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INTEGRATED ENERGY PLANNING FRAMEWORK FOR APPLICATION IN GHANA

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ABSTRACT:

Integrated Energy Planning is gaining currency in the development planning process of developing countries. In Ghana, with the setting up of the National Energy Board (NEB), efforts are being made to draw up a comprehensive energy plan for the country. To undertake this task requires information on various sectors of the national economy. Such information to facilitate the planning effort is not readily available. This paper reviews the framework for Integrated Energy Planning (IEP) and discusses the relevant information which must be acquired in the development of the energy data base.

Key Words:
Development. Integrated Energy Planning, data base, Supply-oriented, energy planning

Introduction

Since the first and the second oil shocks in 1973/74 and 1979/80 respectively, the energy economies of both the developed and the developing countries have attracted the attention of researchers in various academic disciplines.

Historical studies into this relationship have concluded that energy intensity increases during the period of rapid development, followed by reduction in energy intensity as the economy matured and shifted towards services and high - value-added manufactured products. (1).

Ghana is currently going through a period of rapid development. This process, in this period of high oil import bills and falling export earnings, raises various issues for policy formulation and planning. Energy policy can have profound effect on the pattern of urbanization, the relative demand for different modes of transport and agriculture development. Increased energy consumption is an intrinsic part of the process of modernization, industrialization and urbanization.

In spite of the importance of the energy sector in the socio-economic development of nations, Ghana, like many other developing countries, had until recently given little or no attention to planning and policy formulation in the energy sector. Energy planning must be seen as an integral part of the broader development planning although it must be subordinated to wider goals and strategies. There appears to be no alternative development strategy offering an easy escape from the constraints of higher energy costs.

In this regard, energy policy makers must consider the effects of energy supply and use on the development process. To what extent does energy constrain the rate of economic growth or force development into particular patterns? What is the relationship between energy policies and alternative development strategies? Are there particular aspects of development on which energy policies exert a decisive influence? If energy is certain to become scarcer and higher in cost what adaptation and adjustments can minimise the adverse effects on development? These are pertinent issues that must be considered by planners. Effective energy planning requires reliable and relevant information. This paper reviews the framework for Energy Planning and examines in greater detail, the data needs required for the application of its methodology to the Ghanaian situation.

Energy Planning Framework - a review

To collect relevant information for energy planning implies the existence of a planning framework which would determine the level of aggregation and disaggregation and kinds of data to be collected and assembled.

A review of literature on Energy Planning reveals that there are three main approaches in the planning process. These approaches are the "supply-oriented" energy planning, energy demand planning and integrated energy planning.

The supply-oriented energy planning has been the traditional approach to energy planning. This approach involves a rough estimate of energy demand, based on historical energy - GDP elasticity and GDP growth projections. Different supply options are derived that would satisfy this demand. The emphasis clearly is on the supply options, their

engineering and financial aspects and requirements. Generally speaking, supply-oriented energy planning refers to two things. First, by deciding on a certain supply option, the fuel consumption pattern is shaped for a considerable span of time. Second, traditional energy planning while focussing on micro-economic feasibility, largely neglects macroeconomic affordability and adaptability.

The traditional response to the energy problems of a developing country like Ghana has not been feasible because it has been far too costly and would likely mean incurring further debt since it basically involves energy supply system expansion.

The oil crisis in the early 1970s and 1979-80 have revealed serious shortcomings of such an approach to energy planning. It is conceded that when price structures change drastically as they did during these crises, the stable relationship between micro-economic aggregates such as GDP and energy breaks down (2).

There might be a serious disequilibrium between supply and demand. The results are expensive overcapacity and/or bottlenecks that retard economic growth.

The lesson to be learnt from this experience is that much more attention has to be paid to careful energy demand planning (sometimes referred to as end-use approach to energy planning) (3). Energy Demand Planning involves the assessment of possible demand changes and the planning of a supply system that can adjust flexibly to unexpected demand variations. This differs from the traditional supply-oriented approach which instead of considering which source would satisfy the particular end-use (demand), focuses on how much electricity or petroleum products, for example, can be produced and how it can be made to perform all end-uses, regardless of whether or not it is optimally matched to that use. There is however, the tendency to underplay the importance of the supply aspect of planning process.

