COAL SUPPLY SITUATION: AVAILABILITY FOR SUBSTITUTION IN THE KENYAN ECONOMY

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ABSTRACT

This paper analyses the coal/supply situation as it pertains to the availability for substitution in Kenya. It is a part of a study, Coal/Fuel Oil Substitution Potentials in the Kenyan Economy which, in nutshell, investigates the substitution potentials in the Kenyan Economy and further assesses the implications of such potentials to both dependence on imported crude oil and the capability of the economy to adjust in light of two envisaged developments. The first development is the changing quality of the bulk of crude oil on which Kenya depends. The second is the increasing demand for superior products which is expected to evolve, both in absolute and relative terms, as the economy grows.

The potential for these development to affect the fuel oil supply is high. If the effect is negative, the issue of substitution becomes necessarily a vital policy consideration. Coal is, by and large, seen as an immediate option. Accordingly at all levels of policy consideration, the availability of coal as a substitute must be conceived, at least, as probable.

The paper underscores two basic supply conditions. The first is the mineral nature of coal commodity. And, the second is the dependence on imported coal which theoretically can be procured from any outside source. It has been, therefore, necessary to establish the basic mineral supply concepts and approach the Kenyan coal availability from global supply framework.

With these as the background the paper analyses the world supply situation and from this extrapolates to put the Kenyan supply situation into relevant perspectives. In this task the fuel oil and coal consumptions in Kenya are reviewed and analysed in order to identify energy gaps and coal consumption potentials. The conclusion is that, by and large, availability potentials is high to a degree where Kenya would be capable of diversifying the supply source not only to meet her coal requirements but also to ensure a reasonable degree of supply security.

INTRODUCTION

Kenyan Energy System, Options and Substitution Possibilities

Table 1 shows the Kenyan supply and demand structures. Supply and demand conditions as well as and production and use of technologies are the fundamental factors for energy option and interfuel substitution possibilities. Supply conditions and production technologies determine energy availability by quantity, quality and type. Demand creates the market and establishes the pattern of enery consumption. Technology determines both the pattern of use and the flexibility in utilization of available energy types. All these factors must be mutually favourable for interfuel substitution to be possible in an economy.

As the table shows, on the supply side, the Kenyan economy depends on seven sources of energy. However, one source, crude oil, is not used directly as a source of energy. It is refined into several products, most of which are used as direct sources of energy. In Kenya, crude oil is imported and refined in Mombasa into several products; nine of which are used as sources of energies for different applications[1]. Fuel oil is one of such crude oil fuel products. Overall, crude oil should be seen as a broader energy source.

Of the Kenyan energy sources, crude oil[2] and coal are all imported. However, with hydroelectricity only about 13 per cent is imported. Uganda is the sole source of the imported hydroelectricity. In other words, the bulk of hydroelectricity, all woodfuel, wind, solar and geothermal energies are supplied from domestic sources.

Considering the whole Kenyan economy, woodfuel is the leading energy source. It supplies about 80 percent of the economy's energy requirements. Crude oil ranks second, followed by hydroelectricity, coal and geothermal. The extents of the roles played by wind, solar and other biomass related energies have not so far been systematically documented. However, relatively, their utilizations are still limited.

Table 1: Kenyan Energy Sector: Structural and Process Components Model[a]

Supply			Demand	
Energy Source	Resource Base/Location	Supply Mechanism	End User	Current Annual Consumption (Tonnes Oil Equiv.)
Coal	_____[b]/Foreign	Importation, Inland Transportation and Distribution	Industrial and Transport Sectors	83,000
Crude Oil	_____/Foreign	Importation, Refining, Inland Transportation and Distribution	Industrial, Transport, Commercial, Agricultural & Residnetial Secondary electric generation sectors	1,553,500
Hydroelectric	356 MW[c]/Domestic	Conversion, Transmission and Distribution	Industrial, Commercial and Urban Residential Sectors	357,800
	_____/Foreign	Importation, Transmission and Distribution	Industiral, Commercial and Urban Residential Sectors	51,600
Woodfuel	Renewable/Domestic	Planting, Harvesting, Collection & Transportation		7,000,000[d]
Fuelwood	/Domestic	Conversion &	Rural Residential Sector	6,440,000
Charcoal	/Domestic	Conversion & Transmission	Urban Residential Sector	560,000
Wind Energy	Renewable/Domestic	Conversion & Transmission	Agric. Irrigation, Livestock & Rural Residential Sectors	N/A[e]
Solar Energy	Renewable/Domestic	Conversion & Transmission	Residential Sector & Rural Social Services Institutions	N/A
Geothermal Energy	30MW/Domestic	Exploration, Production, Conversion and Transmission	Secondary Electric Generation	55,900

a = The figures are estimated from Statistical Abstract, 198[illegible], Economic Survey, 1985 & Development Plan 1984/88; all published by Republic of Kenya, Nairobi.
b = This shows that resources are outside the country
c = Hydroelectric and Geothermal electric supply bases are given in megawatts.
d = This figure is the sum of fuelwood and charcoal
e = Figures are not available.

The processes which support the Kenyan energy supply system are also shown in the table. Categorized as supply mechanisms, they are part of identification, extraction and transfer processes which are undertaken to availenergy sources for different uses in the Kenyan economy. To a greater degree, these processes are energy source specific, implying that different modes and technologues, depending on energy types are used in order to avail energies for consumption in this economy.

On the demand side, the table shows end users and annual consumption by energy type. Constituting the energy demand structure in Kenya are: 1) Industrial Sector; 2) Transport sector; 3) Commercial Sector; 4) Residential sector; 5) Public sector; 6) and Secondary energy electric sector. Residential sector is the largest consumer of energy. It consumes about 7 million tonnes of oil equivalent (toe), which is supplied predominantly by woodfuel. The end use energy forms are varied but not necessarily energy source specific. They are: heat, light, sound and mechanical power. However, the end use technologies , significantly vary; thereby, as discussed later in this text, influencing the possibilities and/the extent of interfuel substitution in the economy.

Duality of the Kenyan Economy and Energy Use

Dualism of the developing economies sometimes makes it necessary that, in order to avoid disortations and generalizations, macro economic related analyses be based on a dualism model. The model presumes a devision of a developing economy into two: modern and traditional (non-modern)sectors.

Of necessity the dual characteristics greatly influence the patterns of energy use, an actual significane of energy types and the flexibilities in energy use. c it is a major factor underlying the relationship between demand situation and interfuel substitution possibilities.

The modern sector is characterized by high productivity, commercialism, modern technologies high energy dependence, high efficiency of energy use, and dependence on premium energy sources, among others. Accordingly, use of woodfuel in the Kenyan economy is still confined primarily to the traditional sector. The modern sector is the major consumer of other types of energy. The consumption proportions for these fuels in the modern sector alone, changes considerably. Crude oil now leads as the proportion of its contribution to sectoral energy requirements increases to 74 percent.

Seen in terms of crude oil fuel products' and other energies' contributions to the modern sector, diesel fuel ranks first; followed by fuel oil and hydroelectricity, in that order. The first contributes about 21 percent, the second, about, 20 percent and third about 19 percent. Thus, the two products of crude oil and hydroelectricity contribute about 60 percent of the Kenyan modern sector's energy requirements. Also, it can be observed that, if the contribution of the crude oil is analysed in terms of the contribution of its products, hydroelectricity becomes a third contributor to the modern sector's energy requirements.

Energy Substitution Possibilities and Coal/Fuel Oil Dichotomy in Kenya

In theory interfuel substitution possibilities can be as numerous as interfuel permutations or combinations would allow. Similarly, the extent of the substitution would not be restrainable. Energy is required primarily to provide end use energy forms: light, sound, heat, and mechanical energy. In theory any energy source is convertable into these forms.

But, as already been indicated earlier in this text, in practice interfuel substitution possibilities as well as the extent of such substitutions are technically determined by: 1) energy supply situation; 2) energy demand situation; and 3) end use technologies. Thus in the absence of any strong deliberate energy source diversification strategy or other policy interventions, these factors primarily account for energy source diversity which may characterize an energy system in an economy. Their implications and significanes differ with the phase of energy flow in the system.

The major implication of technology, and the end, to substitution possibilities derives from the fact that technology makes an end use energy specific. It restrains the extent of substitution and limits substitution possibilities even where energy supply and demand conditions may be conducive to bread interfuel substitution options.

It is this implication of the end use technology which limits our option to coal for substitution of fuel oil in the Kenyan modern sector. From energy supply situation stand point, hydroelectricity would appear well ahead of coal. Hydropower, which is the source of this energy, has a national base with high potential sites suitable for connections to the national grid system for transmission and utilization in different parts in the economy. Furthermore micro hydropower sites with high energy potentials for small local industrial activities do exist in Kenya. Other qualities which may position hydropower as a superior option in an economy like that of Kenya have been sufficiently discussed by this author elsewhere [3].

