering and analysis can be achieved if the questionnaire is formulated according to the objectives of the survey. Planners and policy makers, who ultimately use the data, should be consulted prior to survey design.

Some important considerations in the design of the questionnaire are the following:

(a) The order and wording of questions are very important. In a major survey, they should be assessed in a pilot test of the survey to minimize redundancy and enhance clarity. For example, there is no need to ask about the total area of the house if the questionnaire has already asked about the number of rooms and the area of each room;

(b) The questionnaire should be easy for the surveyor to complete. It should use the multiple-choice method and/or large blank spaces, boxes, clear instructions and a good reference manual;

(c) The questionnaire should be as short as possible to minimize the interview time;

(d) Questions should be as simple as possible. Questions which are necessarily complex should be broken down into manageable components;

(e) Control questions should be included for important variables so that the accuracy of responses can be cross-checked. For example, asking about quantity of energy consumed and then checking the answer by asking about the amount of the bill;

(f) Appropriate units of measurement should be employed in the questionnaire. For example, it is more relevant to use litres for kerosene or diesel oil rather than “barrels”;

An effort should be made to avoid the following errors, which are frequently made in the preparation of energy survey questionnaires:

(a) Asking highly specialized questions which lay people cannot answer;

(b) Asking for two or more pieces of information in the same question. For example: “Do you use LPG (liquefied petroleum gas), kerosene or electricity for cooking purposes?”;

(c) Asking direct questions about budgets and income. This information should be developed through several sets of questions on expenditure, prices and quantities. (Annex I shows three samples of questionnaires that could be used in ESCWA member countries.)

### 4. *Selection and training of interviewers*

Interviewers should be selected from the local population. Female surveyors are preferred in some cases, such as for household surveys, because they may communicate better with women who are often the main users of fuels. To a large extent, the educational level of the surveyors will affect the quality of the information obtained. Special attention should be given to their training. A manual explaining the objectives of the survey, interviewing techniques and the proper way of asking and recording each question should be prepared, used during the training process and then given to each interviewer.

The training course should last four to six days and should cover the following topics:

(a) Introduction to the objectives of the seminar;

(b) Introduction to methods of conducting interviews, recording responses and handling interviewing problems;

(c) Introduction to work plan, methodology, and sampling procedures;

(d) Discussion of the questionnaire itself, which should include the purpose of the survey and the relevance of each question;

(e) Individual practice interviews conducted on site.

It is essential that survey logistics be carefully prepared in advance so that field work can proceed as smoothly as possible. Important logistical elements of implementing an energy survey include legal clearance, transportation, per diem, availability of necessary equipment and supplies, adequate supervision and quality control. Field coordinators and supervisors should carefully monitor the work of interviewers, attend interviews, check answers, discuss problems and assess preliminary results on a regular basis.

### 5. *Quality control*

Quality control measures in many surveys are applied only at the data-processing stage. Though these measures are necessary, they should be regarded as an addition to, not a substitute for, review at the time of data collection, when there still may be time to correct any systematic faults detected. Close supervision is required to ensure that the work is done properly. The supervisor is the key figure in conducting quality control checks both during and after the interview. Quality control could be done through (a) close supervision of interviews; (b) editing of the completed questionnaire by the field supervisor; (c) ensuring that consistency checks are built into the questionnaire; and (d) verification of the data using secondary sources whenever possible.

If the questionnaire has not been adequately pre-tested, inconvenient last-minute changes have to be introduced. If errors are attributable to the interviewer, then additional training may be required. In addition to attending sample interviews, the supervisor should edit completed questionnaires on a regular basis.

### 6. *Extrapolation of the data*

Editing is a major stage in survey data processing. Its objective is to correct errors. Where possible, editing should be done by computers. In this manner, improperly recorded data can be identified. Computers also should be used in the processing and analysis of data. Several software packages are commercially available for this purpose.

Data extrapolation is a very important step after the energy survey has been completed. The extrapolation mechanism is the opposite of the mechanism of choosing the sample. For example, if, in a certain class, one establishment out of every six is chosen, and if every establishment has been reviewed, the quantitative results of the survey should be multiplied by six. If the answering rate is only 60 per cent, then each result should be multiplied by that percentage, as per the following:

$$\frac{6}{0.6} = 10$$

The report should be divided into sections: a general section should cover the needs of those readers who are mainly concerned with the basic results; and a technical section should present a more detailed analysis of the data. Highly detailed technical material, such as complex statistical analyses, may be included in a series of annexes.

