KENYA'S COAL/FUEL OIL SUBSTITUTION POTENTIAL: IMPLICATIONS TO DEPENDENCE ON IMPORTED OIL AND TO THE ECONOMY'S ADJUSTMENT CAPABILITY

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ABSTRACT

This study seeks to investigate coal/fuel oil substitution potential in Kenya and to assess the implications of the potential both to the dependence on imported crude oil and to the capability of the economy to adjust orderly in response to a possible fuel oil supply deficit which may result from depending on heavy crude as well as from increasing demand for light crude oil products are assessed.

This paper, which is based on the initial research proposal, presents the problem under study in a conceptual framework. Relevant concepts, facts, and theories as well as, relationships among them and their bearings on the problem have been identified and discussed. However, the levels of significance of the relationships and the bearings can only be addressed at later stages of this research.

The nature of the information and data required are perceivable from the body of this paper. However, they are more explicitly presented in form of a questionnaire which is attached as appendix I. Briefly, they relate to the following: (1) coal supply situation: (2) crude oil supply situation; and (3) substitution feasibility factors.

Three observations may be, briefly, made regarding some important considerations underlying the problem under study. The first is that regarding coal/fuel oil substitution *per se* (as applies to other inter-fuel substitution) the issue, traditionally, originates from demand management requirements, on the supply side of energy system. Kenya may be subjected to coal/fuel oil substitution which is necessitated by changes in crude oil quality, the extent of which depends on factors relating to: future crude oil product demand as well as energy demand pattern and trends; refinery technology; and rate at which the crude oil quality would change. Contrary to some people's beliefs, the current domestic fuel oil supply/demand situation may only be a necessary, but definitely not a sufficient, basis for evaluating the extent to which the country is likely to be subjected to this type of substitution. Neither would a partial dynamic analysis of the supply/demand situation provide an adequate basis. Changing crude oil characteristic adds a new dimension to the issue of coal/fuel oil substitution which calls for use of a system dynamic analysis approach.

The second is that regarding coal/fuel oil substitution and dependence on imported oil, the implication should be seen both in terms of the relationship between the dependence itself and in terms of the manner in which the substitution relates, via other relationships, to the overall foreign exchange/balance of payment system. The third relates to the implication of the substitution to the capacity to adjust. Underlying this issue are that: (1) some factors which precipitate the said substitution may be beyond this country's control, (2) the role of energy is likely to become more critical and the relationship between the emerging energy system and the production sector is also likely to become more complex as the country develops; and (3) considerable time lag characterizes adjustments, of industrial/economic system, to the changes caused by events exogenous to the system.

Overall, the research tasks involve: (1) generation of data and information; (2) analysis of coal supply situation; (3) analysis of crude oil/fuel oil supply situation; and (4) analysis of feasibility factors.

TABLE OF CONTENTS

INTRODUCTION

The objective of this study is to investigate coal/fuel oil substitution potential in the Kenyan economy and, further, assess the implications of such potential to both the dependence on imported oil and the capability of the economy to adjust, without disruption, to a situation where the feedstock to refinery is expected to consist of increasingly heavy crude oil as well as where the demand for light crude oil is expected to increase, not only in absolute terms but also in relative terms.

This is not an inventory type of study. It is supposed to generate data and information and use them in analysis and assessment. The peculiarity of this study does not only lie on the newness of the coal/fuel oil substitution issue to the Kenyan energy situation, but, also, on the fact that the study is basically motivated by a new phenomenon which has hardly been related to the issue of inter-fuel substitution. The phenomenon is the new gravity (and also sulphur) characteristics of the crude oil which is expected to be the bulk of world refinery feedstock supply base.

The importance of interfuel substitution can be seen in the way it has pre-occupied policy makers' and researchers' minds in recent years. It has become a major national and/ regional energy policy consideration and subject of research activities following domination and effective manipulation of world crude oil market by the OPEC cartel. It is likely to remain a major policy issue within a foreseeable future as well.

Traditionally, within the national energy policy framework, interfuel substitution issue addresses the issue of demand management with two primary objectives: the first being to moderate strains which demand for energy may create on supply from relatively scarce energy resources and the second being to diversify energy supply base in order to create a greater security against, and/or to reduce vulnerability to, unexpected non-economic interference with supply from one or more energy source(s). Accordingly, coal/fuel oil substitution within the framework of our, would-be, National Energy Policy[1] would be expected to address issue related to demand management, in the Kenyan economy, which would, first, moderate strains energy

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1. The policy has yet to be promulgated.

demand in the economy would create for crude oil supply and, second, facilitate diversification that provides for greater security against, and/or reduce vulnerability to unexpected non-economic interferences with supply of crude oil. However, in addition to the considerations relating coal/fuel oil substitution to the objectives, above, this study is motivated by the fact that a situation may arise in which coal/fuel oil substitution is not to be considered as a choice or as an option, as usually has been the case, but becomes a compulsion arising from changing gravity and sulphur characteristics of crude oils which are expected to be future supply base for the world refinery feedstocks.

In this study the implications of the potentials of the coal/fuel oil substitution to the dependence on imported crude oil is seen in much broader terms. It is seen not only in terms of the relationship between the substitution and the dependence but, also, in terms of the manner in which the substitution relates to the overall foreign exchange system. The underlying fact is that the substitution may relate to the foreign exchange system via its effect on the importation of crude oil as well as via other effects. The relationships and effects may be different. Therefore, in the final analysis its effects must be translated in net terms or in totality.

The issue of the implications of coal/fuel oil substitution to the capability of the economy to adjust arises, primarily, due to the following facts:

1. That some factors which necessitate the substitution may be totally beyond this country's control.

2. That the role of energy in the economy is becoming increasingly critical.

3. That considerable time lag characterizes adjustments of industrial/economic systems to those changes caused by events exogenous to the systems.

Thus, in view of these facts, the issue of the capability of the economy to adjust orderly, in light of the energy situation which is likely to emerge, becomes a central issue to this study.

STATEMENT OF PROBLEM

General Perspectives

As has already been observed in the introductory part of this text, the importance of interfuel substitution can be seen in the way it has pre-occupied policy makers' minds, in both market and planned economies around the world, in recent years. It has become a major national and/or regional energy policy consideration following domination of, and effective manipulation of world crude oil market by the OPEC cartel. It is likely to remain a major policy issue within a foreseable future as well.

Although a complete energy policy has yet to be promulgated in Kenya, interfuel substitution is referred to in the Sessional Paper No. 4 of 1980, which briefly spells out what appears to be a framework of a would-be Kenyan National Energy Policy. However, no explicit reference is made to coal/fuel oil substitution per se. But its inclusion in the final policy can be inferred on the basis of its position in traditional energy policies. Coal/fuel oil substitution ranks high in traditional energy policies. This is attributed to a number of factors. In general, the extent to which a fuelype can substitute for another depends on the following factors: technological feasibility; economic feasibility; and supply situation of the substitute. On the basis of technological feasibility, coal/fuel oil substitution is one of the easiest inferfuel substitutions to achieve. Furthermore, coal/fuel oil substitution is favoured by world coal reserve/resource situation as well as by inter-regional and international coal transportation modes and economics. Thus coal/fuel oil substitution has not only become a major policy consideration but also an easy target in traditional energy policies. Given the energy situation in Kenya, in the absence of a comprehensive energy policy, coal/fuel oil substitution may soon become one of those neccessities which the policy makers will be forced to sporadically respond to. That coal/fuel oil substitution is likely to become a necessity in Kenya will become clearer from the forthcoming discussions.

To extent that the future rather than the present is the major concern, this study will be projective, including ten coming years.

The tasks involved in this study can be summarised as follows:

1. Survey on the state-of-the-art of coal and fuel oil utilization technologies.
2. Identification of plants and planned projects which are likely to be candidate for coal/fuel oil substitution.
3. Identification and evaluation of feasibility factors. These broadly fall under the following: technology; capital availability and costs; public or Government policies, laws, and regulations; industrial structures; and environmental requirements.
4. Analysis of coal supply situation based on the following: actual and potential coal supply and status of coal reserves/resources; coal transport economics and modes; and imported coal trading pattern and regulations.
5. Analysis of crude oil/fuel oil supply-demand situation based on the following: supply sources and gravity and sulphur characteristics; expected demand pattern; contracts and supply agreements and concessions; and state-of-the-art of refinery technology and options available to Kenya.
6. Analysis and comparison of costs and prices of coal and fuel oil.