The third approach which is now current is the integrated approach to energy planning. This seeks to integrate the two approaches into a unified planning framework. Integrated Energy Planning means the analysis of all energy issues within a unified policy framework in order to arrive at a set of nationally optimal energy solutions over a long term, say fifteen to twenty years (4).

An important dimension to this planning framework or approach is that it tries to ascertain the least expensive means of meeting energy needs, considering all options, on both the demand and supply sides. Thus where it is cheaper to save electricity than to produce it, or where it is cheaper to invest in indegenous renewable than buy imported oil, those options are chosen. The goal of this planning method is to provide the desired services at the lowest possible cost. This may also have to take into account such costs as environmental and social costs which are difficult to quantify but should not be ignored.

The experience of energy planning in the country had been the mixture of the first two. These have been at electricity and petroleum subsectors. There has not been any integrated approach to energy planning in the country. It is against this background that this paper seeks to discuss the framework for integrated energy planning and the data requirement for such planning methodology for Ghana.

Integrated Energy Planning Framework and Application in Ghana.

A cursory look at planning activities in the energy sector reveals that whatever planning is done has been confined to the commercial energy sector, namely electricity and petroleum. Planning for renewable and other non-conventional energy resources is of recent origin. The Planning activities were highly disparate in nature resulting in a collection of desegregated investment plans lumped together under a national budget. This type of planning activity has many disadvantages of which a few would be mentioned:

a) there is usually inter-sectoral conflict of objectives;
b) there is lack of balanced resource development. Before the oil crisis in the early 1970s, and drought in 1982/83, the country had taken reliability and availability of supply of crude oil and hydroelectric power for granted. Consequently development of other energy sources was neglected.
c) there is absence of mechanism to deal with interface issues such as energy environment interface and inter-fuel substitution.

The disadvantages underscore the view that a full grasp of the energy situation in the country, and integrated approach to the energy planning process must be adopted. The inevitable outcome of this planning process is a comprehensive Energy Plan for the country.

The framework for an integrated energy planning is presented diagrammatically in figure 1. The central themes of the framework are briefly discussed. The first theme in the planning process is the clear statement of goals and objectives for the plan. This statement is normally accompanied by major policy guidelines which are derived from the stated goals and objectives. Such statements are determined by the political authority of a country. For instance the government has set its broad policy

objectives. These are:

a) to overcome the constraints on existing energy resources via measures to resuscitate dilapidated infrastructure and institutional weaknesses in the energy operating entities;
b) to plan for sustained provision and security of energy supply; and
c) the need to increase the reach of energy resources to all sections of the community to facilitate their socio-economic improvements, especially majority of rural people (5).

The second is the development of an energy data base. To date different forms of energy data exist in the country, and these are lodged with the line agencies, namely, Volta River Authority (VRA), Ghana-Italian Petroleum Corporation (GHAIP), Electricity Corporation of Ghana (ECG), Ghana National Petroleum Corporation (GNPC) and Forestry Commission. These are put in a form suitable for their own respective planning purposes. However to undertake an integrated energy planning process may require energy related and macro-economic data with different levels of aggregation and disaggregation (6).

To design an energy data base the designers should take into account the policy objective to be pursued, the type and extent of analytical work to be carried out and the problem of data availability. Data base development involves three (3) major stages, namely: (a) identification of data needs which are to a large extent influenced by the broad goals and objectives set; (b) data collection and (c) assembling data collected. This is the core of the paper and would be dealt in detail later.