### 7. *Data update*

Sectoral energy consumption data should be updated periodically, and ideally on an annual basis. Using a mail survey is an appropriate means of updating data, especially when dealing with well managed institutions such as large transport companies, power plants, large hotels, large hospitals and educational and government institutions. To ensure a reasonable response rate, the institution responsible for energy planning should remind the concerned institution to fill in the form at least twice each year (June and December).

However, interviewer surveys are costly and time-consuming, and it may not be possible to repeat them every year. To update data on sectors such as households or on subsectors such as small industries and restaurants, the institution responsible for energy planning is advised to:

(a) Carry out periodic full-scale (one representative sample) interviewer surveys (every five to seven years);

(b) Carry out periodic small-scale interviewer surveys (one tenth of the original sample; every two to three years);

(c) Use other methods such as energy-GDP relation or input-output models for estimating annual data.

# II. CLASSIFICATION OF DATA REQUIRED FOR PLANNING IN THE ESCWA REGION

The energy system encompasses a wide range of activities, including the production of energy from different sources, the consumption of energy by a variety of users with different consumption patterns and the use of different fuel types within the system. The study and analysis of those factors is crucial for energy planning. Thus an energy database should encompass the complete spectrum of energy supply as well as consumption of different energy types by various economic sectors, energy prices, energy conversion facilities, energy storage and energy transporting facilities. To enable the energy planner to analyse the interaction between energy use and economic and social development, the energy database should also include a certain amount of economic and demographic data, including gross national product (GNP), GDP, gross capital formation by type of good, energy cost to the economy, information on population and the labour force, trade balance, balance of payments, subsidies by sector (if any) and the government budget.

## A. Energy data

The energy database should provide complete information about resources, production, conversion, imports or exports and consumption. The required data can be disaggregated as shown below.

### 1. *Energy resources*

**Primary level**: This includes reserves, production, imports, exports, bunkers and storage of the following primary sources of energy: coal, crude oil, natural gas, and primary electricity (hydroelectricity and geothermal energy).

**Secondary level**: This includes production, imports, exports, bunkers and storage of kerosene, gasoline, jet fuel, gas oil, fuel oil, and secondary electricity (electricity produced from a primary source of energy).

### 2. *Energy conversion*

This should encompass data about conversion facilities (refineries and power plants), including capacities, structure, own-consumption, system losses, load factors, utilization factors, efficiency and specific fuel consumption.

### 3. *Final consumption*

This should include data about the main consuming sectors, the classifications of which vary from one country to another. The following classifications are used by the majority of ESCWA member countries: transport, household, industry and others. However, some countries combine "household" with "commercial"; other countries use the term "service sector" (which includes commercial establishments and government institutions). The agricultural sector is specified in some ESCWA member countries, particularly in Egypt and the Syrian Arab Republic.

## B. Energy balances

The aim of data collection is to present energy information in a logical and consistent form and to show the flow of energy from the supplier (in primary form) to the end-user. Energy data can be tabulated in a matrix, called an energy balance, in which the columns contain the type of energy supplied (in primary and secondary forms) and the rows contain the formation of supply, the conversion and the major consuming sectors.

The energy balance disaggregates energy data by components. For each component it equates consumption with international trade and changes in stocks. It also separates consumption by various categories that distinguish between energy used for conversion and energy put to final use. Annex II shows three formats for energy balances that can be applied in ESCWA member countries.

One of the important aspects of energy balance computation is the choice of a single energy unit to represent the different variables. It is advisable to use the ton of oil equivalent (TOE) as the reference unit since this unit and the joule are the most commonly used worldwide. The relation between the TOE and the joule is simple:

1 ton of oil equivalent = 42 gigajoules

An energy balance itself does not contain any information on the determinants of final energy consumption and is therefore not sufficient for projection, planning or modelling exercises. Energy balances obtained over a number of years, however, would provide a time series of consumption by sector which can be used to study the behaviour and the determinants of sectoral consumption. Such sectoral studies can provide submodels which can be used to project or plan national energy production, transformation and consumption.

## C. Economic data

The energy sector should not be considered separately from other sectors of the economy because energy is not only a final product but also an input to the production process. It can sometimes be substituted for other inputs. For example, in a typical industrial process, the main elements of production are generally energy, capital, labour and raw materials. To some degree these inputs can be substituted for one another. Hence, the interrelation between macroeconomic parameters should be clearly defined. To achieve this, a minimum amount of economic data should be made available. This includes GNP by type of activity, gross capital formation by type of good, energy cost to the economy, energy prices, subsidies (if any), balance of trade and balance of payments.