Information will be generated via questionnaires and from literature. The bases of projection will be determined in the course of study, they may range from statistical to subjective method.

If coal/fuel oil substitution is to be a part of a Kenya National Energy Policy, it should not address itself restrictively to issues which interfuel substitutions traditionally address themselves to. Traditionally interfuel substitution issues address themselves to a demand management which relates to two primary objectives: the first being to moderate strains which demand for energy may create on energy supply from relatively scarce resources and the second being to diversify energy supply base - by creating a market for different fuel types - in order to create a greater security against, and/or reduce velnurability to unexpected non-economic interferences with supply from one or more energy source(s). The basis for a broader coal/fuel oil substitution objective(s) is discussed below.

Coal/fuel oil substitution should, by design and not by default, address issues beyond those related to the cited objectives. Certain recent developments in world crude oil market have made or are making coal/fuel oil substitution, which addresses itself to moderating crude oil consumption or crude oil adequacy and diversification only from security point of view, an incomplete aspect of an energy policy. A complete one should be, by design, concern with fuel oil demand/supply relationship not only from crude oil supply point of view but also from the point of view of a situation characterized by: refinery feedstock supply which comes from heavy crude oil; a demand for crude oil product which is relatively high and increasing for lighter crude oil products: and refining technology which is changing or is capable of changing so that refineries can undertake more intensive conversions to achieve increased yields of lighter products from an otherwise heavy crude oil feedstock. In such a situation the issue of coal/fuel oil substitution arises not because of the quantity of crude oil but rather because of the quality of the available crude oil and structural changes in an economy, which, although, are inevitable results of economic growth, influence crude oil product demand pattern. Precisely, in order to ensure an orderly adjustment, by an economy, to this situation those aspects of an energy policy, which deal with coal/fuel oil substitution, should by design take into account fuel oil demand/supply relationship resulting from the situation.

In specific a relative scarcity of fuel oil may occur not only because of reduced oil supply or because of growth in demand but also because of the situation cited above. It is such a scarcity which brings about the issue of fuel oil demand/ supply relationship discussed here; it thus raises the issue of broader coal/fuel oil substitution considerations in a contemporary energy policy. The underlying fact is that the amount and the proportion of a light or a heavy crude oil product which can be yielded from a given amount of crude

oil depend on gravity characteristics of crude oil and the intensity of conversion. At a given intensity of conversion, heavy crude oil yields relatively large amount or higher proportions of heavy products. On the other hand, light crude oil would yield relatively large amount or higher proportions of light products. However, improved yield of light products can be achieved by undertaking more intensive conversions.

Thus, a deficit for demand for lighter products may occur in a situation where the refinery feedstock is a heavy crude oil and where demand is relatively high for light products. But the deficit can be reduced or be eliminated by undertaking more intensive conversion which would result in an improved yield of lighter crude oil products. The improved yield, however, is attained at the expense of the production of heavier crude oil products. If a relatively high demand for lighter crude oil products is to be met by intensive refining of feedstock of heavy crude oil, then the fuel oil is bound to decrease. In this situation, even a stagnant economy would look for alternatives just to keep those sectors which depend on fuel oil as an energy source operating. In short the situation raises the issue of substitution and adjustments.

Kenya in Perspectives

The likelihood of the Kenyan economy to find itself in the situation discussed in the foregoing sections and hence the need for broader coal/fuel oil substitution policy consideration can be appreciated by examining the economy's position in terms of the emerging gravity characteristics of crude oil which is likely to form refinery feedstock supply base as well as in terms of the product demand pattern which is likely to emerge in the country. In Kenya, as in other areas in the world, the refinery technique applied would be determined primarily by the nature of crude oil available and product demand situation. Technologies for intensive conversions required for handling relatively very heavy crude oil exist and can be transferred if dictated by crude oil gravity characteristics and product demand situation in Kenya.

Regarding the nature of crude oil that would be expected to supply the Kenyan refineries, the economy is expected to be in a situation similar to those in which the rest of the world is expected to be. The world crude oil refineries are increasingly depending on heavy crude oil as their feedstock supply base. Two factors are seen to be facilitating this situation. The first is the relative abundance of heavy crude oil as opposed to relative scarcity of light crude oil. The second is the changing relationship between light and heavy crude oil to obtain high yields of light crude oil products. Although, by world standards, Kenyan crude oil market is small, and hence can be adequately supplied from relatively scarce reserves of sweet crude oil in existence, the availability of light crude oil to the Kenyan economy is unlikely. The bulk of the world's light crude oil reserves are found in West Africa - mainly in Nigeria and Gabon, North Africa-mainly in Libya and Algeria, and in the North Sea region.

However, given the settings of the infrustructures associated with world oil transportation and marketing as well as the Kenya's geographical position in relation to the locations of the bulk the world's light crude oil, small amount, if any, of light crude oil would be expected to come to the Kenyan oil market.

Kenya's crude oil is imported from the Arabian Gulf region and this region is expected to be the major supplier of the Kenya's crude oil for any foreseable future. Although, some light to medium light crude oil reserves exist in this region, the bulk of oil exported from this region is expected to come from heavy crude oil reserves. Light crude oil reserves in the region have experienced faster depletion because in the past, greater preference has been for lighter crude oil as opposed to heavy one. In addition, like other oil producers, the Arabian Gulf region oil producers are inclined to follow a policy which encourages concurrent exploitation of heavy and light crude oil reserves (where such reserves co-exist) and exportation of crude oil mix which does not result in favouring certain importing markets by supplying them with high proportions of light crude oil. In short, barring any unforeseen large discovery of light crude oil reserves in the Arabian Gulf region and changes in the cited policy, Kenyan crude oil refining sector is expected to depend primarily on increasingly heavy crude oil.

As far as demand for crude oil products is concerned, theory as well as econometric based projections suggest not only demand growth but also relative increases in demand for lighter products. On the basis of the theory alone demand growths would be expected to occur in a growing economy because of increased activities in these sectors which consume the products. Furthermore, such growths would be characterized by a pattern showing relatively higher growth for lighter product demand. This is, first, because those sectors which consume lighter product demand tend to grow faster and, second, because of lack of close substitutes for most of lighter products. Projections of petroleum (crude oil) product demand [2] in Kenya have been made by W.M. Senga, W.J. House and M. Manundu, using econometric models. These projections suggest considerable demand growths for lighter crude products. It is, therefore likely that the demand for petroleum (crude oil) product will increase with relatively faster growth being realized for demand for lighter products.

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2. See W.M. Senga, W.J. House and Manundu, "Assessment of Commercial Energy Supply and Demand in Kenya," IDS Consultancy Reports, No.3, 1980. IDS, University of Nairobi.

OBJECTIVES

In view of the foregoing discussions, the stand taken here is that coal/fuel oil substitution should be a very vital energy policy consideration in Kenya. It should be designed to address the issues related to the following:-

1. Demand management which would moderate strains energy demand in Kenya economy would create for crude oil supply.

2. Demand management which would facilitate diversification which would, in turn, provide for greater security against, and/or reduce vulnerability to unexpected non-economic interferences with supply of crude oil or other energy sources.

3. Fuel oil demand/supply relationship which would enable an orderly adjustments of the economy as the economy becomes increasingly dependent on heavy crude oil as refinery feedstock supply base and, also, as demand for light crude oil product increases in both relative and absolute terms.

It is, therefore, the objective of this study to investigate coal/fuel oil substitution potentials in Kenyan economy and assess the implications of such potentials to dependence on imported oil and to the capability of the economy to, orderly, adjust to a situation of feedstock supply from heavy crude oil and of an increasing demand for light crude products.

COAL SUPPLY SITUATION

In substitution, the issue of supply conditions of the subtitute is very central to the analysis. Thus analysis of coal supply situation is a very important part of this study. One important fact underlies Kenya's coal supply situation; Kenya does not have indigenous known coal resources. Kenya imports coal and it is expected that the foreign coal resources will continue to be the base of Kenya's coal supply in the future.

Overall, the most important factors to the Kenya's coal supply situation can be clasified as follows:

1. Status of current supply sources.
2. Status of potential supply source, as it relates to:
   - Active mines
   - Coal reserve/resource situation
3. Coal transportation mode and economics
4. International coal trading practices.

