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A PRELIMINARY REPORT ON THE DEVELOPMENT OF THE IRON AND STEEL INDUSTRY AND RELATED METALLURGICAL FACILITIES IN THE LUSAKA MULPOC COUNTRIES */

PART I - Existing Situation

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INTRODUCTION

The third meeting of the Council of Ministers of the Multinational Programming and Operations Centre (MULPOC) for Eastern and Southern African States held in Gaborone, Botswana, 28-29 January 1980 made the following recommendations on the development of the iron and steel industries and related metallurgical facilities in the Eastern and Southern African Subregion:

(a) that this project be included in the Lusaka MULPOC Work Programme as a priority project for the period 1980/1981;

(b) that the ECA secretariat speed up the completion of the study on available national feasibility studies and plans to provide background material for the consideration of an intergovernmental meeting of experts with the view to designing the strategy and modalities of implementing the project in the subregion; and

(c) that member States co-operate with the study mission from the secretariat in providing the necessary information and other possible assistance.

In view of the above and in recognition of the strategic importance of iron and steel products in industrial development, the secretariat mounted a mission to investigate the possibility of achieving a greater degree of self-sufficiency in iron and steel production within the subregion by strengthening the existing re-rolling mills in the various countries of the subregion and where justified, the possibility of entering new product lines by establishing new capacities and if considered necessary: the creation of completely new production facilities.

The project was conceived within the framework of the proposed Preferential Trade Areas (PTA) bearing in mind the need for co-operation at intercountry levels on the basis of linkages with local resource and capacity utilization for industrial specialization, complementarity and inter-industry transactions.

Prior to the mission, country reports which had been prepared served as a basis for discussion of possible areas of subregional co-operation. A lot of gaps in data and information were identified and it was expected that the field mission would generate more information pertinent to the definition of concrete subregional projects.

The terms of reference of the mission were as follows:

(a) to investigate ways and means of harmonizing and co-ordinating plans for the development of the iron and steel industries and related metallurgical facilities taking into account the possibilities of co-operation and integrated development within the context of the Preferential Trade Area (PTA) negotiations;

(b) to formulate projects which satisfy the requirements of economies of scale in order to ensure the maximization of productivity and efficiency at national levels on the basis of products specialization and the flow intermediate goods or products and raw materials between national plants within the subregionally integrated market;

(c) to investigate possible institutional framework, strategies and modalities best suited to the countries of the subregion for implementing the projects.

The mission visited eight countries of the subregion: Angola, Botswana, Kenya, Madagascar, Mozambique, Tanzania, Zambia and Zimbabwe. Discussions were held with appropriate government officials concerned and with business circles engaged in the iron and steel projects. Information and data were readily made available to the mission.

This report summarizes the performance of iron and steel industry in the subregion by the year 1980. Chapter I contains a brief discription of the existing iron and steel plants and an analysis of the status of the engineering industry. In Chapter II the plans and projects for the iron and steel industry at the national level are summarized and assessed. Chapter III discusses raw material availability in the subregion. Chapter IV is an analysis of existing supply and demand for iron and steel industry products and planned future capacity and of the existing supporting institutional and physical infrastructure for iron and steel industry. The final Chapter deals with two major problem areas: economic and technical encountered by the subregion in iron and steel production.

CHAPTER I

STATUS OF THE ENGINEERING INDUSTRY AND IRON AND STEEL PLANTS

(a) The engineering industry

Engineering industries provide a base for self-sustaining, industrialization, serving as a focal point for the accumulation and development of technological skills and expertise. Without it any substantial expansion of the industrial structure depends upon imported technology.

The engineering industries which are required for the production of among others agricultural tools, implements and machinery, transport equipment, building materials and other products essential to development are diverse in mix and in complexity of production covering a wide range of groups. Machine-building plants, components factories and tooling plants are the core of engineering activity. Production processes cover metal fabrication, casting, forging, machining and forming followed by treatment of products.

The metallurgical industries on the other hand are aimed at facilitating continuous supply of metal to the engineering industries. In the context of the Lagos Plan of Action the priority areas for engineering inputs are agricultural tools, implement and machinery, transport equipment, building materials, equipment and machinery for production of raw materials for energy and those for generating conversion and transmitting energy.

(b) Status of the engineering industry

The engineering industry in the subregion is essentially dominated by the metal products branch (SITC 69). Some activities exist in the mechanical branches (SITC 71). In the field of electrical industries (SITC 72) the industry is characteristically a maintenance and repair activity. Activities in areas of engineering such as machine-building, components manufacture, tooling and spare parts manufacture are rudimentary except for a few countries, such as Zimbabwe and Mauritius. Activities in electrical machinery, equipment, apparatus and appliances are restricted to assembly lines repair and maintenance.