But, the technologies for the processes where fuel oil is currently used as the source of energy would make hydroelectricity an efficient energy source. For instance some of the processes are supported by aerodynamics, thermodynamics as well as physical states which can be provided only by air and gases involved in and evolved from, respectively, combustion of fuel oil. Thus heat transfer would require dynamics of flue gases and chemical reaction may require a suspending media offered by air and other gases in the combustion vectors, as well as, a state of equilibrium created by the presence of such media. On the other hand the amount of heat, or the level of temperature, required end use may not be high enough to warrant use of hydroelectricity.

In summary, although supply situation, cost relationships and the Kenyan national policy may favour use of hydroelectricity, and not the foreign based coal, for fuel oil substitution, technologies of end uses do not favour this type of interfuel substitution. This leaves us with coal/fuel oil substitution as the only viable option.

Kenya Coal/Fuel Oil Substitution, Policy Implications and Analytical Framework

Coal/fuel oil substitution has become an important energy policy issue in Kenya. This importance derives from two major reasons. First, substitution is seen as an energy management mechanisms through which desirable energy conservation and diversification can be achieved. Second it may help develop the economy's capability to cope with the emerging situation of increasing dependence on how quality crude oil which must be processed to meet the increasing demand for high quality petroleum products. Refinery output for fuel oil and output for high quality products tend to be negatively correlated and an appropriate production mix is crucial if the requirements for sectors which depend on them have to be met. To the extent that substitution affects the fuel oil demand, it is seen as a possible solution.

However, in substitution, supply situation of the substitute becomes a fundamental consideration. Particularly at a policy consideration level, the availability of the substitute must be conceived, at least, as probable. This section, therefore, covers a very significant issue regarding the coal/fuel oil substitution in Kenya.

Kenya coal supply situation is characterized by two major basic conditions are greatly linked to in-situ status of the commodity. The second is that Kenya having no known coal deposit, depends onthe international market as the supply source. Of necessity, therefore, a framework of a complete analysis of coal availability. For substitution in Kenya must be based on these basic conditions.

The first condition requires that concepts of resources and reserves be well understood. Furthermore, the status of resources and reserves, the relationships between resources and reserves as well as the relationships between reserve and production be adequately established. The second condition requires that: (a) the above tasks be accomplished on a global basis and (b) the international market be sufficiently analysed to identify the factors pertinent to coal supply situation so as to eventually know how these factors interplay to relate to the

Kenyan coal availability conditions. Beyond resource/reserve situation these factors include: production capacities of coal producing nations; their export capabilities; the international freight industry behaviour and characteristics; alternative uses of coal; and international coal; trading pattern and import/export preferences.

ORGANIZATION

First, in addition to the foregoing text, this section explores the conceptual aspects of resources, reserves and supply and presents coal supply system model. The model identified linking factors and examined the types of dynamics which affect the status of, and the relationships between, resources, reserves and coal supply. Second, global status of resources and reserves has been analysed. At this stage, the quantity of reserves and resources; their distribution by country; the reserve/resource relationship as well as reserve/production relationship, by country in terms of ratios, have been demonstrated. Eventually their implications to supply situation are discussed.

Next, an analysis of the international coal market identified key supply parameters: (a) export capacity; (b) international freight industry characteristics and behaviour; and (c) alternative uses of coal; trading patterns and import/export preferences.

Their impications are concurrently discussed. This section is followed by an overall summary of supply implications and extrapolation of identified basis conditions to interpret the implications on potential coal availability to the Kenyan market. The Kenyan supply picture is, further handled by looking at the situations prevailing at the actual coal sources. Although Tanzania is not one of the current suppliers, it is treated under this section for a number of special reasons which are articulated in the text.

The final part reviews the consumption of coal and fuel oil in Kenya and estimates the potential and minimum expected requirements on the basis of scenario which eliminates use of fuel oil by assuming complete substitution.

CONCEPTS OF RESOURCES AND REVERVES AND COAL SUPPLY MODEL

As implied earlier in the text it is underscored here that any meaningful analysis of a mineral commodity supply situation must start by establishing the concepts of resources and reserves. These two concepts should be understood because they describe fundamental components of mineral commodity supply systems. It is further necessary to understand the relationships within the supply system of which these components are part. Therefore this sub-section reviews these concepts and presents a conceptual coal supply model which shows: the relationships between resource, reserves, and supply as well as the elements whose dynamics underly the relationships and conversion processes.

Although the terms resources and reserves in relation to mineral commodity endowments are frequently used intercheably, technically, they are different in meaning. Consequently, the aspects of the supply system they describe are not only different but also have different implications to mineral commodity supply situations.

Resources are mineral in-situ deposits which are to some extent known to exist or sometimes can be inferred to exist but cannot be exploited beneficially due to inhibitions by socio-economic, technological and institutional conditions as well as due to the state of knowledge. At least one of these sets of conditions must change favourably in order to make the resource deposit subject to beneficial exploitations. This results in a change in the position of the deposit as potential supply source. The change converts a resource to a reserve.

Reserves are thus those deposits which have been sufficiently identified, are known to the extent that they can be beneficially exploited, using the exisitng technology and, under the prevailing socio-economic conditions and within a feasible institutional framework. Reserves can, further, be divided into two sub-categories. The first consists of the deposits which are known to exist but have not been developed because of lack of infrastructures and facilities necessary for their exploitation. The second consists of the deposits which are being exploited and hence have

been developed through constructing infrastructures and facilities necessary for their exploitation. They are associated with operating mines. For them production is the only major process required for conversion to active supply sources.

Figure 1 shows the mineral supply model integrating resources, reserves and supply and those elements whose dynamics can transform a deposit from resources, to and reserves to actual supply. The positions of deposits are reversable through reverse dynamics and relatively slow forward dynamics or a stagnation.

From the foregoing text and the figure referred to the hierachies within a mineral supply system can be set. The reserves associated with operating mines are the immediate source of supply. The requirements for transformation to actual supply are basically operational in nature. They are: production; shipment; and trade. The infrastructures and facilities requires to support these operations are assumed to be existing. The next immediate supply source are those reserves which are yet to be developed through constructing mines, infrastructure and facilities which are necessary for exploitation. The resources occupy the last position.

STATUS OF COAL RESOURCES AND RESERVES

It was observed earlier that Kenya, having no known coal deposit, depends on the international sources. On the basis of convential economic theory pertaining to international trade, any country which has coal resources and reserves has a comparative advantage over Kenya with respect to coal production. In other words, any country with coal deposit is a potential exporter of coal to Kenya. All the world resources and reserves are thus potential supply bases for coal required by Kenya for coal/fuel oil dubstitution. Therefore, the analysis of the status of f global coal resources and reserves provides a bottom-line framework for a logical interpretation of the Kenyan supply situation.