Status of Current Supply Sources

The status of the current supply sources would be pertinent to, at least, very short - run coal availability or supply situation. Thus, with adequate coal reserves in the deposits which are associated with the on-going mining activities (or with adequate coal reserves associated with deposits which can be economically exploited using the existing mining facilities) current supply sources can be seen as the most reliable source of supply for, at least, the near future Kenya's coal requirements. Presently, Kenya meets its coal requirements from coal imported from Swaziland. In specific, therefore, it is highly probable that, at, least, for the very near future Kenya's coal supply will come from Swazi mines which have been, or are currently, supplying Kenya with coal. However, how far into the future as well as the degree of reliability of supply from the current source, even for a very short time, depend on other factors; in addition to adequacy the reverses. These factors include trading and political relations between Kenya and

Swaziland, continuity of coal production, and, finally, the trend of Swazi coal supply pattern. In the final analysis, at least, assumptions must be about these factors in order to provide a clear picture of the length of the period and the reliability which can be associated with the situation of coal supply from the current supply sources.

Status of Potential Supply Sources

From the foregoing discussion the possibility of supply shortages may be caused by the inability of existing sources of coal to meet both short-term and long-term coal requirements. Consequently, this brings about the issue of potential supply sources of which the relationship to the overall coal supply situation is founded on status of existing mines and reserve/ resource situation.

Thus, issue of coversion of potential coal supply into actual coal supply to Kenya will depend on two factors:

1. The status of those mines which, although are not currently supplying coal, are capable to supply Kenya with coal at competitive energy costs.

2. The status of coal reserves/resources which if exploited can supply Kenya with coal at competitive energy costs.

Basically, the diferences in requirements for conversion of potential supply associated with above are the factors which in turn differentiate the implications of the associated potential to the overall supply situation. The differences in the implications should be considered in analysis and evaluation of Kenya's coal supply situation.

For the existing mines and coal reserves, the implications of associated supply potential to coal supply situation differ basically in terms of time dimension, provided that a sufficient market size exists. The basic economic and technological variables which determine relationships between these potential

supply to actual supply are basically the same. For coal resources, however, the implications of associated potential supply to actual supply differ from implication of potential supply associated with existing mines and coal reserves in terms of both time dimension as well as the economic and the technological variables which determine the relationship between the associated potential supply and the actual supply.

In specific, conversion of potential supply associated with existing mines, or mining activities, to actual supply usually takes a relatively short time. The time is determined primarily, by how long it takes to complete arrangements which enable channeling of the mine products to the market. However, conversion of potential supply associated with reserve would usually take a relatively longer time. This conversion requires development of the reserves and construction of facilities necessary for commercial exploitation of the reserves. Thus, the least time is that time which it takes to complete these activities. Conversion of potential supply associated with resources to actual supply requires a much longer time and different economic and/or technological conditons. Thus, in addition to time required for development of resources and construction of facilities required for exploitation, changes in economic and/or technological conditions are required in order to enable commercial exploitation of the resources.

Thus on the basis of the foregoing discussion, in general, in the hierrachy of potential supply, the existing mines rank first, reserves rank second and resources rank third. The bases for these differences are very critical considerations in analysis and evaluation of the coal supply situation.

The hierrachy stated earlier in this text is a conventional ordering based, primarily on time, economic, and technological requirements for commercial explcitation or conversion of the sources of potential supply into actual supply bases In certain situations this ordering may be different. In particular the rank of active mines and that of reserves may be reversed. The factors which may contribute to this change are those which are usually only remotely related to economic and

technological requirements for commercial exploitation or conversions stated above. In Kenyan situation, where coal is imported, these factors include: proximity; trade and political relations between Kenya and exporters; and other elements which may necessitate inter-regional or international trade.

Thus for Kenya, due to deviation from the conventional considerations of the said economic and technological requirements and/or supplementing these considerations with other "unconventional" ones, regional coal reserves, particularly those in Tanzania, may rank, as sources of potential supply, above active mines. In this case, basis of proximity, supply potential of the Tanzanian reserves is enhanced by the distance as well as by the existence of an already well developed transport infrastructures which include road, railway and waterway systems. Improved relations between the two countries are expected to have similar effects. Furthermore, the need for Tanzania to improve her balance of payments or foreign exchange situation and the difficulties Tanzania is likely to encounter in penetrating traditional and new coal markets outside East African region are expected to facilitate coal trade with Kenya.

A rather complete picture of Kenya's coal supply situation and its relationship with the whole issue of coal/fuel oil substitution must be seen in terms of both conventional potential supply ordering and "unconventional" potential supply ordering. In particular the position of the coal reserve in Tanzania must be assessed on the basis of "unconventional" considerations as well.

Coal Transportation Mode and Economics

The mode and economics of coal transportation can also be critical factors to coal supply situation, particularly in the Kenyan situation where importation of coal may, Considerably, rely on trans-oceanic shipment. In general, a trans-oceanic shipment may require either use of very specialized facilities and infrastructures or use of ordinary and multi-purpose facilities and infrastructures. With the specialized mode of transportation the costs of building and operating the

facilities are usually high. The facilities are usually owned,or lease on long term basis, by the sellers. The nature and the ownership of the facilities tend to make this mode of transportation inflexible both in terms of the commodities or goods and the routes it can serve. Because of the economies of scale, the market served must be large enough to enable utilization of full capacities.. These factors limit supply of commodities, which must be shipped by specialized means, to large markets.

The bulk of coal is, however, shipped as dry bulk cargo. The transportation for dry cargo does not require specialized facilities and infrastructures. On the other hand, the transportation is done by ordinary multi-purpose carriers or facilities. For trans-oceanic shipment, carriers are usually obtained competitively from ocean freight markets. They are usually leased on short term contracts but are also available from spot markets. To the extent that the facilities and infrastructures associated with dry cargo shipment are multi-purpose, they are less costly on a commodity basis. Their costs are shared. The carrier capacities can be utilized, possibly, fully, on both return (both to and fro) journeys, as different commodities can be transported together. The transportation costs are, thus, less sensitive to sizes of the markets and costs due to idle capacities are minimized. Overall, the flexibility inherent in dry bulk cargo transportation mode and the related costs favour the availability of coal in the international market, thereby putting coal at an advantage over other energy sources, like crude oil and fuel oil, in terms of availability.

International Coal Trading Practices

To the extent that Kenya will depend on imported coal, Kenya's coal supply situation is subject to international coal trade conditions. The type of international trade and actual or potential relationship with Kenya's supply situation is key to this study. In general, the international trade can be either free or non-free. Non-free trade is characterized by the existence of at least one of the following: tariffs (or export taxes); quotas; cartel; and bilateral or multi-lateral

trade agreements. Basically, on purely economic theory, free-trade is usually preferred. This is based on allocative and distributive efficiencies associated with the working of free market mechanisms.

In the international scene, these effeciencies may be realized only at global levels, as opposed to local or regional levels. Thus at regional or local levels a market failure may be realized. Also, the working of free-market trade may conflict with national objectives of a government which is a party in the trade. Furthermore, a regional or a local market failure may result from commodity characteristics. These situations are the major causes for interventions, in international market or trade, which are undertaken either unilaterally or multi-laterally. These interventions, however, affect commodity supply situation. Therefore, the nature of international coal trade becomes one of the important factors in the Kenya's coal supply situation.

Summary:

The research questions which relate to coal supply situation can be briefly framed as follows:

1. What has been the supply source and supply history from this source?

2. What is the status of current sources of supply?

3. Which sources (mines) have not been supplying coal to Kenya but are capable of supplying the coal at competitive costs?

4. What has been the previous barriers of trade in coal between these sources and Kenya? And in what manner have these barriers changed, or are they capable of changing, to favour the trade?