The third central theme to the planning process is microanalysis which embodies the analysis of the components (3-8) indicated in figure 1. This segment of the planning framework is focussed on economic growth and demand projections at macro and sectoral levels. It also involves resource assessment and technology evaluation. The analysis done enables various supply-demand balances to be derived; ie. balancing the projected demand against projected supply. In the balancing exercise energy flows have to be traced from each source to each end-use. With the alternative supply-demand balances an assessment is made of the impact of the supply-demand balance on the country's economic structure and its environment. This type of microanalysis is not only an important activity typically undertaken by an energy planning unit but its use to identify the major directions of a desirable energy policy is conceptually straight forward (7). The end result being the translation of such general energy strategies into investment programmes involving the application of specific technologies. These investment programs which have to be screened during the financial planning process are accompanied by demand and supply management tools to facilitate efficient implementation of the Energy Plan.

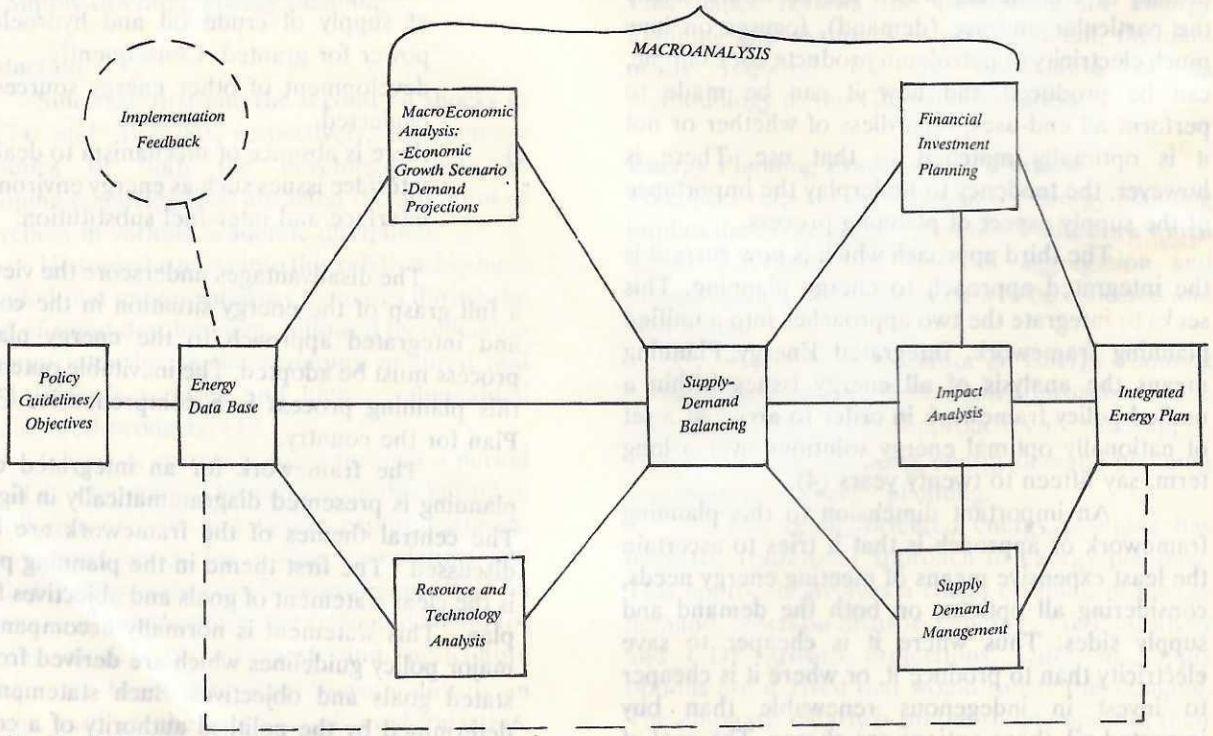

Fig. 1 : INTEGRATED ENERGY PLANNING FRAMEWORK

NOTE: Adapted from Integrated Energy Planning Manual. Asian & Pacific Development Centre.

Present Situation of Energy Data Base Development in Ghana.

In 1985, the NEB was set up to advise the government on energy policy and planning matters. In addition it was to monitor the operations of the line agencies in the energy sector, and advise on the rational development and use of the country's considerable renewable energy resources.