## D. Demographic data

These data include population in urban and rural areas, percentage of the population with access to commercial energy resources, percentage of the population with access to electricity, number of households in urban and rural areas and the labour force.

# III. ENERGY DEMAND ANALYSIS

To forecast energy demand and to evaluate the impact of energy policies or general economic policies adopted by the Government, a detailed analysis of energy demand in the different consuming sectors is necessary. This section deals with the analysis of energy demand, first at the aggregate level and then at the level of consuming sectors.

In the analysis of energy demand, researchers must choose between methods with low data and computation requirements that yield quick but limited results, and more powerful methods yielding more detailed and consistent results. The more powerful methods, however, often require significant investments in data collection and computation and may be sensitive to the quality of the data and the computational models. Among the former are studies of energy-GDP relations and macroeconomic demand studies; among the latter are macroeconomic models with an input-output base and techno-economic models directed towards end-use analysis.

The choice of methods is limited by the availability of data in the short run. In the long run, however, an effort should be made to remove this constraint by gathering more detailed information for use in more sophisticated models. One possible format for collecting detailed information on energy flows is furnished by energy balances.

## A. THE ENERGY-GDP RELATION

At the most aggregate level, energy consumption may be assumed to depend on GDP, which measures the value of output of final goods and services in an economy. Assuming also that no technical change occurs or that no substitution among inputs is possible, energy consumption would be proportional to output, and its output elasticity[1] would be equal to one. Hence if the elasticity is found to differ from unity, it must be due to one or more of the following:

(a) Technological improvement may lead to a drop in the energy intensity. This is the principal reason that energy elasticities for industrial countries are found to be below unity;

(b) Changes in the structure of GDP may lead to a shift towards more or less energy-intensive sectors. For instance, the relatively rapid growth of industry and transport in developing countries is one factor behind their high GDP elasticities with respect to energy consumption;

(c) Changes in the composition of energy consumption may alter the average efficiency of energy use. In developing countries, commercial energy typically replaces non-commercial energy (which is often excluded from statistics). So there is a purely statistical rise in energy consumption and in the estimated GDP elasticity with respect to energy consumption over time;

(d) Changes in lifestyle may lead to a change in the GDP elasticity with respect to energy consumption.

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[1] This is the ratio of the average growth rate of energy consumption during a certain period to the average growth rate of GDP during the same period.

Since the effects of these four phenomena are often combined, energy-GDP elasticities can be used as indicators only, not for predictive purposes.

## B. Input-output analysis

An input-output table portrays the flows of inputs and outputs throughout the entire economy, just as an energy balance portrays the flows of energy in the economy. An energy balance may be regarded as consisting of those columns of an input-output table that relate to energy, with two differences: (a) the units used in energy balances are physical units of energy, whereas an input-output table expresses information in terms of monetary value; (b) an energy balance gives figures for energy in a more disaggregated form than that required in an input-output table.

An input-output table, since it shows the sales of one sector to another, is also called a "transactions matrix". If the inputs to each sector are divided by its output, the result is a matrix of input-output coefficients called a "technology matrix". The technology matrix is a highly versatile tool: (a) it can be used to calculate both the direct and indirect effects of a change in output; (b) it shows the links between the output of final goods (goods which are consumed or invested) and intermediate goods (goods that are used to produce other goods); (c) a change in technology can be represented as a change in input-output coefficients, and its implications for the entire economy can be determined by modifying the technology matrix. Thus it can be used to assess the impact of energy-saving technologies or of inter-fuel substitution on the economy; and (d) as part of a linear programming model, a technology matrix can be used optimize energy use throughout the economy and to analyse the effects of constraints such as the need to balance trade or to ration supplies.

A more detailed view of the overall role of energy in the economy may be had from an examination of a transaction matrix of all sales and purchases by the economy in any year, as shown in annex III. The columns of this table refer to the purchase by each sector of the output of other sectors. The rows refer to deliveries or sales by a producing sector to particular users. By definition, the sum of all demands (minus customs duties) on any row must equal supply from imports and domestic output.

As a result of these advantages, input-output analysis forms the basis of models used in developed countries for macroeconomic forecasting. Egypt and Jordan are applying input-output models to analyse energy policy problems in the context of the entire economy. However, the large-scale computations required by detailed input-output models have been a major constraint to their application to developing countries.