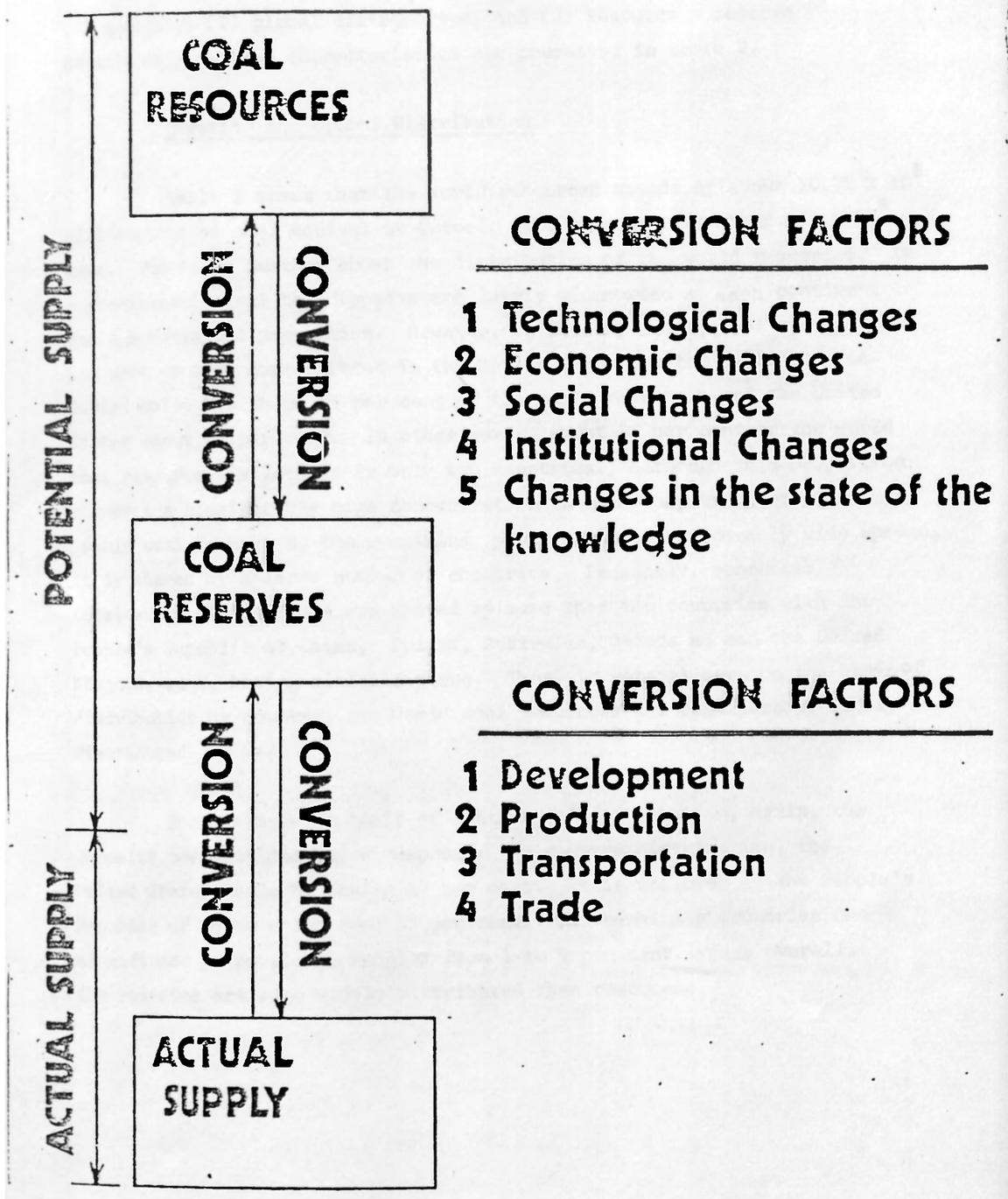

Figure 1: Coal Supply Model

The characteristics of the status of primary concern here are: (1) quantity; (2) global distribution; and (3) resource - reserve relationship. These characteristics are presented in table 2.

Quantity and Global Distribution

Table 2 shows that the world resources stands at about 10.75×10^6 million tons of coal equivalent (mtce). The reserves are about 0.7×10^6 mtce. The table further shows the distribution of the world resources. At a continental level the deposits are fairly widespread as each continent has a substantial proportion. However, on country basis, coal resources are more or less concentrated in the Soviet Union and the United States. Soviet Union has about 45 per cent of the world resources and the United States about 24 per cent. In other words, about 70 per cent of the world coal resources is located in only two countries. Although this proportion suggests a considerably high concentration in ownership and control of world coal resources, the remaining proportion is considerably wide spread. It is shared by a large number of countries. Precisely, resources outside the USSR and USA are shared by more than ten countries with the People's Republic of China, Poland, Australia, Canada ad and the United Kingdom, each, having sizeable share. Thus, in general even on the basis of distribution by country, the world coal resources are considerably widely distributed.

For reserves on basis of continental distribution, again, the deposits are considerably widespread. By country distribution, the United States leads by having 17 per cent. It is followed by the People's Republic of China which owns 15 per cent. The remaining countries own significant proportions, ranging from 1 to 9 per cent. Thus overall, the reserves are more widely distributed than resources.

Implications of Global Distribution to Supply

Distribution of this type has two major implications to world coal supply situation. The first is that it ensures regional availability of coal and also facilitates regional self-sufficiency. Coal is likely to be availability of coal and also facilities regional self-sufficiency. Coal is likely to be available on regional basis thus reducing chances of world wide regional imbalances. The second implication partains to the effect on the inter-regional or international trades in situations where such trades are necessitaed by either regional imbalances or export/import preferences. The relatively low concentration of resource/reserve ownership and control which are inherent in this kind of distribution is not conducive to monopolistic or oligopolistic practices which might subject the international coal market to cartel. In other words, the distribution would subject the world market to a reasonable level of healthy competitions thereby enabling coal from different sources to reach any given market so long as costs and shipment related factors allow. Export diversification strategy, which is discussed later in this text, would therefore be based purely on the motives to reduce market risks other than to exercise monopoly powers in the international coal market.

Resource/Reserve Relationships

The relationships between resources and reserves are also shown in Table 2. These are shown by country and also for the world, as a whole, as reserve/resource ratios. In essence these ratios are comparison bases indicative of relative aboundance of two categories of coal endowment: those which are exploitable under the existing socio-economic conditions; the prevailing institutional arrangements; and the present the state of knowledge and technological conditions and those which cannot be exploited until, at least, the state of one of the above favourably changes.

Except for the Republic of South Africa, Poland and Botswana, the ratios are low. The overall ratio for the world is about 0.06. The low ratios which characterize the reserve/resource relationships suggest that

only small a portion of the world coal endownment is exploitable under the existing conditions. There are, however, exceptions, with high ratios. They are countries, where, in comparison with most oft the industrialized world, the extents of exploration of coal have been limited. In other words, the high ratios tend to reflect limited knowledge on the resource situation; a situation which is a common characteristic of the states of the knowledge on mineral resources in regions where only limited exploration activities have been undertaken.

Implications of the Relationships to Supply

Overall the low ratios observed above have favourable implications to coal supply situation. They suggest good prospects for coal availability, particularly in the long run. Put differently, coal deposits are far from being depleted as the bulk of them are still falling under supply base category which, with favourable changes can be converted to actual sources of supply.

WORLD PRODUCTION OF COAL

Table 3 shows world production of coal and also the distribution by country. Distribution of the world coal production is similar to that of the world resources. Those countries with biggest resources are also the largest coal producers. The United States tops in coal production, producing about 25 per cent of world production. The second is the Soviet Union, producing 23 per cent. The third is the People's Republic of China, producing about 21 per cent. Although the three mentioned countries control more than 65 per cent of world coal production the remaining 35 per cent is widely spread among several countries, with even developing countries of Africa producing significant proportions. The implications of global distribution of coal production is similar to those of distribution of resources and reserves.

Table 2: World Coal Resources and Reserves by Country

Country	Resources (Mtce)	%	Reserves (Mtce)	%	Reserve/ Resources (Ratio)
Australia	600,000	6.00	32,800	5.00	.0.05
Canada	323,036	3.00	4,242	1.00	.0.01
People's Republic of China	1,438,045	13.00	98,883	15.00	0.07
Federal Republic of Germany	246,800	2.00	34,419	5.00	0.14
India	81,019	1.00	12,427	2.00	0.15
Poland	139,750	1.30	59,600	9.00	0.45
Republic of South Africa	72,000	1.00	43,000	6.00	0.60
United Kingdom	190,000	2.00	45,000	7.00	0.24
United States	2,570,398	24.60	109,900	17.00	0.04
Soviet Union	4,860,000	45.00	56,711	9.00	0.01
Botswana	16,000	0.15	9,946	1.00	0.62
Mozambique	3,950	0.04	341	0.001	0.09
Swaziland	14,200	0.13	2,868	0.004	0.20
Tanzania	1,590	0.01	453	0.001	0.28
Zambia	130	2.01	45	2.001	0.35
Zimbabwe	29,200	0.270	3,124	0.005	0.11
Other Countries	164,094	1.50	49,196	0.070	0.30
Total	10,750,212	100	662,932	100	0.06

Source: Up dated from: Coal-Bridge to the Future-Report of the World Coal A Study, Mimrod Press, Boston. 1980 Mineral Industry of Africa, Bureau of Mines of the United States Department of Interior, Washington, 1984. Energy Environment and Development in Africa; SADCC: Energy and Development to the Year 1980, Beijer Institute, Stockholm; 1984.

Table 3: World Coal Annual Production by Country

Country	Production (Mtce)	Percentage
Australia	45.7	2.1
Canada	28.9	1.3
Peoples Republic of China	459.0	21.1
Federal Republic of Germany	152.5	7.0
India	95.0	4.4
Poland	159.9	7.4
Republic of South Africa	98.7	4.5
United Kingdom	87.9	4.0
United States	535.2	24.6
Soviet Union	505.2	23.3
Botswana	0.1	0.005
Mozambique	0.3	0.01
Swaziland	1.0	0,05
Tanzania	0.3	0,01
Zambia	0.1	0.005
Zimbabwe	0.2	0.01
Other countries	2.0	0.1
Total	2172.1	100.00

Source: Up dated from: Coal-Bridge to the Future-Report of the World Coal Study, Nimrod Press, Boston, 1980. Mineral Industry of Africa, Bureau of Mines of the United States Department of Interior, Washington, 1984.