5. Which other resources/reserves if exploited can supply Kenya with coal?

6. What mode of transportation are useable to transport coal from the sources (mines) to destination in Kenya (plants)?

7. Which international coal markets handle Kenya coal and what are the characteristics of these markets?

8. What are the cost components of shipment freights?

9. What arrangements are made in procuring carriers for coal shipments?

CRUDE OIL DEMAND/SUPPLY SITUATION

Crude oil/fuel supply-demand situation is central because as mentioned earlier in the text the emerging supply-situation may be the primary cause for the need to substitute fuel oil with coal. Factors underlying the said supply-demand situation are:

1. Crude oil supply sources and gravity characteristics of the crude oil
2. Product demand pattern
3. Crude oil marketing system
4. State-of-the-art of refinery technology and options available

Supply Sources, Gravity Characteristics and Product Demand Pattern

Possible supply sources and gravity characteristics of crude oil, and how these factors relate to the issue of coal/fuel oil substitution, have been discussed earlier in the text. Demand pattern and how it relates to the issue of the said substitution have also been discussed in the text. It was observed that Kenya will continue to depend on crude oil imported from the Middle East. This observation was based on the following factors: proximity and hence the international crude oil reserve/resource distribution and geographical location of Kenya; locations of the large world sub-markets for crude oil; and the setting as well as the nature of the ownership of crude oil transporting, handling and refining facilities and infrastructures. As far as product demand patterns is concerned, it was observed that, on the basis of both theory and actual projections, the future trends will be towards relatively increased demand for light products and that the resulting requirements will be met at the expense of the availability of fuel oil. A more detailed analysis will be part of the task of this research.

Crude Oil Marketing System

As far as the marketing system is concerned, perhaps the most significant influence on the supply situation will derive from those changes which will result from replacing multinational oil corporation with Kenya National Oil Corpration or participation of the national corporation. The replacement will result not only in changes in the identity and, hence, the objectives of the marketing and purchasing agency but also in changes in the structure of crude oil and fuel oil marketing system. Being private commercial establishments, the primary objective of the non-governmental marketing and purchasing agencies is to maximize profit. Furthermore, being multi-national in nature, any objective is pursued with interests which derive from the international integrated nature of the corporations. The objectives are not likely to conform to Kenya's national objectives. On the other hand, Kenya National Oil Corporation will be obliged to make the marketing activities conform to Kenya's national objectives. These changes are likely to affect crude oil and fuel oil supply situation.

The existence of private marketing and purchasing agents in the crude oil marketing system, creates a situation where international flows of crude oil occurs in an integrated system where a purchasing agent may have substantial control over purchasing, transportation, refining, and distribution phases of the marketing system. The existence of these agents also facilitate vertical relationships among the agents. It may be observed that although the integrated nature of the structure of the international oil market has considerably changed as a result of taking over the control of crude oil production, resource management and price administration as well as a result of emergence of relatively independent private crude oil buyers and government owned independent buying agents, the marketing phase still remains considerably integrated. A large number of purchasers and or marketing organizations which are connected with these multi-national oil corporations, which still control transportation, refining and distribution of crude oil and crude oil product, still exists within the international crude oil marketing system. Although, the introduction of Kenya National Oil Corporation,

to procure crude oil for Kenya, may not have a very significant impact on the existing structure or (characteristics) and behaviour of the international crude oil marketing system in general, it can make Kenya crude oil supply be subjected to a marketing system which is relatively free from those market characteristics and behaviour inherent in an integrated multi-national corporation controlled marketing system. Thus, on the basis of the relationships between market characteristics (or basic market conditions), and, also, considering that the National Corporation will operate within the framework of the Kenyan national policy, the major changes ensuing can be briefly characterized as follows:

1. Changes in cost structure arising from, at least, one of the following: absence of cost savings inherent in operations of vertically integrated system; absence of the costs associated with an existence of a middleman in a marketing system; and the nature of new terms of leasing crude oil transport facilities.

2. Changes in crude oil trading terms and emergence of concessions which are more favourable to Kenya.

3. Changes in degree of accessibility, of the Kenya consuming market, to the international crude oil exchange market system and the international crude oil spot market

Further investigation in this area as well as the analysis and evaluation of the relationships between the above and supply situation will be one of the tasks of this study. However questions relating to list above must be addressed in order to evaluate the implication of the changes in marketing system to supply demand situation or/and to the problem under-study.These questions can be broadly framed as follows:

1. What are the differences between the structures of subsidiaries of the multinational corporation, which import crude oil to Kenya, and the structure of Kenya National Oil Corporation?

2. What are the changes likely to result from these differences in terms of cost associated with integration, middlemen and leasing or operating crude oil transport facilities?

3. What are the differences between the relationship, between Kenya National Oil Corporation and the national corporations of the countries which sell oil to Kenya, and the relationship existing between the subsidiaries of the multinational corporations and the same national corporations of the countries which sell crude oil to Kenya?

4. What are the implications of these relationships or the differences to crude oil procurement terms?

5. Given the structure of Kenya National Oil corporation; to what extent will it be able to penetrate the international crude oil exchange and spot markets?

State-of-the-Art of Refinery Technology

The state - of - the - art of refining technology is very critical to supply/demand situation because the advancement in the technology should keep pace with changing oil characteristics, market requirements, and enviromental requirements. As has been observed earlier, gravity characteristics of crude oil is expected to change as crude oil becomes increasingly heavy. This change will be accompanied by changes in crude oil sulphur characteristics, resulting in high crude oil sulphur content. Given these situations, in the long-run, the appropriate refinery technology is that which will enable more intensive conversion of heavy crude oil such that the refinery products meet the emerging crude oil product demand pattern, and, at the same time, enable

desulphurization to meet enviromental requirements and product quality market requirements. Adoption of any technology as well as improvements (or activities related to technological improvements) should be undertaken in light of these situations.

In certain circumstances, the environmental considerations may be ignored when adopting certain types of refinery technology. Also requirements imposed by market conditions may be moderated via policies and other related activities. However, it may be difficult, if not impossible, to down play the significance of crude oil quality. This is particularly so for a country like Kenya which depends on imported crude oil. Crude oil quality is taken as a given and an overriding factor. In long run, however, environmental considerations and market requirements become very important as the impacts of degenerating environment on quality of life and market dynamics, and related changes, which are usually associated with growth become unrestrainable.

The reality of the above observations is shown in the trends in refinery technologies which recently developed in industrialized world and whichis expected to continue in a foreseeable future. In particular, Japan and the United States have undertaken changes in refinery technologies which are considered appropriate in terms of the emerging quality of crude oil, environmental considerations and market requirements. These changes are not done because these contries are advanced but primarily on the basis of factors mentioned above.

In case of Kenya, although some conditions may be unique to the country, it would be expected that the changes in the refinery technology be considered on the same basis. It is, therefore, reasonable to assume that these were the primary considerations underlying the decision taken by the Ministry of Energy to adopt cracking technology. Accepting this premise and taking into account the similarities of the expected quality of crude oil, imply a consistence of this trend and with the world trends in refinery technology; particularly with Japanese trends because the quality of the bulk of crude oil Japan is expected to depend on is expected to be similar to quality of the bulk of

of crude oil Kenya is expected to depend on. Any significant difference must be justified on the basis of sound differences in certain relevant conditions including, the time span.

In short in relating the state-of-the art to crude/fuel oil supply/demand situation and the problem under study the following questions should be adressed:

1. On what considerations was the decision to adopt cracking technology based?

2. Given the emerging characteristics of crude oil which is expected to be the supply base-and the Kenyan situation, to what extent is the above technology appropriate?

3. What is the implication of world wide trends in refinery technology in relations to crude oil quality and how does this relate to the Kenyan situation, particularly in the long run?

4. What other refinery technologies exist and to what extent are they appropriate to the Kenyan situation?

5. How do these technologies compare in terms of their cost and availability to Kenya?

6. In view of the fact that refinery technology is the link between supply and demand of crude oil, what is the general state-of-the art of technology as reflected by the existence of technologies which have not yet been adopted at commercial scales?

FEASIBILITY FACTORS

Investment Capital

The relevance of the investment capital to the problem under study can be viewed on the basis of the two premises. The first is that the consequential changes and adjustments may require new investments for which capital must be raised. The second is that, if some of the required capital is acquired from external sources, the effects of the capital flow have implications similar to the effects of dependence on imported oil, via foreign exchange or balance of payment system.

Regarding the relationship between investment capital and the problem under study, two central issues are capital availability and capital cost. Scarcity of investment capital - which is a state of capital availability - can adversely affect the capability, of an economy, to orderly adjust to those changes which arise from crude oil characteristics and supply/demand pattern. In essence, the scarcity of investment capital may in this respect, disrupt the economy and as consequent bring about undesirable economic and social elements like inflation, stagnation and unemployment. On the other hand, assuming investment capital availability, similar situation may result from high capital costs, particularly, if these costs are passed to market through higher product prices or charges and/or if these costs reduce the profit margins of the productive activities associated with the output. Investment capital related impacts on the capability of the Kenyan economy to adjust in light of the emerging situations can be analysed and evaluated in terms of effects of capital cost and availability.