Egypt and Jordan acquired the Energy and Power Evaluation Programme (ENPEP) developed by Argone National Laboratory. ENPEP is an energy planning package designed mainly to prepare bases for the planning of the power sector. It includes a **MACRO** module (containing, *inter alia*, macroeconomic data, currency value, inflation rates), a **DEMAND** module (containing, *inter alia*, efficiencies and energy intensities) and a **BALANCE** module which can generate energy balances for the base year and forecasted years. The package also includes a **PLANTDATA** module for registering the installed capacities, a **LOAD** module for the computation of load curves, and **MEAD**, **WASP** and **IMPACT** modules for the calculation of the environmental impact of power projects. ENPEP, in principle, could be one of the options as a package for establishing an energy database with the following limitations:

(a) The parameters defined for the economy and energy may be oversimplified;

(b) The design is deliberately oriented toward electric power planning;

(c) Energy demand can be disaggregated according to subsectors and useful energy through the **BALANCE** module. However, the system does not allow for the insertion of information on equipment (for example, for households);

(d) The system lacks the facilities which would enable the generation of complete energy balances.

## C. THE TECHNOLOGICAL APPROACH

The application of economic models to energy problems is generally characterized by the importance accorded to the effects of income or output and prices. However, these basic economic relations portray human behaviour, which is often unpredictable. In addition, they must be formulated in terms of monetary value, which makes it possible to distinguish between changes in quantity and price. Dissatisfaction with these models has led to the use of models that rely to a greater extent on technical variables.

Final energy consumption in technical models can be derived as follows:

$$FEC = \sum_{i=1}^{n} (SL/E)_i$$

where:

| | | |
|---|---|---|
| FEC | = | Final Energy Consumption |
| S | = | specific energy required per unit of production or service |
| L | = | level of production or service |
| E | = | efficiency of energy utilization |
| i | = | the productive sector. |

The advantage of this approach is that "S" does not vary with respect to the type of fuels.

# IV. ENERGY DATA COLLECTION METHODOLOGIES USED IN THE ESCWA REGION

## A. ENERGY CONSUMPTION DATA

Various energy planning methodologies requiring different sets of data are utilized in the countries of the ESCWA region. While most countries in the region collect energy data on a regular basis, coordination of these activities is lacking in general. Consequently, there is no regional energy database. Different data collection methodologies are used in different countries, and in some cases different terms are used to describe similar energy products. This section provides a general review of the methodologies used in the region with a special focus on Egypt, Jordan and the Syrian Arab Republic.

The main issues of the energy sector in these countries are outlined below.

### 1. *The direct impact of supply conditions on energy consumption*

Owing to actual energy supply conditions, the concentration of people in rural and urban areas is an important determinant of the type and amount of energy consumed. The availability of non-commercial energy such as biomass, the extension of distribution networks and even the existence of local markets for LPG and kerosene are all factors which influence the level and pattern of energy consumption, especially in the household sector.

### 2. *Sector definitions*

In many developing countries, energy planners consider energy-consuming sectors individually for analytical purposes. These sectors are: (a) transport; (b) industrial; (c) household; (d) agricultural; and (e) service.

However, this division may not be appropriate for all countries. For example, while agriculture is very important in Egypt and the Syrian Arab Republic, it may not be as important as in other ESCWA member countries. However, analysing energy demand in each of the above sectors can be very useful for energy planning and macroeconomic planning in general.

### 3. *The difficult distinction between domestic and economic activities*

Because household activities often include non-commercial but nevertheless productive activities, it is sometimes difficult to identify them for energy planning purposes. This is true for the rural as well as the urban population. For example, the consumption of gasoline by private cars is included in the household sector in some countries and in the transport sector in other countries. The same applies to the consumption of fuel by tractors, forklifts, cranes and construction equipment.

## B. Quality of the current energy data

A distinction can be made between three main parts of the available energy data: primary supply, conversion and final demand data.

**Primary supply data** (reserves, production, imports/exports, sales to domestic refineries, stocks) are available with reasonable accuracy in Egypt, Jordan and the Syrian Arab Republic and can be extracted from the annual and seasonal reports of oil companies, oil ministries, electricity authorities, gas companies and other relevant institutions.

**Conversion data** (internal consumption of the energy sector) can be obtained from the annual reports of refineries and electricity authorities.

**Final demand data** suffer from many deficiencies in all three countries, particularly the Syrian Arab Republic. Data on oil product consumption can be obtained from sales statistics (established by the sales and marketing sections of oil distribution companies, gas distribution companies and electricity distribution agencies), but because the same product is consumed by several sectors, accurate sectoral energy consumption data may be difficult to obtain.