Energy Environment and Development in Africa: SADCC: Energy and Development ofto the Year 1980, Beijer Institute, Stockholm

RESERVE/PRODUCTION RELATIONSHIP

The strength of reserve-production relationship as a mineral commodity supply pameter derives, first, from the depleting nature of mineral endownment and, second, from long lag time which characterizes the exploration and pre-prodctuion (or reserve development) phases of the mineral industry. With some assumption of level or rates of production, the relationship between production and reserves serves as an indicator usable for evaluation of mineral supply adequacy. The reserve/production ratio or the reciprocal can be used. The ratios for coal reserve-production relationships are shown by country as well as for the world Table 4. In fact these figures can be interpreted as factors by which the reserves are greater than the current production. As such, their reciprocals give the proportions of the reserves which are being extracted to meet coal supply requirements. In effect these ratios show the relationship under static or initial scenario on the status of reserves and the levels of production. Overall the implication of the table is that for most countries the reserves are several times greater than the current production. The sallest ratio, is that for Soviet Union, which is 112. The largest one is for Botswana which is 99,410. However, for the world the ratio is about 300.

Implications of Reserve/Production Relationship to Supply

The implication is that on the basis of current production levels and amount of coal reserves, the reserves are capable of sustaining production for foreseeable future. These ratios can be interpreted to mean the number of years for which such sustenance would last. Thus considering the Soviet Union as the indicator of the shortest period, the implication is that the shortest time a national reserve would sustain production is bout one hundred years. On a global basis, however, on the average, the current world production would be sustained for about three hundred years.

COAL EXPORT POTENTIAL

Those countries which do not have adequate domestic coal supply to meet their requirements must import coal from those countries with coal surpluses. Thus, coal surpluses must be available to the world market in sufficient amount to meet the worlds imports requirements. One of the major factors which determine the availability of coal for this purpose is export capability of the producing country. Underlying this factor are the producer's production capability, on the one hand, and domestic supply-demand balances on the other. However, the capability, of each country, to provide the surpluses for export market is measured by export potential.

A study[4] has analysed, estimated and projected export potentials, for the producing countries, upto the year 2000. According to the study, the largest exporters are likely to be the United States and Australia. Each country is expected to be capable of exporting 100 mtce per year. The second largest exporters are likely to be the Republic of South Africa; Poland; and Soviet Union. Each of them is expected to be capable of exporting more than 5 mtce. The remainder together are expected to be capable of exporting between 20 and 50 mtce[5]. These projections are expected to meet the world coal import requirements. Thus on the basis of this study coal export capability of the producers is expected to meet world import requirements.

INTERNATIONAL FREIGHT INDUSTRY

The importance of characteristic and behaviour of transport sector on a commodity supply situation cannot be over emphasised. The nature of transport sector determines whether a given consumer can get his supply from a chosen supply source or producer, the nature of international freight industry is, therefore, an important factor. The major elements here are:(a) mode of shipment; (b) capacity availability; (3) freight rate behaviour.

Table 4: Reserve/Production Relationship by Country.

Country	Reserve/Production Ratio
Australia	717.72
Canada	146.78
Peoples Republic of China	215.67
Federal Republic of Germany	225.70
India	130.81
Poland	372.97
Republic of South Africa	435.66
United Kingdom	512.53
United States	205.34
Soviet Union	112.17
Botswana	99410.00
Mozambique	1136.67
Swaziland	2868.00
Tanzania	1510.00
Zambia	450.
Zimbabwe	15620.00
Other countries	--------
World	305.48

Source: Tables 2 and 3.

Shipment Mode

On the basis of mode of shipment, the international freight industry can be categorized into two major sectors. The first is a "specialized sector". It is dependent on highly specialized facilities and infrstructures. The commodities it handles are predominantly liquids, the major ones being: liquified natural gas (LNG); liquid sulphur; and petroleum fuels. A number of characteristics and behaviour of interest to international commodity flow, are inherent in this sectors. Vessel capital and operating costs are relatively high. Capacity supply is usually based on prior requests. The majority of the existing facilities are usually owned, or alternatively leased, by the commodity sellers. The sector is, therefore, captive and consequently less competitive. These elements render the shipment modes, in this sector, relatively inflexibility in terms of both commodities or goods and international routes to be served. Because of the inflexibility and effect of economies of scale on transport cost, to be cost effective, the markets served must be sufficiently large to enable full capacity utilization.

The second sector handles coal shipment. It is considerably different from the one discussed above. It is "a general sector". It depends on multipurpose facilities and infrastructures handling dry materials; the bulk of which are coal iron ore, grains, bauxite and phosphate rocks. The shipment mode here is flexible with respect to both the commodities and the served routes. Even small markets can be served at sustainable costs. Furthermore, to the extent that the carriers are multi-purpose, the cost sharing is feasible thereby making unit costs relatively low on a commodity basis. Consequently, the transport costs are, less sensitive to market sizes as the full capacities can be utilized on shipment of different commodities. The major inherent characteristics and behaviour are: healthy competition, more ready capacity availability; non-captive ownership; and short term leasing arrangements.

Capacity Availability

As stated earlier coal shipment is performed by a sector which also serves other commodities. The capacity availability in light of multi-purpose nature of this sector is therefore a basis factor to coal supply situation. Adequate capacity must be availabe on a continuing basis to handle increasing volume of commodities. In the past the dry bulk capacity had adequately supported international coal trade. For the future, the expected situation is based on the perspectives developed from estimates and projections of a world coal study[6]. The estimates considered a number of crucial factor to availability including: total increases in demand for all relevant commodities; the lives of the vessels; and rates of scrapping and losses. The conclusion of this study was that for foreseeable future, dry cargo vessel capacity will be adequate to support total increased volume of international trade dry bulk commodities, including coal. Thus the ship capacity is not seen as an adverse factor for international coal supply situation.

Freight Rates

Freights rates are essentially transport charges. They greatly determine coal supply costs. Thus in turn they greatly influence the delivered prices of coal. The major determinants of levels and behaviour of freight rates are: (1) length of trade routes; (2) economies of scale; (3) ship capacity supply/demand situation.

Table 5 shows freight rates, and distances for selected coal trading routes. In general the freight rates increases with route distances. However, the relationships are not necessarily proportional. The US (East Cost) Pakistan route is the longest, among the routes shown. The freight rate for this route is also the highest. But, there are few significant deviations from this generalization. For instance, the South Eastern Coast - Kenya route is among the shortest. But freight rate for the route is among the highest. Another exception of a smaller order can be seen in comparing the situation for cases of Australian-Indian and South African-Italian routes. The distance of the first route is about 5,000 nautical miles and for the second route the distance is 6,500 nautical miles; the second route being about 1,500 nautical miles longer than the first.

However, at US$14.0, the freight rate for the first route is significantly higher than that for the second route which stands at about US$10.3. The unproportional relationship between distance and freight rates and exceptional cases in which lower freight rates are associated with longer distance are usually due to discounts and to other factors which may be in effect independently.

A second factor which affects the g freight rates of the ocean-going shipments is the ship size. Due to economies of scale, utilization of the big vessels results in low unit shipment costs. On the other hand utilization of small vessels result in relatively high unit shipment costs.

The effects of the ships size on freight costs have been studied for some selected routes. In specific, such a study was performed for three different ship capacities and for three different routes[7]. The capacities were 150,000 DWT; 115,000 DWT; and 75,000 DWT. The three routes originated from South Africa, Canada and Australia and ended in Western Europe. For each route the capacities were reduced from 150,000 DWT to 115,000 and then to 75,000 DWT. For the South Africa-Western European route, the rates increased by 15.8 and 20.5 per cent as the capacities reduced from 150,000 DWT to 115,000 DT and from 115,000 DWT to 75,000 DWT, respectively. For Canada-West European Routes the rates increased by 9.4 and 6.0 per cent for similar respective capacities reductions. Finally, for the Australian-West European route the rates increased by 7.9 and 18.1 per cent for similar reductions.

A final factor which affects freight rates is shipment capacity supply-demand relationship. Two recent experiences demonstrate effects of this factor. The first one occurred along Japan/Australia route in 1981[8]. Along this route , the normal freight rate was about US$5.0 per ton of coal. However, in late 1984, the freight jumped upto US$20.0 per ton due to high ship space demand. Later the rate declined to US$17.0 and then finally to US$12.75 as the capacity became more available. In the beginning of 1985, the rates eventually settled at the normal level as supply and demand became close to an equilibrium. The second, experience which was relatively moderate, occurred along North America (East Coast)- Western Europe route in 1986[9]. As a result of depressed

capacity demand which prevailed during the most part of the first half of the year, the rates declined to about U S$3.50 per ton. This rate increased to about US$5 and then finally to about US$6 per ton as demand increased.