Investment capital may be acquired from outside economy (external sources). If the capital is acquired from external sources, paying back of principal, interests, and dividends, as well as repatriation of profits create a capital outflow which may adversely affect foreign exchange or balance of payment system. An aspect of the relationship between investment capital, acquired from external sources to finance those investments required for adjustment as well as to respond to necessary changes, and the dependence on imported crude oil can be viewed in terms of the similarity of their effects. The

primary issue regarding dependence on crude oil is not the dependence itself. Rather, it is the effects of the dependence on foreign exchange or balance of payment system. Purchasing crude oil from external sources also creates a capital outflow which may adversely affect foreign exchange or balance of payment system. In view of the effects of dependence on imported crude oil on foreign exchange or balance of payment system, in the final partial analysis, the most desirable foreign capital to acquire is that which improves foreign exchange or balance of payment system, or, alternatively, that which more than offsets the adverse effects of dependence on imported crude oil on the system. Thus, the most desirable capital cost and availability conditons should be such that the above prevails.

Types and Sources of Investment Capital

The following types of investment capital are likely to be available to coal/fuel substitution ventures in Kenya:

1. Common stock
2. Preferred stock
3. Long-term debt
4. Public finances
5. Retained earnings
6. Depreciation allowance

The sources of these investment capital differ considerably. The first three forms of investment capital are raised from capital market institutions. Common stock and preferred stock capital come from stock security market. The differences between the two derive, principally, from the differences in rights and powers given to the respective investors. Long-term based capital comes from bond market and financial institutions. Public finance comes from the Treasury. However, retained earning capital is raised internally, or within the firm, from the profits. Finally, depreciation allowance capital comes from savings accruing from depreciation based tax exemption proceeds accumulated over the years.

Usually, the legal status of the ownership of the plant where substitution has to be undertaken would determine the type of investment capital the ownership would be accessible to. Traditionally, private corporations can raise finances from any or all of the types above, except public finance. However, with participation of the Government, a private corporation may directly or indirectly benefit from public finances.

In general, each of the above investment capital has inherent advantages and disadvantages. Furthermore, the advantages commonly conflict. Also, the advantages and the obligations attached to a given type of capital commonly conflict with objectives and philosophies of the ownerships of projects for which capital is required. Consequently the ownership may tend to acquire investment capital mix, and to operate in a manner which optimizes their financial structure in terms of both cost and flexibility. Thus at the plant ownership level, given the cost and the availability conditions, the ownerships may be constrained by their investment principles and philosophies. These may be reflected on their behaviour and decisions in respect of substitution.

Determinants of Cost and Availability of Capital

Cost and availability of the first three types of capital are determined by similar category of factors. These are:

1. The type of capital market
2. Supply/demand situation in the capital market
3. Risks associated with the investment for which the capital is required
4. Security based primarily on the fixed asset value of the ownership as well as on the ownership performance
5. Government policies and practices affecting capital markets.

In Kenya, like in most developing countries, substantial amount of investment capital comes from outside. Therefore, via the first four determinants, cost and availability of the investment capital required for substitution can be influenced by forces

outside Kenya. In addition, it may be observed here that although the risk attached to a given investment venture may be basically attributed to the nature of the venture, the perception of potential sources of investment capital on the venture may also have substantial effect on the risk. Thus, if some investment capital comes from outside, the outside forces are likely to affect cost and availability via that component of risk factor attributed to the perception of the outside sources. Overall, the extent to which outside forces would affect cost and availability of capital required for substitution in Kenya, would depend largely on the proportion, of the total investment, which comes from outside.

Cost and availability of investment of the remaining capital are determined by factors of different categories. Cost and availability of public finance depend by and large on the government's priorities and policies regarding control of and participation in activities which are traditionally outside the public domain. Cost and availability of capital from retained earnings and depreciation allowances are also relatively independent of the factors listed above.

As already been mentioned, retained earning capital comes from profit retained by the venture ownership. Costs attached to this type of capital arises basically in terms of internalized opportunity costs. This type of cost, in a situation such as the one in which substitution considerations are likely to be undertaken, is likely to be more conceptual than real; the cost of internally generated capital arises on assumption that there is more than one attractive investment area where the capital can be invested. An element of ownership priorities and investment principles and philosophies are likely to affect the way this cost is conceived internally. Regarding the availability, by the nature of the sources of this capital, the determining factors are profitability and the ownership policy on dividend reimbursement visa-viz re-investment policy.

Finally, investment capital can be raised from depreciation allowance which has been accumulated over years. This type of capital may also be used at the discretion of the ownership or

the management. Ideally, it should be utilized for maintenance and replacement directly related to the plants or projects for which depreciation allowance was generated. The question of capital cost does not arise if the capital is used in this manner. However, the question of opportunity cost may arise if it is used otherwise. By the nature of its source, the availability of this type of capital depends primarily on length of time for which depreciation allowance has been accumulated (or the age of the plant or the project for which depreciation allowance has been generated), tax provisions, and the depreciation method used.

In view of the foregoing discussion on investment capital situation, the following questions are raised within the context of this study.

1. Who owns the plants under study?
2. What has been and is the source of their investment capital?
3. Where are these sources located? Are they domestic or foreign sources?
4. What proportion of capital is connected with investment in the power unit?
5. What type of risks may be attached to the operation? And to what extent can these risks influence capital availability and cost?
6. What tax policy requirements affect depreciation?
7. What is the age of whole plant and how much depreciation allowance would have been accumulated in light of the tax policy requirements?
8. In the last five years, what has been the proportion of retained profits?
9. Into what use were the retained profits put?
10. What is the dividend reimbursement policies Are these policies consistent with the divident reimbursement practices?

11. What percentage of the reimbursed dividend has been chanelled back to the domestic capital market?

12. What is the average weighted capital cost, given the existing capital structure for the plant of the firm?

13. What is the capital cost absorption potential or capability of the plant or of the firm?

14. What would be capital requirements for substitution?

15. To what extent would these costs affect

    (a) output level?

    (b) output prices?

    (c) ownership profit?

16. Which ones of the following objectives are identifeable ownership of the plant:

    (a) Profit maximazation
    (b) Domestic diversification
    (c) International diversification
    (d) Regional equitable distribution
    (e) National development

17. How do these reflect and affect their attitudes towards coal/fuel oil substitution?

Environment

In recent years, environmental impact has become a major consideration in productive activities. Newer productive activities or new changes and development associated to on-going activities are being subject to increasingly strict environmental requirements.

Environmental issues arise because of the need to protect human health and quality of the living environmental damages which may result from environmental pollution from waste materials or by-products from productive activities. Of necessity, two basic conditions must exist for the issues to be relevant to a productive process. The first is the existence of environmental pollution control regulations, and/or laws and policies. The second is that the productive process is an actual or a potential generator of pollutant which the environment cannot safely absorb.

Environmental issues must be seen basically within the context of two rather conflicting facts. The first is that the productive processes which generate pollutant are essential activities for human existence. The second is that the pollution generated by these activities are dangerous to the quality of human life. The issue is not that of finding an absolute solution to the environmental problems. Rather, it is that of finding a relatively optimal solution. In other words to function within a condition of existence in which neither productive activities are seriously inhibited by environmental considerations nor productive activities seriously damage the environment.

In this study the effects of environmental problems on problems under study will be analysed and evaluated on the basis of the following:

1. Government regulations, and/or policies and laws or relevant public concerns and the roles of the institutions charged with coordination and implementation of the above.