LPG, for example, is consumed by household, commercial and industrial sectors, and it is difficult to determine the proportional consumption of LPG by each sector mentioned. Furthermore, gas oil is used by almost every economic sector, including industry, household, transport, agricultural, commercial and services. Retailers are interested in selling their products whether their customer is an industrialist, a transporter or a householder. This makes monitoring fuel consumption by sector extremely difficult. However, this problem does not exist with electricity consumption. Data on electricity distribution can be easily extracted from the consumer sales files of the distribution companies, whether they are in the public or private sectors. Fortunately, different tariffs are applied to different sectors, obliging the distribution companies to keep separate files for each economic sector and to know the exact consumption of each sector.

General economic and demographic data relevant to the energy sector (demographic growth, population, GDP growth, investment in the productive sector, balance of trade, government budget) can be obtained in fairly good detail from departments of statistics in Egypt, Jordan and the Syrian Arab Republic.

Global energy information (international oil demand, oil prices, energy consumption, oil products prices and electricity rates in neighbouring countries) is regularly maintained and updated in Egypt and Jordan through direct contacts with the source of the information as well as with international and regional organizations such as the International Energy Agency, the Organization of Petroleum Exporting Countries and the Organization of Arab Petroleum Exporting Countries. The situation in the Syrian Arab Republic is different since no single institution is responsible for gathering and collecting such information.

## C. Management information systems

Projects financed by the United Nations Development Programme are under way in Egypt, Jordan and the Syrian Arab Republic aimed at establishing management information systems (MIS) in the electric utilities of those countries. The objectives of these projects are to:

(a) Improve the existing technical information, computer systems and basic work activities;

(b) Gather and maintain information on the activities of the electric utilities;

(c) Support maintenance and construction planning and scheduling;

(d) Provide information regarding equipment installed to support operations, engineering, testing and records management functions;

(e) Support equipment reliability research and analysis;

(f) Provide information to facilitate control and accountability;

(g) Provide historical information in order to identify more readily high-maintenance items and the age of facilities.

The project in Egypt has been completed; in Jordan it is under implementation; in the Syrian Arab Republic it has not yet begun.

## D. Energy demand forecasting

In both Egypt and the Syrian Arab Republic, demand projections are based on "demand for fuel" rather than "demand by sector". That is, the focus is on forecasting demand for kerosene, gas oil, jet fuel and other energy products rather than on forecasting demand by energy-consuming sector.

However, energy planners in Egypt have acquired an input-output model and other macroeconomic models which can be used for aggregate demand forecasting. However, these models require an enormous amount of sophisticated and detailed data which is often unavailable in developing countries.

The situation in Jordan with regard to energy demand forecasting is similar to that of Egypt with the exception that Jordan has carried out many energy surveys to identify energy consumption in the major energy-consuming sectors (the household, industrial, commercial and agriculture sectors). Unfortunately, these surveys have not been followed up, and their results have not been updated. However, efforts are currently being aimed at consolidating and improving the energy data bank of the Ministry of Energy and Mineral Resources of Jordan and to facilitate the linking of this bank with other data banks available in the Ministry of Planning and the Jordan Electricity Authority, which is part of the Ministry of Energy and Mineral Resources.

## E. Overall situation in Egypt, Jordan and the Syrian Arab Republic

### 1. *Egypt*

In Egypt, energy planners rely heavily on the reports issued by various energy institutions and the Central Agency for Public Mobilisation and Statistics in collecting energy data. Final demand data, however, suffer from many deficiencies, including the inaccurate categorization of consumption data by consuming sector. The consumption of the armed forces and central security departments, for instance, is included in transport sector consumption. Another problem for energy planners is that demand projections are based on "demand for fuel" rather than "demand by sector" methodologies. However, the Organization for Energy

Planning (OEP) has acquired some energy models and is planning to use them for energy demand forecasting. OEP also has prepared energy balances for and is planning to carry out energy surveys in some industrial subsectors to identify their consumption rates.

### 2. *Jordan*

In Jordan, the Ministry of Energy and Mineral Resources (MEMR) and Jordan Electricity Authority (JEA) are responsible for energy and electricity data collection. MEMR has established a modest energy data bank. There is a great reliance on reports issued by other energy institutions. Energy surveys have been carried out to identify energy consumption in the household, services and agricultural sectors. The consumption of the armed forces and public security departments is also included in the transport sector's consumption.