Frequently, this factor is the major cause of the short-term freight variations. The freight rate increase with demand and the increase can be very significant depending on the capacity supply - demand gap for a given route.

Summary and Implications

The implications of the International Freight Industry to coal supply situation have been discussed under three major elements of the market: mode of shipment; capacity availability; and freight rate behaviour. The sector of the industry which handles the coal has a number of characteristics with relatively favourbale implications to supply situation of coal, particularly in comparison to the implications of characteristics of a counter-part sector to the supply situation of those commodities it handles. In particular with respect to mode of shipment, flexibility inherent in the sector has favourable cost implications to small markets as well as to remote markets. Capacity availability is not seen as a problem to supply situation. Whereas with freight behaviour, though determined by a number of factors, the nature of the market keeps the levels of freight rates competitive and moderate with significant flactuation being caused onlyb by short-term capacity supply/ demand gaps.

ALTERNATIVE USES

The nature of the uses of coal is also an important supply consideration particularly in so far as it determines the extent of competition among the uses and therefore the availabilities for these uses. Major uses of coal can be broadly classified into two. First, coal is used for generation of thermal energy. Second, coal is used in metallurgical processes. The first use consumes just over 75 per cent of the world coal production, thereby leaving less than 25 per cent for the second use.

Furthermore, use of coal for energy generation can be sub-divided into two based on whether coal is used directly or indirectly for this purpose. In the direct use, coal itself is used to produce thermal energy through a process of combustion. Generated thermal energy is used for production of electric power and also for industrial applications. In the indirect use, coal is converted into either gaseous and liquid fuels, through the conversion processes of coal gasification and coal liquification, respectively.

Of the 75 per cent of the world coal production used for energy generation, the shares by proportion are as follows: about 0.8 is used for generation of electric power and about 0.2 is used for thermal generation for industrial applications. Thus interm of global shares about 61 per cent of world coal production is consumed for electric power generation and about 14 per cent is used for thermal generation for industrial applications.

Table 5: Distances and Freight Rates for Selected Coal Rates [a, b].

SOURCE	DESTINATION						
	N.W. Europe	Italy	Turkey	Japan	India	PAKISTAN	Kenya
Australia	-	-	15.00(9,000)	4.9(3,000)	14.00(5000)	-	-
South Africa	-	10.25(6,500)	-	-	-	-	-
U.S. East Coast	-		-	16.20(10.000)	-	22.0(16,000)	-
U.S. West Coast)	11.50(3,600)	-	-	-	-	-	-
Africa (South Eastern Coast)	-	-	-	-	-	-	18.00(1,20)

SOURCE: Distance are computed from the Times Atlas of the World; comprehensive Edition, 1977.
Freight rates are obtained from Industrial Minerals

a. Distances are in nautical miles and the
b. Freight rates are in US$.

Coal gasification and liquifiction started attracting interests only recently. Coal derived liquid and gaseous fuels were seen as possible substitutes for petroleum derived gaseous and liquid fuels. Relative abundance of coal, the events ensuing from 1973 oil embargo as well as cartel activities of OPEC lead to intensification in research, and development of coal gasification and liquifiction technologies. However, to-date use of coal in these areas have not progressed fast enough to capture any significant market.

A world coal study suggests[10] a significant growth in coal utilization in the future. However, the growth rates are not expected to be uniform. A faster growth is expected in the sector of energy generation. Growth rate for the coal use in the matellurgical process is, however, expected to decline, resulting in a relatively slower growth. In terms of global shares again consumption in the energy sector is expected to reach 85 per cent whereas metallurgical sector is expected to consume upto 15 per cent of wolrd coal production.[11] The use in energy sector is expected to be dominated by consumption for electric power generation. Proportion for industrial energy uses is expected to be significant. However, uses of coal for both gasification and liquification are expected to grow much slower due to technological constraints which are yet to be overcome in order to make large scale applications viable for this type of coal use.

INTERNATIONAL COAL TRADING PATTERN AND IMPORT/EXPORT PREFERENCES

The significance of an established international commodity trading pattern, lies mainly on two implications. The first one relates to accessability to the commodity supply system by small regional markets and by new entrants. For these categories of markets, a trading pattern can either create high barriers or reduce barriers. High market barriers favour monopolistic practices. These categories of

markets would thus be easily isolated by market compartmentilization and discrimination and subject to non-competitive practices associated with a largely controlled market. However, high market barriers would easily evolve from highly concentrated trading patterns. The second implication relates to supply continuity for all markets including the tradition consumers. Here again a highly concentrated trading pattern would tend to restrict coal flow not only along favoured markets but also to those few traders along the major trading routes.

The nature of international coal trading pattern is characterized by figure 2, and tables 6 and 7. These illustrations show that the pattern is considerably diverse. First, figure shows that several routes radiate from major coal producing countries to different parts of the world. Second, table 6 shows diversity both in directions of the routes and the distances the routes cover. The route distances range from 3,600 to 15,400 nautical miles. But various distances are covered within this diverse route network. Finally, table 7 shows the extent to which major world consumers of coal diversify their supply sources. Alternatively it shows the extent to which the major exporters diversify the destinations of their coal exports. Considering source diversification, the table shows that Western European Consumers import their coal from, at least, six sources, as follows: 25 per cent from Australia; 20 per cent from the United States; 15 per cent from Canada and the Republic of South Africa; 10 per cent from Poland, and 15 per cent from the rest of the world. Japan imports her coal requirements from, at least, five sources, as follows: about 33 per cent from each Australia and United States; 10 per cent from each Canada and the Republic of South Africa, and 14 per cent from the rest of the world.

Economics aside, a major factor underlining existing coal trading pattern is import/export preferences. The preferences are determined by diversification strategy which in turn aimes at minimizing supply security in case of importers and market security for

exporters. The consequence is that coal from a given source would not only be destined to the market which is most advantaged with respect to shipment related cost. It would, also be shipped to other markets provided the costs are within the economic limit.

It can be implied that unless the economics of coal changes considerably, the coal trading pattern will continue to be determined largely by import/export preferences. Furthermore, it is logical to imply that since supply and market securities are rational considerations, diversification strategy will continue to be in practice. It is therefore reasonable to state that unless global security changes considerably, the existing international trading pattern will persist.

Implications of the Pattern to Supply

It has been demonstrated that the international coal trading pattern is diverse. The implications of this type of pattern have also been discussed in the text. Thus applying specifically to coal, first the small and new markets would find it relatively easy to access to word coal supply sources and second supply continuity is ensured for virtually all consumers of coal.

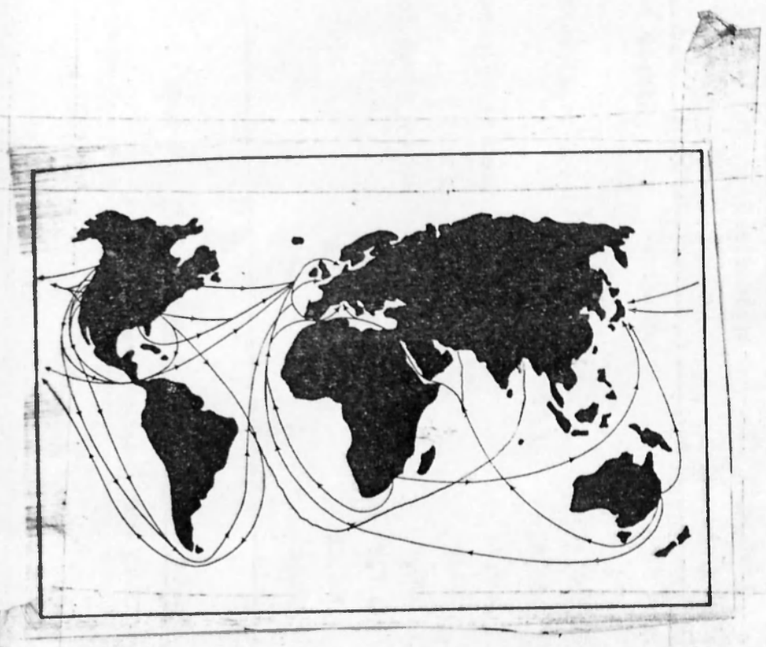

Figure 2: Maritime Coal Trade Routes [a]

Source: Coal - Bridge to the Future: Report of the World Coal Study p. 171.

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[a] Note that for crude oil the major routes originate from Middle East, through Suez Canal to Europe and North American and from North Africa to Europe and North America. For the implications of cost and route pattern comparisons see the discussions on the International Freight Industry in this text.