2. Type of fuel being burned and hence the polluting materials produced and the types of associated pollution problems.

3. Plant site or location

In general the government or its agent, by way of regulations; policies; or legislations; defines what constitutes a threat to human health and environmental qualities, specifies the requirements on an allowable level of pollution, specifies ways of complying with the requirements, and sets penalties for violations. The effects via the government related requirements and specifications can be analysed and evaluated from compliance cost or non-compliance cost stand point, assuming technical or technological feasibility for compliance.. On one extreme, there is a possibility of complete compliance with the requirements. On the other, there is a possibility of violations. At a given degree of stringency, therefore, the underlying factors are the existence of a government enforcement agent (or enforcement departments), power given to the enforcement agent, the existence of adequate resources and staff or relevant and efficient expertise in the areas of implementation and identification and prosecution of violators. Therefore, in connection with the foregoing, the fundamental questions are:

1. Are there any government regulation in existence at present?

2. If none exists, what is the most likely government position in the future? If the regulations exist what are the requirements and how finely or explicitly are they stated?

3. What are the legislations? What government division(s) is (are) charged with enforcement? What powers are given in connection with enforcement? And what are the resources (both financial and personnel wise) are associated with enforcement?

4. How severe or light are the penalties for violation?

The nature and the extent of pollution, and, therefore, the associated problems and issues, depend on the type of fuel being used. Thus the manner in which the environmental issues relate to the problem understudy may depend on a fuel type in question. As far as fuel oil is concerned, environmental problems and issues of major concern are those related to air pollution arising primarily from emission of sulphur dioxide into the air during either fuel combustion or refining process. In the first case sulphur which remains in fuel oil[3] during crude oil refining or during distillation is oxidized into oxides of sulphur which are emitted from power units into the atmosphere. In the second conversion of sulphur in crude oil into gases which are eventually emitted into air may take place during distillation of crude oil. Thus in both cases environmental problems and issues relate to air pollution.

However, with the burning of coal environmental problems and issues are more multiple because they relate to more than one type of pollution. They relate to air pollution, to water possibly, to soil pollution. Coal contains a number of impurities, including sulphur, which are usually converted to oxides during coal combustion. Some of these oxides are produced as solid oxides, whereas some, including oxide of sulphur, are produced as gases. Those produced as solid include oxides of silicon, aluminium, sodium, Iron, potassium, and calcium. These substance have the potential of polluting both water and soil. Environmental issues and problems associated with emission of gaseous oxides from coal combustion are similar to the one which arise from emission of gases associated with the burning of fuel oil. Although the manner in which the environmental issues and

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3. Due to carbon and suphur chemistries, sulphur content of crude oils tends to be positively correlated to the density of crude oil; high sulphur levels are generally associated with high molecular weight hydrocarbons. On distillation, the bulk of sulphur in crude oil tends to remain in the heavier, higher boiling fractions; one of which fuel oil is.

problems related to problem under investigation in this study may be technically affected by fuel type, and thereby by the nature of the ensuing pollution type, the manner of the relationship may, also, be determined by how biased the government requirements are against one type of pollution. For instance requirements may be more stringent for water and soil related pollution than it is for air related pollution.

Thus overall, control requirements and method of compliance may differ depending on whether the fuel is fuel oil or coal and on associated pollutants. For control on emission of gaseous like sulphur oxide the differences in method of compliance may exist because of differences in concentration of the gases in the stream of stack gases because of differences in continuity of stack gas flow. These differences may imply significant differences in technology and costs which are associated with compliance. Therefore, the implication of this differences to the problem under investigation can be viewed in terms of availability of compliance technology and ability to afford compliance costs.

On the basis of fuel type based environmental problems and issues, the questions which arise with regard to burning of coal Vs burning of oil, and vice-visa, may be framed as follows:

1. What are the impurity characteristics of coal?

2. What are the sulphur characteristics of crude oil? What are other impurities which may raise environmental concerns attributable to burning of fuel oil.

3. Given the refinery configuration and technology, what, on the basis of material balances, is the likely distribution of sulphur by products and hence what is the most likely sulfur levels in fuel oil?

4. What are the biases of the environmental or pollution control regulations with respect to the types of fuel and nature of the polluting products?

5. What are possible compliance methods? What are the associated technologies and cost for compliance? What is the availability situation and the ability to afford costs?

Plant location or plant site, also, has bearing on environmental issues and problems associated with productive activities of a plant. Although, there may be a threshold level of pollution which is, perse, dangerous to the environmental requirements relating to the levels beyond the threshold may differ depending on plant location (site). The underlying factors in the relationship between plant location (site) and the environmental issues and problems, relevant to this study, are: population density; vegetation; farming activities; other productive activities and the extent of pollution from them; and the topography of the area where plant is located. Accordingly, the following questions arise in connection with plant location (site) and environmental issues and problems be addressed in this study:

1. What is (both human and animal) population density in the area of plant location (site)?

2. What is the vegetation of the area of plant location (site)?

3. What type of farming activities (agricultural, livestock raising, fishing and forestry) are going on in the area of plant location (site)?

4. What type of industrial activities are going on in the area and to what extent are they polluting or have they polluted the area of plant location (site)?

5. What is the topography of the area?

Under certain circumstances, in order to comply with pollution control requirements, the pollutants may be converted to materials[4] which may be useful in other applications;[5] even though purely commercial production of such a product may not be viable. Thus the product resulting from conversion of pollutants may be saleable, or may be disposed of by marketing. In such circumstances the conversion costs and the market conditions are the basic decision variables. Thus the decision to choose marketing as an alternative to other means of compliance depends; first on the relationship between the costs associated with conversion of pollutant to saleable products, as well as those costs associated with marketing the materials, and costs associated with other methods of compliance; second on the relationship between these costs and the prices for the saleable products; and third demand situation.

A non-market method of compliance becomes desirable if the netback from the sales of marketable products is negative and its magnitude is greater than that of cost associated with non-market method. Thus, it is more costly to market than it is to comply otherwise. Furthermore, the decision to convert the pollutant to saleable products may be subject to the market demand situations. It is the demand or market requirements which, in the first instance, determines whether the market can provide an outlet for the products. The nature of demand is also primary to the product price and hence its relationship with costs and netback mentioned above. If the product from pollutant (non-discretionary products or by-products) meets residual market demand resulting from inadequate supply of commercially produced products, then the market price is likely be determined on the basis of marginal costs of the commercially produced products. Thus the producer of the products from pollutants are price takers within the market. On the basis

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4. Such materials of products are usually called non-discretionary product because they are produced as a result of complying complusory regulations or by-product because their production depends on production of certain main product(s)

5. Sulphur oxide may be converted to sulphuric acid (H_2SO_4) which is useful in a number of industrial applications. Also, it may be converted to gypsum which has some industrial use, as well.

of the theory of cost allocation to non-discretionary products or by-products, a price determined in this manner increases the net revenue for pollution creating production activities and thereby reduces the cost of complying with pollution control regulation requirements. Therefore, marketing becomes a more desirable method of compliance. However, any market situation which makes the cost of disposal, by selling the material produced by converting pollutant into marketable product, less than cost associated with other disposal methods would make marketing more desirable. In essence this is a situation which enables cost absorption by the producers and/or paying the buyers to accept the product (this is equivalent to selling the product at no more than zero price) so long as the associated cost is less than cost associated with other methods of compliances or, put differently, so long as the magnitude of the negative netback from sales is not greater than that of the associated other methods of compliance.

The questions associated with the foregoing discussion are:

1. Can the pollutants be converted to saleable products?
2. If so, then at what cost?
3. What are the costs associated with other compliance methods?
4. Should a conversion of a given pollutant be possible, what is the situation of market for the resulting saleable product?
5. Should market be a desirable disposal outlet, how do the following compare: prices of saleable products; cost of conversion for marketing; cost of other methods of disposal or compliance? What do the above imply to the overall cost of compliance?

Industrical Structure

Industrial structure refers to a variety of industrial characteristics. Here, we will be concerned with those aspects of industrial structure which affect flexibility or capability of industrial adjustment. Plant ownership (or firm) integration is the one aspect of industrial structure which has been identified as having considerable potential to affect plant flexibility and industrial adjustment capability.

Two types of integration exist. The first is vertical integration. And the second is horizontal integration. The difference derives, basically, from direction of involvement, of a firm or an operating unit, with respect to its primary activities. A firm (a plant ownership) or an operating unit is said to be vertically integrated if it is involved in activities which has upstream and/or downstream linkages with its primary activities. In case of upstream linkages, the involvements are in the following activities: production, distribution and marketing of, as well as rendering other services with respect to, its input factors. In case of downstream linkages, the firm or the plant ownership, is involved in activities related to: uses, distribution, and marketing of, and rendering other services with respect to, its primary outputs or products. On the other hand, a firm (a plant ownership) is said to be horizontally integrated if it diversifies into activities in the sectors of products(outputs) which can be classified as substitutes and/or supplements to the firms primary products or outputs.