### 3. *Syrian Arab Republic*

In the Syrian Arab Republic, there is no single institution responsible for energy data collection. The Bureau of Statistics is responsible for the collection of demographic and socio-economic data and collects energy data as well, though it relies heavily on reports issued by energy institutions. Final energy consumption data by sector is not available.

# V. CONCLUSIONS

Reliable information is essential for organizations and individuals involved in energy planning in the ESCWA region. While energy data collection procedures differ in each ESCWA member country, many of them have similar energy planning needs and face similar problems collecting data.

The availability of disaggregated data on energy supply and demand is necessary for: (a) the identification of energy problems and trends; (b) the preparation of supply and demand projections; (c) the conducting of market research; (d) the development of effective policies and programmes as part of overall energy strategies; and (e) the evaluation of proposed ongoing and completed projects. Without comprehensive knowledge of the way in which energy is acquired and consumed, attempts to develop activities and policies to improve the welfare of the inhabitants and to protect the environment could be counter-productive.

Supply data is available and can be obtained with reasonable accuracy in almost all ESCWA member countries from the annual reports of energy-producing institutions. Final demand data, however, suffer from many deficiencies, and the effectiveness of policies aimed at the energy sector in ESCWA member countries may be reduced if they are based on inadequate data. It is especially important, in the light of the current emphasis on sustainable development and the role of hydrocarbon energy in worsening local and global pollution, to ensure that adequate and consistent energy data is available to energy planners and government officials.

**Annex I**

**ENERGY QUESTIONNAIRE**

Sector: Industry

Subsector:

Date:

**A. Identification**

1. Name of Company
2. Address
3. Contact for further inquiries — Name:<br>Position:<br>Telephone:
4. Date licensed/commissioned
5. Number of employees

**B. Processing activities**

1.

| Major Products | Design capacity | Actual production | Units (tons, pieces) | Remarks |
|---|---|---|---|---|
| 1.1 | | | | |
| 1.2 | | | | |
| 1.3 | | | | |
| 1.4 | | | | |

2.

| Major raw materials | Design capacity | Actual input | Units | Remarks |
|---|---|---|---|---|
| 2.1 | | | | |
| 2.2 | | | | |
| 2.3 | | | | |
| 2.4 | | | | |

Working periods: Year round:
Seasonal: Number of months:
Number of: Plant working:
Shifts/day: Hours per day:

## C. Energy consumption Year:

1. Purchases and consumption

| Energy type | Unit | Quantity purchased | Cost per unit | Quantity consumed |
|---|---|---|---|---|
| Electricity | KWh | | | |
| Fuel oil | Tons | | | |
| Diesel oil | Tons | | | |
| Gasoline | Tons | | | |
| Kerosene | Tons | | | |
| LPG | | | | |

2.

| Type of process | Primary energy consumed | Capacity (KW) | Generated (KWh) | Self-consumed (KWh) | Sold (KWh) |
|---|---|---|---|---|---|
| | | | | | |

## D. End use of energy

### 1. Fuels

Share of end use categories in the total consumption of each fuel

| Fuel | Process heat (%) | Low temp. heat (%) | Transport (%) | Non-energy end-use (%) |
|---|---|---|---|---|
| Fuel oil | | | | |
| Diesel oil | | | | |
| Gasoline | | | | |
| Kerosene | | | | |
| LPG | | | | |

### 2. Electricity

Share of end use categories in total electricity consumption

| Process heat (%) | Low temp heat (%) | Motive power (%) | Air cond. (%) | Lighting, others (%) |
|---|---|---|---|---|
| | | | | |

### 3. End use equipment

| Type | Installed capacity | Utilization rate | Energy consumption | Remarks (conditions, age, etc.) |
|---|---|---|---|---|
| | | | | |

**E.** Summary of the major energy problems as viewed by plant management

## INSTRUCTIONS FOR COMPLETING THE QUESTIONNAIRE

A. (1,2) Give the actual name and address of the enterprise.

(3) This should be a person who can provide reliable information about production figures as well as energy consumption and overall planning activities.

(4) Date when the enterprise started production.

(5) Total number of full-time employees. Part-time employees should be added up to the corresponding number of full-time employees.

B. (1) Give up to four major products, the possible production of each by the machinery available if there would have been a 100% rate of utilization of all units, the actual production in a given year and reasons for shortfalls (constraints such as breakdowns of units, lack of energy, or changes in the production programme).

(2) Give up to four major raw materials consumed in a given year the necessary input at a 100% rate of utilization, the actual input and the constraints (e.g. insufficient supply).