Table 6 Selected Maritime Coal Trade Routes and Distances

Source	Destination	Cape Route (Nautical Miles)	Canal Route (Nautical Miles)
Canada (West Coast)	West Europe	15,400	10,000
	Japan	4,800	-
United States (East Coast)	West Europe	3,600	-
	Japan	16,000	6,000
United States (West Coast)	West Europe	13,800	400
	Japan	4,750	-
Republic of South Africa	West Europe	7,200	-
	Japan	8,700	-
Australia	West Europe	13,700	11,400
	Japan	3,600	-

Source: Coal-Bridge to the Future - Report of the World Coal Study

Nimrod Press, Boston, 1980 p. 170

Table 7: Coal Source Diversification as Consumption Percentages of Major Consumers.

Consumer	Major Sources of Coal					
	Australia	United States	Canada	South Africa	Poland	Rest of the World
Western Europe	25	20	15	15	10	15
Japan	33	33	10	10	-	14

Source: Compiled from Coal Bridge to the Future: Report of the World Coal Study.

SUMMARY: BASIC CONDITIONS, IMPLICATIONS AND AVAILABILITY POTENTIAL TO KENYAN MARKET

The foregoing text has identified those basic conditions and analysed their implications to the world coal supply conditions. Here we put the Kenyan supply situation in the context. In other words this section will sythesis the ensuing implications and relate them to the Kenyan availability situation.

First with respect to resource and reserve we have identified: quantity, relationships, and distribution. All of these measures are by and large indicate favourable coal supply situation. The abandance of resources and reserve and their relationships, suggest that greater opportunities exist for broadering the more immediate supply base by converting resources to reserves, subject to realization of desirable dynamics. However, the nature of distribution favours supply conditions by reducing concentrations of regional and national resources and reserve ownership and control. In other words, on the basis of conventional theory of industrial economics which relates market structures or characteristics to behaviour, the implication here is that concentration of this type would render supply restraining and disrrupting barriers and efforts less effective.

Second reserve/production relationships shown as ratios, also indicate favourable international supply situation. The implication here is that greater opportunities to expand production by merely increasing utilization capacities, developing and exploiting idle reserves do exist.

A third condition pertains to export capacity. Underlying this factor are the production capacities, assuming sufficient reserve supply base, and the domestic supply - demand balances. A desirable export capacity, based on production situation on the one hand and domestic

demand situation on the other must exist in order to sustain any expected international coal requirement. It was found that desirable capacities have existed and are expected exist in the foreseable future.

The conditions stated above relate to supply conditions through the capacities to generate coal and avail surplus upt the points of production only. The strengths of the remaining conditions are however, inherent in their relationships with, and implication to, feasibilities of transfering the surplus from exporting countries to various importing countries. The first condition under this category pertains to characteristics and behaviour of the dry cargo sector of the international freight industry as determined by: mode of shipment, shipment capacity demand, availability behaviour, and freight rate behaviour. The second condition pertains trading pattern. Underlying this factor is export/import preference, a behaviour which is based on the diversification strategy which has been in turn necessitated by needs for risk minimization or security maximization.

In totality these conditions are favourable to supply situation in that they facilitate coal supply and trade across the ocean and the international boarders. With respect to international freight market, the flexible nature of mode of coal transportation, competitive characteristics of dry cargo sector and hence the stable and competitive freight rate behaviour have been conducive to windspread transactions, trading patterns and reasonable unit costs which have favoured even small markets as well as those markets which are relatively far away from sources of coal. With export/import preferences, and within the limits of of economic costs, a cost independent trading pattern has emerged in the international coal market. This pattern has the capacity to facilitate availability of coal to new and small markets,and the capacity to reduce moncpoly characteristics in the international market. It therefore ensures high degree of supply certainity.

Kenyan Position

Overall, the conditions which have been discussed in the foregoing text would facilitate availability of coal to the Kenyan market. The category of conditions which pertain to: resource/reserve abounduance; resource/reserve relationship, resource/reserve distribution; reserve/production relationship; and production capacities and export capacities, generally, ensure a favourable basic supply situation to the Kenyan market in the same manner they do to the international market. Conditions which pertain to transport feasibility were found technically favourable on a global basis. Here again, Kenyan situation is similarly favoured. With respect to distance, it was found that a route of upto 16,000 nautical miles is feasible. Kenyan market lies within this distance from the major coal producers. This means that the Kenyan market lies within a feasible coal trading distances. With respect to the freight rate, two major favourable observations can be made: First, Kenya can procure coal at a cheaper freight rate than the current current procurement freight rates, and, second the Kenyan market is capable of absorbing freight rates which fall on the high side of the international freight rate range. These are deduceable from table: 5 which shows that, at US$ 18.00 per ton, the procurement freight rates for Kenya is among the highest in the world. Further, underlying the favourability of the freight rate to transport feasibility are the market forces which tend to keep the rates at low and competitive levels. The implication here is that freight rates for coal routes to Kenya are likely to decrease once the Kenyan market is adequately integrated within the international coal market system.

For trading pattern the Kenyan market is positioned within the reach of critical route systems. Thus Kenya market lies within the reach of a route system which links Australia to major coal markets in Western Europe, Mediterranean region and Middle East. It is also within the reach of a major route system which links major coal sources of North America to Middle East and Asia. Further more, the Kenya market

is within the reach of the international dry cargo route system to which it is connected by her international port of Kilindini. With favourable freight rate and the flexibility, which was earlier identified as a favourable characteristic of the dry cargo sector, the trade pattern would facilitate coal availability to the Kenyan market.

CURRENT SUPPLY SOURCES AND THEIR SUPPLY POTENTIALS

So far the actual supply sources have not been discussed. Here these sources are reviewed and their supply capabilities are assessed. Kenya imports coal from only two countries: Swaziland and Mozambique. Swaziland supplies about 65 per cent of the Kenyan Coal consumption. Thus the remaining 35 per cent comes from Mozambique. These two have satisfactorily met the Kenyan requirements. Their capability to meet envisaged increases will depend on a number of factors some of which are reviewed in the forthcoming discussions.

Swaziland Coal and Supply Potential to Kenya

As already been stated this source supplies about 65 per cent of the Kenyan Coal requirements. The potential of Swaziland as a supply source for the Kenyan coal requirements depends, first, on those general basic conditions which have, earlier, been discussed within global context and second on some specific conditions precipitated by the political situation and associated changes in the southern region of Africa.

Regarding the general basic conditions, resource/reserve situation, production and reserve/production relationship for Swaziland have been earlier shown in tables 2, 3 and 4, respectively. And considering these figures together with: production capacity, export capacity, domestic balances; and competitive positions of the Kenyan competitors for Swaziland coal, one gets the picture of the implications of the basic conditions on the potential of the Swazi coal deposits as a

supply base for the Kenyan coal requirements. The supply implication deduceable from the figures in the tables is that considerable expansion opportunities exist for both actual production and production capacity. Recent production trends tend to support the above implication as they demonstrated substantial expansion capability between early 1970s and Mid 1980's. During this period the average annual production increased from 130,000 to 180,000 tce.

However, even with minimal effects on the Swazi export capacity, the supply potential with respect to the Kenyan market must, further, be seen against the background of the competition for surplus coal for export from other export markets. Precisely, the extent of the availability of Swazi surplus coal would to a significant degree depend on competitive advantages Kenyan market has over other export market and vice-versa. One crucial factor here is that policy of Swaziland which ties export of coal to her development activities.

There are three major export markets for Swaziland coal. These are: Kenya; South Korea; and Mozambique. Kenya is the largest market. It exports about 50 per cent of Swazi coal export. The remaining portion is shared more or less equally between Korea and Mozambique. Various trading relations exist between Swaziland and importers of her coal. Any type of such relationship would, however, influence competitive positions of an importer as they do reflect the degree of committments between Swaziland and the importer.

The Kenyan coal consumer and the Swazi Coal producers do not have any long-term bilateral coal trade agreements. At best there may be short term supply agreements commonly designed to ensure some degree of supply and market certainities. However, such agreements are usually less binding and hardly last for more than six months. Furthermore they are usually modified or cancelled on short notices. Thus, trade in coal between Kenya and Swaziland is largely governed by, first, free market forces which necessitate such exchanges and, second, diversification

strategy which is a usually practised to minimize supply risks on the part of Kenya and market risks on the part of Swaziland.

But, the Swaziland has an export policy which ties coal trade between it and South Korea to some development activities. The trade is under a wide range of bi-lateral trading agreements which are in turn tied tied to development activities. Thus whereas one of the fundamental motives for the trade can be attributed to diversification strategy, the trade is largely governed by those arrangements which involve long term committments. Effects of free trade elements are therefore reduced in the case of South Korea and Swaziland coal trade.