To effectively perform the task, the NEB has to develop an energy data base. As stated earlier in this paper, the various line agencies have their own data bases to serve their respective planning needs. Putting the Integrated Energy Planning (IEP) process in place would require the developing of a data base which would meet the needs of the IEP process.

It goes without saying that the lack of relevant and reliable information makes it almost impossible to translate the policy objectives of government into implementable plans. The NEB is very much aware of this and since its inception has developed an initial data base based on data from secondary sources like VRA, ECG, GHAIP, GNPC and petroleum products marketing companies. In addition the Board has been augmenting the initial data base with primary data from surveys it has commissioned. Two of these surveys are the industry-wide energy audit and charcoal/firewood consumption survey.

Information Needs for Integrated Energy Planning.

An immense body of relevant information is necessary for effective planning, particularly when the government aims not only to augment and diversify resources but also to manage the demand for available resources. The energy system is subject to continuous changes. Structures and patterns of energy demand undergo rapid changes partly due to technological changes and partly as a consequent to rapid market adjustment. The following is an attempt to highlight the kinds of information that are relevant and as such must be collected and assembled in the development of energy data base for the country.

Data Base Development (DBD)

This seeks to identify, generate and assemble information required for energy sector analysis and decision making. There is an interdependent relationship between data base development and energy planning. While energy planning depends on the availability and quality of data, the reverse is also true since gaps and deficiencies in data base can be identified and assessed as a result of energy planning. This iterative process of data base development is illustrated below in figure 2.

It must be emphasized that assessment of the initial data requirement for energy planning depends on the policy objectives to be pursued and the analyses to be carried out in the planning process. Required data for planning are generated and collected from existing information stock. Also a preliminary supply-demand balance is constructed both to identify gaps and deficiencies in the initial data base. This is what takes place in stage 5 of the framework discussed earlier. The data base provides information as inputs to economic scenario; while carrying out these analyses, the need for additional information is identified which leads to additional data collection.

Identification of Data Required

This is the first step in data base development. Such data relates to a country's energy system where activities of production,transformation and consumption of energy interact. It also includes the variables and parameters which influence the energy system.

a) Data Required for demand analysis.

This can be grouped into two categories:

i) the first relates to information affecting demand for energy, such information includes the following:
-macro and sectoral activities in the economy (eg. composition and growth of GDP):
- income levels in the country (distribution of income);
- prices of energy (domestic and international);
- demographic development (growth rates and distribution within rural and urban as well as regional contexts);

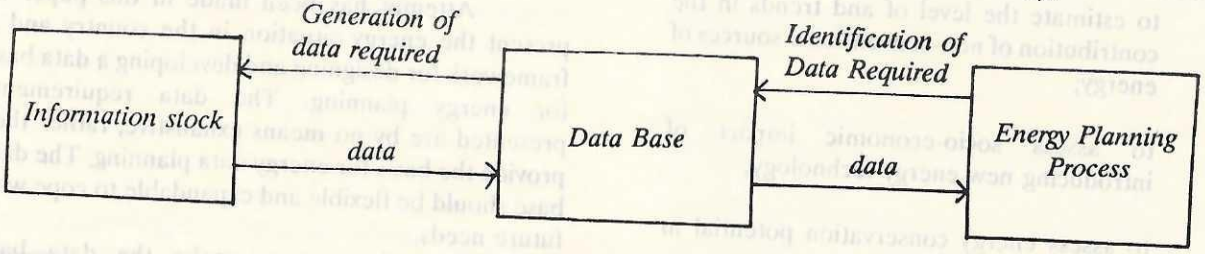

Fig. 2. Iterative Process of DBD

- governmental policies and regulations;
- rural economy (categorizing the major productive and service activities which are quite energy intensive);
- climatic conditions (rainfall regime and distribution, global irradiation, temperature distribution etc.);
- geographically-distributed energy consumption figures built up over the year;
- environmental problems related to production and consumption;

the second category deals with energy demand proper and the following are the data requirements:-