(3) Mark with an "X" if the enterprise is working year round or seasonal. If seasonal, give the number of months. Give the number of shifts per day and the number of working hours per day of the plant.

C. (1) Give the amount of every type of energy purchased in a given year (corresponding to your energy bill), the cost per unit and the quantity actually consumed (giving consideration to stock changes).

(2) Only for plants with self-generation of electricity.

D. (1, 2) For each type of energy used, give the percentage of use in each category. For every fuel used, the total must add up to 100%.

(3) Give information regarding the major energy-consuming appliances. Specify the most important devices as well as those within the main fields of energy consumption. Under remarks, specify age, changes within the near future, general condition and maintenance, breakdowns and fuelswitching (planned or realized).

**Annex I** *(continued)*

**EVALUATION SHEET**

**Energy demand in industry**

Year of survey:
Industrial sector:

## I. Production

| Plant No. | Age of plant | No. of employees | Major products manufactured | Annual production | Capacity utilization |
|---|---|---|---|---|---|
| | | | | | |
| Total production of major products | | | | | |

**Annex I** *(continued)*

**EVALUATION SHEET** *(continued)*

## II. Energy consumption

| Plant | Fuel consumed | | Energy content (GCAL) | Electricity | | Total (GCAL) |
|---|---|---|---|---|---|---|
| No. | Type | Amount | | (KWh) | (GCAL) | |
| | | | | | | |
| Total energy consumption | | | | | | |

**Annex I** *(continued)*

**EVALUATION SHEET** *(continued)*

### III. Energy distribution

| Plant No. | Type of equipment/process | Share on consumption of | |
|---|---|---|---|
| | | Fuel (%) | Electricity (%) |
| | | | |
| Average | Process heat<br>Low temp. heat<br>Motive power<br>Others (elect.) | | |

**Annex I** *(continued)*

**EVALUATION SHEET** *(continued)*

## IV. Self-generation of electricity

| Plant No. | Installed capacity (KW) | Annual generation (KWh) | Own Conspt. (%) | Sales (%) | Fuel consumed Type amount (L, Ton) |
|---|---|---|---|---|---|
| | | | | | |
| Total | | | | | |

## V. Specific energy consumption

Total production output (tons, value added):
Total fuel consumption (GCAL):
Total electricity consumption (HWh):
Percentage of calorific value of self-generated electricity:
Total energy consumption:
Specific energy consumption:

**Annex I** *(continued)*

**ENERGY QUESTIONNAIRE**

**Sector**: Commercial

1. <u>General information</u>

Hotel name:
Class:
Ownership:
No. of employees:

2. <u>Area information</u>

Total area:
Heated area:
Air conditioned area:

3. <u>Other information</u>

No. of rooms:
No. of beds:
No. of meals (last year):

4. <u>Energy data</u>

| Uses of Energy | | | | | | |
|---|---|---|---|---|---|---|
| Fuel type | Heating | Air conditioning | Water heating | Cooking | Lighting | Equipment |
| Gas oil (litre) | | | | | | |
| Kerosene (litre) | | | | | | |
| LPG (kg) | | | | | | |
| Electricity (KWh) | | | | | | |

Name of person who filled the questionnaire:
Telephone No.:
Signature:

**ENERGY QUESTIONNAIRE** *(continued)*

**Sector:** Household

1. General information

- House owner
- Income
- Family size

2. House information

- Detached
- Semi-detached
- Apartment
- House area
- No. of rooms
- Construction:

Concrete cement blocks stone

3. Heating system

Central heating Kerosene stove

Gas oil stove LPG stove

Electrical heater

4. Air-conditioning system

Window type Total capacity:

Central Total capacity:

5. Water heating system

Electricity Kerosene LPG

Gas oil through central heating system

Gas oil through individual stove

Solar

**ENERGY QUESTIONNAIRE** *(continued)*

6. Cooking system

| | | |
|---|---|---|
| Electrical | LPG | Kerosene stove |

7. Lighting

(a) Incandescent lamps

| | |
|---|---|
| Number | Total capacity in watts |

(b) Energy-saving lamps

| | |
|---|---|
| Number | Total capacity in watts |

(c) Other lamps

| | |
|---|---|
| Number | Total capacity in watts |

8. Availability of electrical appliances

| | | |
|---|---|---|
| Television | Washing machine | Refrigerator |
| Freezer | Vacuum cleaner | Videocassette recorder |
| Dish washer | Iron | Air conditioner |
| Hair dryer | Kitchen appliances | Fan |