In a nutshell, with no long-term bi-lateral trade agreement between Swaziland and Kenya, on the one hand, and long-term commitments between Swaziland and South Korea, on the other hand, Kenyan market can only occupy a second position within the Swazi supply priority list. As such this situation reduces the potential for supplying Kenyan market with coal.

The foregoing factors operate on the supply side. On the demand side of the Swaziland market, the state of consumption is one of the major factors tied to export supply potential. As implied, in the earlier discussion, this factor operates through its effect on export capacity also. In essence, the domestic market can be seen as a competitor of the export markets. Thus the degree of competition would determine the export supply potential. This situation is bound to be increasingly effective. Thus, even though it is suggestive from the foregoing that coal production is largely export oriented some trends in Swazi domestic energy consumption sector indicate that the exports markets are bound to face increasing competition from the domestic market. Pertinent feature here are trends, patterns and levels of consumption. The current consumption stands at about 92,000 tons of coal equivalent (tce) per year [12]. Of this about 72,000 tce is supplied from the domestic production. The remaining 20,000 tce is imported from the

Republic of South Africa [13] . The major consumers are industrial, household and electric power sectors. The first two sectors consume about 84 per cent and the last consumes about 16 per cent of the domestic consumption. At this state of consumption the Swaziland would still have at at least about 50 per cent of its production available for export markets even after eliminating her dependence on imports from the Republic of South Africa.

However, considerable changes in the state of consumption are expected to occur in patterns and levels of consumption. Electric power sector's share of coal consumption is expected to increase from the current 16 per cent to 55 per cent by the end of 1980's [14] . The total consumption is expected to increase at an average rate of 5 per cent annually over the 1980/2000 period. In other words, consumption is expected to increase to over a million tce by the end of this century. Unless matched by equivalent expansion of production, these changes are bound to substantially affect the Swazi's coal export supply potential.

For production, the extent to which any reasonable expansion can be achieved largely depends first on the feasibility to expand production of Mpaka Collieries mine and second on the feasibility to expand transport capacity. In the past, these factors have considerably restrained production of coal in Swaziland. The bulk of Swaziland is produced from the Mpaka Collieries. It produces about 90 per cent of the domestic production. It is the only source of the export coal. Furthermore, the mine accounted for the bulk of production increases which in turn were responsille for the trends discussed earlier. Due to these developments, the mine's production is close to approaching design capacity. The marginal capacity increases are on the declining trend, implying, declines in the production growth. Also, logistic capacity has been an additional constrain to coal production expansion in Swaziland. With about 60 per cent of the domestic production supplying export market Swaziland coal production is largely export oriented.

The production has been tied to the ability to transport coal to the ports for export. Unless the capacity of the exporting transport facilities and infrastructure increase significantly, the expansion of production would be expected only to be moderate with the bulk of the additional production supplying the Swazi market. Plans are, however, underway to expand logistic capacity so that Swaziland can expand its coal export. Of necessity, the effect of this would be to increase supply potential to Kenya. But this should be seen largely in long-term perspectives.

Finally, the political situation in the Southern Africa is also a major issue regarding the Swaziland's supply potential. In particular the threat posed by this situation has necessitated formulation and implementation of policies aimed at reducing dependence on the Republic of South Africa for energy supply.

Current dependence of Swaziland on South African energy sources is considerably high. It has been earlier pointed out that about 20,000 tce of coal, representing about 20 per cent of domestic consumption, is imported from the Republic of South Africa, annually. Furthermore, Swaziland imports about 200 gwh [15] of electric power, which represents about 60 per cent of its consumption, from the same country, annually. Worse still, it depends entirely on the Republic of South Africa for its petroleum products requirements. It imports about 190,000 tce to meet its annual requirements [16].

Measures to change this dependence are already underway. Because of uncertainities arising from the political situation in South Africa, the Swaziland National Policy has put attainment of energy independence as a priority. The policy statements articulated expanded use of domestic coal for electric power generation as a means of attaining self-dependence on energy. Underscoring growing domestic demand, this is considered as a medium term objectives. The long terms policy

objectives aim at significant reduction of dependence on refined petroleum products from the Republic of South Africa. This is supposed to be achieved not only by refining crude oil within the country but also by substitution of the more scarce crude oil fuel products with the more available domestic sources of energy such as coal. Again here the overall effect would have a negative impact on the potential for supplying export market. The supply potential with respect to the Kenyan market will be affected accordingly. Thus in trying to reduce her dependence on the energy sources from the Republic of South Africa, Swaziland will have to divert more of her coal production to meet increasing domestic energy requirements, thereby reducing the surplus which would, otherwise have been available for export market.

Mozambique Coal and Supply Potential to Kenya

As mentioned earlier Mozambique supplies about 35 per cent of the Kenyan coal requirements. The information which would enable us to perform an analysis of the supply potential in a detailed manner as in the case of Swaziland is not available. However, some few relevant observations on which a less detailed assessment can be based exist.

The resources reserve status indicate relative abundance, (see Tables 2, 3 and 4) implying high potentials for production and capacity expansions. The desire to exploit these potentials have been reflected in the expected degree of expansion. Currently the annual production stands at about 600,000 tons [17]. However, plans are underway to expand the annual production to 6 million tons, [18], thereby increasing the production ten times. Although the time within which this production target will be reached is not specified, by the end of this century only one third of the target is expected to be reached. A recent projection puts the expected annual production at about 2 million tons by the year 2000 [19].

The feasibility of achieving these production targets and therefore the impacts of such expansions on the export supply potentials should be seen in light of real situation of Mozambique. As earlier observed, achievement of 6 million ton per year as annual production would mean increasing the production a thousand times. Achievement of the second target would mean a three hundred times increase within ten years. By and large achieving these target would require support of substantial amount of resources and a number of adjustments. But these conditions are unlikely to be met considering the states of security and economics prevailing in Mozambique.

Even when a substantial expansion in coal production is achieved, supply potential for the Kenyan market would be subject to yet another bi-lateral trade agreement and/or arrangement tied to development commitments. The planned expansion is intended to meet metallurgical coal requirements for the Brazelian steel industry. The governments of Brazil and Mozambique have reached anagreements under which the Brazil Government is to develop the Mozambique coal to achieve this objective.

Finally, as in the case of Swaziland the domestic demand implications on the export supply potential can be seen in terms of the expected trends in the domestic consumption. The current consumption in about 30,000 tce per year [20] The annual average growth is expected to be about 3 per cent. Thus with the current consumption and the current rate, the annual consumption is expected to be about 500,000 tce by the end of the century. This growth in consumption will be a consequence of first, the demand growth due to general economics growth and, second, the growth due to the impact of the Government strategies to reduce dependence on the external sources of energy. Overall this growth will necessarily lead to increased dependence on domestic sources of coal, thereby adversely affecting export supply potentials.

TANZANIA COAL AND SUPPLY POTENTIAL TO KENYA

Although Tanzania has never supplied coal to Kenya, some conditions render its potential for coal production an explorable issue within the context of coal supply potential to the Kenyan market. These are: (1) the state of her coal endowment, (2) location with respect to the Kenyan market, and (3) transportation and trade connections with Kenya.

Tanzania has high quality coal deposits, the bulk of which are located in the Southern Western Tanzania area Ruvuma Regions. The resources is estimated at 1520 million tons and the reserves at 319 million tons [21]. The current production stands at 10,000 tons per annual [22]. But plans are underway to expand production to 200,000 tons per year. This expansion is expected to be realized through expanding the capacities of the existing mines as well as through opening new mines. Two major constrains to the expansion of production are (1) capital and (2) market uncertainity [23]. In order to acquire adequate capital, the Government of Tanzania has approached the international community. To date, coal is produced to meet domestic requirements, only, consisting, mainly, of demand from the industrial sector, which consumes about 70 per cent of the production for both energy generation and metullurgical application and electric power sector, which consume the remaining 30 per cent. However, plans to expand the market is based on the expectation that, first, the domestic consumption will significantly expand and second, export markets will be appropriately penetrated to absorb the surplus output.

The following are seen as the possible export markets: Italy; Kenya, Uganda, and Malawi. [24] The diversity of the markets reflects the export diversification strategy which Tanzania intends to be adopted as mean of reducing risks related to market uncertainities [25].