On a plant basis, a plant which is owned by an integrated firm is usually operated within the framework of the integrated setting. Thus the decision affecting the operations are taken with the operational principles and objectives of the integrated firm On the other hand a plant which is owned by non-integrated ownership (or firm) operates, more or less, on an independent basis. In general, those plants which will be identified as candidates for coal/fuel oil substitution may fall within these two extremes. It must be observed that government ownership or participation may affect the independence or dependence of a plant or of an ownership. Finally, to the extent that some ownership of the Kenya based plants may be organizations which are involved in

activities outside the country, integration should be considered with respect to both domestic and international industrial or market systems.

As far as plant flexibility and capability, of an industrial system to adjust to changing energy situation, are concerned, integration has both advantages and disadvantages. The advantages derive from greater potential to raise capital, which may be required to effect necessary changes. This potential is due to the following: first, those elements of integration which facilitate cost savings derived from economies of scales and from reduced cost inherent in integrations, and, second, those elements of integration which enable investment capital mobilization across different operating units or plants, and finally, those elements of integration, like the values of assets owned by the integrated firm which enhance credit worthiness of the firm. Thus the cost savings can enable generation of capital within the firm and because of the easy mobility, these savings together with other savings, such as those from cumulative depreciation allowances can be moved to finance activities related to changes required in order to adjust to changing energy situation. Also, integration is advantageous as far raising capital, which required to the changes, from capital market. On the hand, the disadvantages derive from those elements of integration which may impede changes required in order to adjust to changing energy situation. Benefiting from integrated operations may be the motives involvement is commercial activities such as production, distribution, and marketing of energy sources which is used by the plants. A change over may mean a lose of substantial portion of ownership's commercial activity.

In view of the foregoing discussion regarding implication of integration to industrial capability to adjust to changing energy situation, the following questions will be addressed:

1. What is the structure of plant ownership (s)? And how do the activities for which energy is used relate to other activities in both domestic and international economies.

2. If the activities and their relationships imply integration, what in turn and the implication of the integration to cost savings and depreciation allowance transfer?

3. If the asset values associated with integration can be assessed, what do they imply to the potential of the ownership to procure capital which may be required to finance changes.

Technology

Some observations have been made earlier in the text relating to some technological aspect of coal/fuel oil substitution. It was observed that coal/fuel oil substitution is feasible. Furthermore, it was observed this substitution is relatively easy to effect compared to substitution which would involve either coal or fuel oil and other fuels, excluding probably natural and LP gas. Basic to these observations are two important facts. The fact underlying the first observation is that the technologies of coal and fuel oil utilization are well proven, although their states-of-the art are not necessarily the final ones. The fact underlying the second observation is that the differences in technologies of utilization of these two fuels are small compared to those between technologies of utilizing other fuel and the technologies of utilizing coal or fuel oil. In this context, therefore, the issue of technological constrains and parameters appears rather trivial or irrelevant.

However, within the general state of technological feasibility of coal/fuel oil substitution, there may exist technological constrains arising from relatively minor technical differences. Thus, although these differences may not prevent the substitution per se, they may create constrains which, in the context of the problem understudy, may have significant implication to local substitution potential. The nature of such constrains depend on a number of factors:

(1) The nature of production process for which the energy generated from the fuel is used.
(2) The configeration of the plant system.
(3) The scale of the production system
(4) The ages of the power plant and the production plant.
(5) The relationship between engineering and technical maintenance requirements and resources available.

The constrains may be more characteristic than general in nature. Therefore, they should not be generalized. Rather, they should be evaluated on plant by plant basis. On plant basis, the primary questions which arise relate to the extent to which the new replacement should be undertaken, on one hand,

and the appropriate technology, given the state-of-the art of coal utilization, on the other.

Therefore, the questions which must be addressed in this connection are as follows:

1. On the basis of the nature of the production process, which of the following modification would be most desirable?
   (a) Overhaul
   (b) Partial overhaul
   (c) Retrofit

2. On the basis of the configeration of the plant system, which of the following modification would be most desirable?
   (a) Overhaul
   (b) Partial overhaul
   (c) Retrofit

3. On the basis of the designated expected plant life, which of the following modification would be most desirable?
   (a) Overhaul
   (b) Partial overhaul
   (c) Retrofit

4. On the basis of economic life of the plant, which modification would be most desirable?
   (a) Overhaul
   (b) Partial overhaul
   (c) Retrofit

5. On plant basis, given the state-of-the art of coal fuel utilization technology, which would the most appropriate technology to be adopted considering the following?
   (a) The nature of production process
   (b) The configeration of plant system
   (c) The scale of production

(d) The plant age

(c) The relationship between engineering and technical maintenance requirements and resources available.

APPENDIX I

(Questionnaire)

COAL SUPPLY

I Status of Current Supply Sources

1. Where has the country obtained coal?
2. What has been supply history in terms of
   - (a) Continuity?
   - (b) Trend?
   - (c) Reliability?
3. What is the status of current coal supply sources in terms of:
   - (a) Production history?
   - (b) Supply pattern (historical)?
   - (c) Reserve status and (historical) R/P ratio?
   - (d) Resource status and historical resource dynamics?
   - (e) Factors which have been responsible for resource conversions?
   - (f) Mine Capacity?
   - (g) Political and other relations which have bearings on current supply source (i.e. geopolitics and regional politics)
   - (h) Expected production level
   - (i) Expected supply pattern

II. Status of Potential Supply Sources

1. Identify the coal mines which although are not currently supplying Kenya with coal but can supply coal to Kenya.
2. For each mines determine the following: (No. 1)
   - (a) The quality of coal
   - (b) Why in the past the mine has not supplied Kenya with coal
   - (c) Ten years production history
   - (d) Ten years supply pattern
   - (e) Coal reserve status and coal resource dynamics

(f) Factors which have been responsible for resource conversions
(g) Mine capacity
(h) Geo and/or regional politics related factor which may affect coal supply potential

3. Identify regions with reserves or deposits which are not being exploited, but if exploited can supply Kenya at competitive costs

4. For each reserve or deposit determine the following:
   (a) Reserve/resource status
   (b) Factors which are important in determining supply potential with respect to Kenyan market.

III. Transportation Mode and Economics

1. Describe the shipping connection between Kenya's Port of Mombasa and the sources of the following :
   (a) Current supply of coal
   (b) Potential supply of coal from the active mines
   (c) Potential supply of coal from reserves

2. Describe the transport connection between Mombasa and the plants which are considered candidates for coal/fuel oil substitution.

   (1) Plant 1
   (2) Plant 2
   (3) Plant 3
   (4) Plant 4
   (5) Plant 5
   (6) Plant 6
   (7) Plant 7
   (8) Plant 8
   (9) Plant 9
   (10) Plant 10
   (11) Plant 11
   (12) Plant 12
   (13) Plant 13

(14) Plant 14
(15) Plant 15

3. If coal can be transported from the sources to plant directly without going through Mombasa Port, describe the transportation connections between plants 1 to 10 and the following:
   (a) Sources of current supply of coal
   (b) Sources of potential supply of coal from active mines
   (c) Sources of potential supply of coal from reserves

International Coal Trading Practices

1. Which of the following characterizes the international coal markets which are relevant to the supply of coal to Kenya?