- data on energy demand, ie. consumption by economic subsector (industry and mining, agriculture and fishing, residential, public and VALCO), demand category by energy source (eg. petroleum product, electricity, biomass), future demand growth patterns, and changes in consumption patterns.
- data on conversion efficiencies of end-use devices.
- data on amount of fuel types produced and transported.

b) Data required for energy resource assessment

Data on total reserves of crude oil, natural gas, hydropower potentials, forest resources, rates of addition to and regeneration of the reserves, possible production or extraction rates, extraction costs and constraints on production are required for energy resource and assessment and potential to meet projected demand.

c) Information on energy imports and evaluation of energy supply technology.

Information is required on reliability and prices of energy imports. Information is also required on sources of imports and how imports are paid for.

To do a technology evaluation requires information on the country's energy supply system. The system includes the refineries and power plants. In addition to the above, information is also required:

i) to estimate the level of and trends in the contribution of non-conventional sources of energy;

ii) to assess socio-economic impact of introducing new energy technology;

iii) to assess energy conservation potential in different consuming sectors.

These and many other issues are of interest to the energy planner.

Traditional Energy Sources: Data requirements.

Traditional sources of energy ie. biomass, have been the backbone of rural life in the country. Notwithstanding their importance, data on traditional sources of energy represent the weakest component of the country's present energy data base. One recognizes that there are a lot of difficulties in collecting and assembling of such data. This is mainly due to the highly decentralized nature of the rural energy system. There are also problems with measurement of fuels and efficiencies of end-use devices used by the rural people. In collecting and assembling data on traditional energy sources, these data are required at all levels, namely, national, regional and district levels. For meaningful analysis, it may be beneficial to relate energy consumption to level of income, agricultural development, livestock population and rural industrialization. These and other information are needed to enable one to understand the process of generation and use of these energy sources. Data requirement in this area may include the following:

- pattern of energy use for various agricultural, domestic and industrial activities in different seasons and in different regions of the country;
- the relationship of energy use patterns to factors like family size, landholding, cattle population, income, education, urbanization etc.;
- possibilities of energy conservation (improved efficiency) and inter fuel substitution under various fuel price scenarios;
- possible changes in supply position i.e. changes in forest area, grazing land, crop pattern etc.;
- localities that experience shortages of fuelwood, charcoal etc.;
- data on the flow of traditional energy sources throughout the country eg. sources and destinations.

Conclusion

Attempt has been made in this paper to present the energy situation in the country and a framework for designing and developing a data base for energy planning. The data requirements presented are by no means exhaustive, rather they provide the basis for energy data planning. The data base should be flexible and expandable to cope with future needs.

In order not to make the data base

development an end in itself, there is the need for coordination between energy planning and data collection efforts. Furthermore, to maximize the return on scarce government resources, unnecessary duplication of data collection by different government agencies should be avoided. This can be done, for instance, by incorporating questions relevant for energy planning into existing surveys such as agricultural census and cost of living surveys. Finally energy data planning, i.e survey designing, should be a multi-disciplinary effort.

REFERENCES

1. *Reister, D.B. The link between Energy and GDP in developing Countries. Energy vol.12 no. 6, June 1987.*
2. *Leach, G. L. Jarass, G. Obermair, L. Hoffman : Energy and Growth - A Comparison of 13 Industrial and Developing Countries. Butterworths, London 1986.*
3. *Susan Hassol & Ted Flanignan: Energy Efficiency for Developing Countries. Development Forum. vol. 16 no. 6 Nov./Dec. 1988.*
4. *Munasinghe, Mohan : Integrated National Energy Planning for Developing Countries. Natural Resource Forum 1986*
5. *Energy and Ghana's Socio-Economic Development: A brief prepared by Ministry of Energy for PNDC. 1988.*
6. *Asian & Pacific Development Centre - Integrated Energy Planning: A Manual vol.1 1985.*
7. *Energy and Ghana's Socio-Economic Development: A brief prepared by Ministry of Energy for PNDC. 1988.*

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