Among these export markets, Kenya is seen as having the highest potential as an export outlet to the Tanzania coal. A number of reasons can be cited in accounting for this situation. The first two reasons have already been stated in connection with potential of Tanzanian coal deposits. The first is the easy accessibility to the Kenyan market due to transport routes system connecting Tanzania and Kenya. The major coal deposits lie within this system. Their sites are connected to Tanzania - Zambia Railway (TAZARA) at Mbeya. This railway ends in Dar-es-Salaam which is in turn linked to Kenya via road, ocean and rail routes. The second reason is the long standing trading tradition which dates back to the colonial days. Trading still continue between the two countries and the recent opening of the borders is likely to strengthen it. Other reasons however, relate to the nature of the Kenyan economy, particularly, in comparison to the economies of those potential markets within Eastern Africa. Among these are: the size of the market: the stability of the Kenyan currency; and the political stability in Kenya.

In summary the only major negating factors to potentials of Tanzania coal with respect to coal availability in Kenya is the investment capital. This constrains the expansion of production. With expansion in production, the export capability of Tanzania will likely be increased. Even though because of export diversification strategy Tanzania considers a number of countries as potential export markets, for factors inherent in transport route system, trading tradition and the nature of Kenyan economy and institutions, the Kenyan market is seen as the most attractive of all the potential export markets. However, the timing of the actual supply capability can not be estimated because the information on which this can be based is not available.

COAL AND FUEL OIL CONSUMPTION AND COAL CONSUMPTION POTENTIAL IN KENYA

Table 8 shows the annual consumption of coal, fuel oil, the total energy equivalent and the share of total energy requirements

which had been met by coal for the 1973/84 period.

For coal, the consumption was about 50,000 tce in 1973. In 1984 the consumption had increased to about 118,200 tce. Thus the consumption of coal in the Kenyan economy had more than doubled within a decade. The trend was charactirized by notable flactuations, the most pronounced ones being in 1975, 1978, and 1982. These were mainly due to flactuations in production in the cement industry which is the major coal consumer.

Both increased substitution and expansions in the cement and ceramic industries account for the overall increasing trends in coal consumptions. On the average, consumption of coal in Kenya grew at an annual rate of about 4 per cent with a more rapid growth being realized in the later parts of the period.

For fuel oil, the consumption was about 433,000 tce in 1973. However, in 1984, the consumption, being at about 432,000 tce, was slightly lower. Annual fuel oil consumption was characterised by, first, a steady increasing trend which pushed the consumption to a maximum of about 538,000 tce in 1977 and, second, a declining trend resulting in overall period minimum of about 364,000 tce in 1983. From this figure the consumption increased to about 432,000 tce which was reached in 1984. As earlier stated this consumption was lower than in the beginning of the period covered here.

The trends in fuel oil consumption were influenced mainly by four factors: the general trend of growth in economy, the introduction of more fuel oil intensive factories, notably the Pan-African Paper Mill at Webuye, the price of crude oil; and fuel substitution, which as earlier pointed out were undertaken in cement and ceramic industries. Of these factors, the inception of the more fuel oil intensive factories and the general economic growth were the main causes of the increasing trend over the 1973/79 period. However,

substitution largely accounted for the subsequent declining trends. The prices of crude oil had moderate effects on the increasing trends whereas they played facilitating role on substitution.

The relationship between coal consumption potential and consumption of fuel oil is obvious. The implication is, however, that the minimum potential for coal consumption in the Kenyan economy can be evaluated on the basis of a scenerio that eliminates fuel oil. The basic assumption is that use of coal can be expanded so that it completely replaces fuel oil. The difference between the actual coal consumption and total energy consumption is the measure of coal potential. Put differently this figure is the actual fuel consumption. For the future this assumption prevails but the total potential would be the total projected energy consumption, which on assumption of zero growth would stand at the 1984 consumption. Also to the extent that coal potential is a reflection of the extent to which coal use can be expanded by replacing fuel oil, in terms of proportions it can be measured either directly by the share of fuel oil consumption or indirectly by the share of coal consumption. In other words, the third column of table 8 which is fuel oil consumption shows the potential for coal in the respective years. However, the shares of coal, in the fifth column, are indirect measures of the potentials as they indicate the extent to which coal use would be expanded to completely replace fuel oil.

At the current pattern of energy consumption the implication of the fuel oil elimination scenerio is that coal use potential is about 432,000 tce per year. For the future the figure would be the projected total energy requirements. On the assumption of zero growth this figure would stand at 550,200 tce, the current total energy consumption. In terms of proportional indicators the 22 per cent which was the share of coal in 1984 implies that potential for coal use stands at 78 per cent, of the total energy consumable in the sectors in question.

In short, although use of coal has grown considerably and the use of fuel oil has considerably declined over the last decade, fuel oil still dominates as a source of energy in the sectors where coal and fuel oil are substitutes. With a low actual use and with highly feasible substitution possibilities, the potential for coal in Kenyan economy is high. The economy can expand its annual consumption of coal by 432,000 tce even at a zero growth rate, thereby eliminating the use of fuel oil. In other words this figure is the minimum additional coal supply Kenyan economy would require to realize a complete substitution of fuel oil with coal, at a zero growth rate for consumption of energy in the areas where substitution would be relevant.

Table 8: Coal and Fuel Oil Consumption and Share of Coal Consumption in the Kenyan Economy fortthe 1973/1984 Period

Year	Consumption in 100 Tons of Coal Equivalent (tce) and Share of Coal in Percentage			
	Coal	Fuel Oil	Total	Percentage
1973	50.0	432.9	482.9	11.5
1974	54.0	437.1	482.1	10.3
1975	32.0	464.3	196.3	6.9
1976	45.0	528.5	573.6	7.9
197	44.0	537.7	581.7	7.6
1978	35.0	487.1	522.1	6.7
1979	60.0	454.0	514.1	11.7
1980	60.0	485.1	545.2	8.3
1981	91.2	441.4	532.1	17.1
1982	75.0	460.2	535.2	14.0
1983	91.0	364.0	409.7	15.4
1984	118.2	432.2	550.2	21.5

Source: CBS, Respective Yearly Economic Survey.

SUMMARY AND CONCLUSION

Coal supply prospects are remarkably good. The analysis of conditions which influence supply situations and the evaluation of the Kenyan position within the international coal economy indicate that accessability of the Kenyan consumers to the international sources of coal is considerably favourable. Coal can reach the Kenyan market from different sources, which at the moment are not supplying coal to Kenya, with considerable ease and at costs which are comparable to the costs at which Kenya is currently acquiring its coal requirements. On the other hand, a number of constraints face the current Kenya's suppliers of coal.

Coal consumption in Kenya has increased considerably both in absolute terms and in relation to consumption of fuel oil. In terms of energy equivalent of coal and fuel oil combined, the energy provided by coal was about 7 per cent of the energy requirments of those sectors which depended on these sources of energy in 1977. However, by 1984 this proportion had increased to about 20 per cent. The increase was due, primarily, to moderate substitution of fuel oil with coal which has taken place with time and subsequent growths in consumption as well as the emergence of new users.

However, considerable potential for coal consumption, within the Kenyan economy, still exists. This arises from substitution possibilities indexed by fuel oil consumption levels. A complete substitution of fuel oil with coal would necessarily lead to at least five times increase in annual coal consumption. This raises the question of capability of the current supply sources as well as of the prospects for potential supply with respect to meeting the Kenyan requirements should substitution be fully effected.

In a nutshell the answer is, that, although the capabilities of the current sources of coal supply to Kenya appear subject to a number of constraints, with the existing basic conditions and related international supply potentials, on the other hand, and the Kenyan market position, on the other, this market would be capable of deversifying the supply sources not only to meet her coal requirements but also to ensure a considerable degree of supply security.

NOTES

1. For more details see Table 10.3, Economic Survey 1986, The Republic of Kenya, n Nairobi.

2. Ibid., Table 10.2.

3. Okech, Benjamin A., Appropriateness of Hydro-Power Production as a Development Priority for Basin Organizations, IDS, Working on Development and Environment in the Management of International Drainage in Africa, 3rd to 9th August, 1987.

4. See Coal - Bridge to the Future; Report on the World Coal Study, Cambridge (Massachusetts): Ballinger Publishing Company 1980, pp.110-112.

5. Ibid.

6. Ibid. pp.170-171.

7. Ibid. pp.172-173

8. See Industrial Minerals, 1984.

9. Ibid. 1986

10. See Coal - Bridge to the Future; Report in the World Coal Study, Cambridge (Massachusetts): Ballinger Publishing. Company 1980, pp.105-109.

11. Ibid.

12. See Energy Environment and Development in Africa: 2 SADCC: Energy and Development to the Year 2000. The Beijer Institute and Scandinavian Institute of African Studies, 1984; p.152.

13. See United States Bureau of Mines, Mineral Year Book 11, 1984.

14. See Enenergy Environment and Development in Africa; 2 SADCC; Energy and Development to Year 2000. The Beijer Institute and Scandinavian Institute of African Studies, 1984, p.156.