   (a) Competition (explain)
   (b) Monopoly (explain)
   (c) Oligopoly (explain)
   (d) Future market (explain)
   (e) Restrained market via trade barriers:
      - Import duties (explain)
      - Export duties (explain)
      - Quota (explain)
      - Others (specify and explain)
   (f) Commodity Agreements trading
      - Bilateral (explain)
      - Multilateral (explain)
   (g) Contract Market (explain)

2. State the freight rates for coal shipment and identify the freight components, i.e. (a) Port charges, (b) insurance, (c) shipping cost, and (d) others for the following conditions
   (a) Lease
   (b) Longterm contract
   (c) Shortterm contract
   (d) Spot market
   (e) Minimum capacity

CRUDE OIL SUPPLY

I. Supply Sources, Oil Characteristics and Demand Pattern

1. Identify the supply sources of crude oil brought to Kenya and for each provide the following information

   (a) (i) The reserve base
   (ii) The resource base
   (b) Production capacity for the past five years
   (c) Actual production for the past five years
   (d) Production/Resource ratio for past five years
   (e) Expected production rate for next five years
   (f) Past recent gravity trend for the past five
   (g) Sulphur characteristics
   (h) Gravity characteristics
   (i) Other properties relating to the quality of crude oil and quality of oil products (specify)

II. Marketing system and Its Characteristics

1. Describe expected crude oil product demand pattern in Kenya.

2. Identify the companies which import crude oil to Kenya and for each describe its activities in relationship with other companies whose activities are in the following areas;

   (a) Crude oil production
   (b) Crude oil purchasing
   (c) Crude oil shipment
   (d) Crude oil refining
   (e) Crude oil product distribution
   (f) Crude oil marketing
   (g) Crude oil consumption

1. Under what arrangements are crude oil tankers operated by the companies which transport or import crude oil

(a) Owned by the companies?
(b) Leased by the companies?
(c) Contracted by the companies?
(d) Hired on short term by the companies?

2. What are the terms of agreements between producers or sellers and purchasers or procurers of the bulk of the crude oil which comes to Kenya?
   (a) Longterm agreements
   (b) Short term agreements
   (c) Spot market

3. Identify spot markets for crude oil where Kenya can get its supply and explain the possible supply continuity along the following lines;
   (a) Stability of the markets
   (b) Volume of crude oil which goes into the market
   (c) Volume of crude oil imported to Kenya

4. Describe the function of Kenya Oil Corporation with respect to; crude oil purchasing or procurement, transportation, refining, marketing, distribution and consumption.

III. State-of-the-Art of Refinery Technology

1. Identify the types of refinery technologies in existence
2. Which of the types named in 8 is being used in Kenya?
3. Which of the following is attributed to adaptation of the present refinery technology in Kenya
   (a) History
   (b) Cost
   (c) Appropriateness in terms of crude oil quality
   (d) Product demand pattern
   (e) Other factors (specify)

4. What are the trends of the world refinery technologies as shown in Japan, U.S.A. and Western Europeans situation?

5. Which one of the following has influenced the trends in No. 4

   (a) Time
   (b) Cost
   (c) Quality of crude oil
   (d) Product demand
   (e) Environmental requirements
   (f) Others - specify

6. How does Kenya's present technology and expected trend in technology differ from those of the rest of the world i.e. Japanese, American and West European?

7. Which of the following factors explains the difference, if any exists at all?

   (a) Time
   (b) Cost
   (c) Quality of crude oil
   (d) Product demand pattern
   (e) Environmental requirements
   (f) Other factors - specify

FEASIBILITY FACTORS

Investment Capital

1. Identify the plant ownership
2. Specify which of the following has been the sources of investment capital for plant

   (a) Common stock
   (b) Preferred stock
   (c) Long term debt
   (d) Public finance
   (e) Retained earnings
   (f) Depreciation allowance

3. Specify the location of first three sources of investment capital

   (a) Domestic
   (b) Foreign

4. What proportion of capital is connected with investment in the power unit?

5. Identify the risks which may be attached to the operation.
6. Describe tax policy as it relates to plant depreciation.
7. Specify the age of the plant.
8. Estimate the amount of depreciation allowance which has been accumulated in light of the tax policy and plant age.
9. Specify other tax requirements or tax breaks which may affect the savings accruing from operation associated with power plant.
10. Determine the proportion of the profit which has been retained (ratio of retained earning and profit) in the last five years.
11. Specify how such retained earnings have been used.
12. Describe the dividend reimbursement policy.
13. Describe the dividend reimbursement practices.
14. To what extent has the reimbursement of dividend practices has been consistent with the policies?
15. If a pattern of inconsistancy has existed, what is the

16. What percentage of the reimbursed dividend has been chanelled back to the domestic market?

17. Specify the capital structure.
18. Given the existing capital structure determine average weighted capital cost.
19. What is the capital cost absorpiton potential or capability of the plant or of the firm?
20. What would be the capital requirements for substitution?
21. To what extent would costs affect
    (a) Output level?
    (b) Out-put prices?
    (c) Ownership rofit?

22. Which of the following objectives can be characterized as ownership's objective?
    (a) Profit maximization
    (b) Domestic diversification
    (c) International diversification
    (d) Regional equitable distribution
    (e) National development

23. How do these reflect and affect their attitude towards coal/ fuel oil substitution?

Industrial Structure

For this plant here designated plant

1. Identify the ownership
2. Specify other activities the ownership is involved in.
3. Describe the nature of each activity.
4. Specify those activities which are entirely based in Kenya
5. Specify those activities which are entirely based outside Kenya stating where they are based.
6. Specify those activities which are based outside Kenya and have relationship to the activities of the plant.
7. Describe the type of relationship.
8. Which of these activities and the relationships which constitute vertical integration with respect to energy sources for this plant?
9. Which of these activities and relationships constitute horizontal integrations?

10. If the activities and their relationships constitute a vertical integration, has there been transfers of the following, across plants?

    (a) Cost savings accrued from integration
    (b) Profits
    (c) Depreciation allowances

11. If such transfers have been done, to what extent has the power plant or power unit benefited?

12. What has been the barriers or limitations on such transfers?

13. If there has not been an incident of transfer, which one of the following was the cause of non-transfer?

    (a) Infeasibility (explain)
    (b) Necessity (explain)
    (c) Priority (explain)

IV Technology

1. For each plant considered provide, or where necessary describe, the following:

    (a) Production process
    (b) System configeration or structure
    (c) Production scale
    (d) Input factor intensity
    (e) Plant age
    (f) Plant designated life
    (g) Plant economic life and relevant depreciation techniques for the system and/or for the units.
    (h) Engineering and technical maintenance requirements
    (i) The resources in terms of skill available for number (h)

2. Identify and describe the existing fuel utilization technologies

3. On the basis of the nature of the production process, which of the following modifications would be most desirable?

(a) Overhaul
(b) Partial overhaul
(c) Retrofit

4. On the basis of the configeration of the plants or the plant system, which of the following modifications would be most desirable?

(a) Overhaul
(b) Partial overhaul
(c) Retrofit

5. On the basis of the designated plant life, which of the following modification would be most desirable?

(a) Overhaul
(b) Partial overhaul
(c) Retrofit

6. On the basis of economic life of the plant, which modification would be most desirable?

(a) Overhaul
(b) Partial overhaul
(c) Retrofit

7. On plant basis, given the stat-of-the-art of coal fuel utilization technology, which would be the most appropriate technology to be adopted considering the following?

(a) The nature of production process
(b) The configeration of plant system
(c) The scale of production
(d) The plant age
(e) The relationship between engineering and technical maintenance requirements and resources available.

Environment

1. Identify policies, regulations and legislations on environmental quality control.
2. If there are indications that the above may change in the future:
   (a) Specify the indication
   (b) Specify the direction and the degree or the extent of changes which are likely to occur
3. Identify the Government Ministries, Departments and Agencies which enforce the environmental quality control related laws.
4. Describe the powers given to these respective Government Ministries, Departments and Agencies with respect to the enforcement.
5. Specify the expertise establishment in, and the financial resources of, these Government wings which are relevant to enforcement responsibilities.
6. Describe the impurity characteristic of coal used in Kenya which are relevant to the environmental quality.
7. Describe the impurity characteristics of fuel oil which are relevant to the environmental quality.
8. Given the refinery configeration and technology, on the basis of material balances, specify the likely sulphur distribution in the crude oil product.
9. Specify the differences between the regulations which affect pollution from burning fuel oil and regulations which affect pollution from burning coal.
10. Describe the kinds of biases these difference may create with respect to use of these fuels.
11. Identify the possible compliance methods for each law or regulations.
12. Specify differences in technologies associated with the respect compliance methods.
13. What is the availability and cost situation of these technologies?
14. For each plant specify the following:
   (a) The current population density and population trends in the area of the plant location.
   (b) The type of vegetation of the location.
   (c) Kinds of farming activities (agriculture, livestock

raising, fishing and forestry) are going on in the area of the plant location.

(d) Other industrial activities going on in the area.

(e) The nature of environmental impacts from the above activities.

(f) Topography of the area in relationship with favourability to import or export environmental impacts.

15. What saleable materials can the pollutant be converted to.

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