9. Price and quantity

| Fuel | Unit | Price/unit | Quantity/year |
|---|---|---|---|
| Electricity | KWh | | |
| LPG | Cylinder/kg | | |
| Kerosene | Litre | | |
| Gas oil | Litre | | |

**Annex I** *(continued)*

**ENERGY QUESTIONNAIRE** *(continued)*

10. End-use consumption

| Service | System capacity | Specific consumption | No. of daily running hours | No. of months in use per year |
|---|---|---|---|---|
| Air-conditioning | | | | |
| Space heating | | | | |
| Water heating | | | | |
| Cooking | | | | |
| Lighting | | | | |

## Annex II

### ENERGY BALANCE (format 1)

Unit: MTOE

| | Crude oil | Oil products | Gas | Hydro | Renewable | Total |
|---|---|---|---|---|---|---|
| Domestic production<br>Imports<br>Exports<br>Bunkers<br>Stock change | | | | | | |
| T.P.E.S* | | | | | | |
| Electricity generation<br>Petroleum refineries<br>Other transformation | | | | | | |
| Industry<br>Transport<br>Household<br>Others | | | | | | |

* TPES = Total Primary Energy Supply

**Annex II** *(continued)*

**ENERGY BALANCE** (format 2)

| | Biomass | Coal | Oil | Oil products | Gas | Electricity | Total |
|---|---|---|---|---|---|---|---|
| Production<br>Import<br>Export<br>Bunkers<br>Stock changes | | | | | | | |
| TPES | | | | | | | |
| Electricity generation<br>Refinery<br>Other transformation | | | | | | | |
| TFC | | | | | | | |
| Industry<br>Transport<br>Household<br>Agriculture<br>Services<br>Others | | | | | | | |

TFC = Total Final Consumption

**Annex II** *(continued)*

**ENERGY BALANCE** (format 3)
MTOE

| | Coal | Oil | N.Gas | LPG | Gasoline | Kerosene | Gas oil | Fuel oil | Other products | Primary electricity | Secondary electricity | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Production<br>Imports<br>Exports<br>Bunkers<br>Stocks | | | | | | | | | | | | |
| Total Supply | | | | | | | | | | | | |
| Refinery<br>Power Plants<br>Energy Sector:<br>Own use<br>T&D Losses<br>Non-energy<br>Uses | | | | | | | | | | | | |
| Final Energy | | | | | | | | | | | | |
| Transport<br>Agriculture<br>Industry<br>Household<br>Others | | | | | | | | | | | | |

## Annex III

### (Year) TRANSACTION MATRIX

| | Agri 1 | Min 2 | Ind 3 | Elec 4 | Pet. P. 5 | Trans 6 | Serv 7 | House cap 8 | Govt. con 9 | Inv. 10 | Expo 11 | Impo 12 | Duties 13 | Gr. output 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Agri 1 | | | | | | | | | | | | | | |
| Min 2 | | | | | | | | | | | | | | |
| Ind 3 | | | | | | | | | | | | | | |
| Elec 4 | | | | | | | | | | | | | | |
| Pet. P. 5 | | | | | | | | | | | | | | |
| Trans 6 | | | | | | | | | | | | | | |
| Serv 7 | | | | | | | | | | | | | | |
| Crude oil 8 | | | | | | | | | | | | | | |
| Value added 9 | | | | | | | | | | | | | | |
| Gross output 10 | | | | | | | | | | | | | | |
| Ener. subsidy 11 | | | | | | | | | | | | | | |

*Note*: The columns refer to the purchase by each sector of the output of other sectors. The rows refer to deliveries or sales by a producing sector to particular users.

## BIBLIOGRAPHY


Aburas, R. and J.W. Fromme. "Household Energy Demand in Jordan", *Energy Policy*, July/August 1991.

Blitzer, Charles R. *Energy-economy Interactions in Jordan*. Energy Laboratory, Massachusetts Institute of Technology. January 1992.

GOPA consulting company. "Energy Demand in the Commercial and Service Sector in Jordan" Germany, March 1988.

Jordan. Ministry of Energy and Mineral Resources. "مسح استهلاك الطاقة في القطاع المنزلي" [Survey of household energy consumption]. November 1987.

NEA/CEC/AIT Project on Energy Demand Analysis and Medium/Long Term Forecast in Thailand. March 1986.

World Bank. "Population Growth, Wood Fuels and Resource Problems in Sub-Saharan Africa". Energy series, paper No. 26, March 1992.

World Bank. "Some Considerations in Collecting Data on Household Energy Consumption". Energy Series, paper No. 3, March 1989.