(c) Entry into the engineering industry

The following levels of development stages for the engineering industries have been assumed:

(i) the level when the engineering industry is predominantly a maintenance activity, the aim being to service, repair and maintain equipment and machinery already installed;

(ii) the level when the engineering industry has a capacity to fabricate metal products. During any capital construction, the local engineering industry may supply fabricated sheet metal, plate and structural items. The aim of the engineering industry activities is assumed to be that of increasing the share of local content in capital construction;

(iii) the level when the engineering industry attempts to re-furbish and retro-fit obsolete and worn parts and components (and may in some cases redesign components).

(iv) level when the engineering industries develop to a level when components, sub-assemblies, equipment and machinery are locally produced.

(d) Phased development of the engineering industry

In estimation of the indirect demand, the following assumptions have been made about the growth of the engineering industry.

1980-1985 strengthening of the maintenance capacity to service existing sectors of the economy;

1985-1990 increased share of local participation in the design, construction, fabrication and installing of capital equipment and machinery for new industrial capacity and additional capacity for services and support infrastructure;

1990-2000 entry into machine-building industries.

(e) Status of the Iron and Steel Industry

Basic characteristics of existing iron and steel plants

The capacity of existing iron and steel plants are not synchronized with plans for the future development of the engineering industries. Current product mix from the iron and steel industries satisfies a small fraction of the construction sector. Output for the metal - fabricating industries is based on scrap melting in the majority of the countries of the subregion (the notable exception being Zimbabwe).

Current metal supply to the rudimentary engineering industry which exists now is based on imported products and sub-assemblies and the characteristics of the industry are summarized as follows:

(i) national markets are small resulting in uneconomic production programmes;

(ii) fragmented markets have resulted in high investment and unit cost and competion for skilled manpower;

(iii) the small markets have constrained the creation of infrastructure, institutions and technical base to support engineering industries.

(iv) growth of metal industries has been constrained by the structure and scope of engineering industries.

(f) Existing iron and steel plants

The only integrated iron and steel complex in the Eastern and Southern Africa subregion is in Zimbabwe. The complex, which is based on the RISCO complex consists of among others a sinter plant, blast-furnace, steel rolling mills and auxilliary services installations, has an installed capacity of about 0.8 million tons of crude steel. Product groups include billets, flats squares angles, rails, sections etc.

In Kenya there are three rolling mills namely KUSCO Ltd. (Mombassa), EMCO Steel (Kenya) Ltd. in Dandora and Steel Rolling Mills Ltd. in Kikuyu. The KUSCO mill which is basically a wire rod mill with an annual production capacity of 10,000 tons has an electric furnace based an scrap and a continuous casting machine. Production also includes a 7,000 tons per annum galvanized wire line and a 4,000 tons per annum annealing line.

EMCO steel which is a subsidiary of the Maduani Group produces reinforcing rod and merchant bars. Its total annual output is estimated at 15,000 tons per year of finished steel product. On the other hand, the Steel Rolling Mills in Kikuyu which is suitable for producing semi-reinforcing rods has a planned capacity of 24,000 tons. The Kenya Railways Workshop also has the capacity for industrial components and parts. Annual output now stands at 2,000 tons per year.

In the United Republic of Tanzania the Steel Rolling Mills at Tanga which is 80% owned by the National Development Corporation of Tanzania is equipped to produce re-infrocing bars and light angles. The mill's capacity is about 40,000 tons per annum.

The steel making capacity in Ethiopia consists of two electric arc furnaces one at Asmara and the other at Akaki in Addis Ababa. Both units which are based on scrap and imported ingots have a total capacity of 70,000 tons per annum. The Akaki plant also consists of galvanizing and corrugating line with a planned capacity of 24,000 tons per year of light gauge galvanized sheets.

In Uganda the Uganma steel and Engineering Corporation consists of a foundry and induction furnace. The annual output is estimated at 2,000 - 3,000 tons per year.

CHAPTER II

PLANS AND PROJECTS FOR THE IRON AND STEEL INDUSTRY AT THE NATIONAL LEVEL

Profiles of national projects

1. KENYA

The idea of establishing an integrated iron and steel project was conceived in 1976. A pre-feasibility report was made by the Centre for Metallurgical Research in Leige, Belgium in 1978. A Quasi Government Iron and Steel Consulting Organization AUSTROPLAN of Austria did the feasibility study on the proposed iron and steel project.

KENYA is faced with two options i.e. the establishment of an iron and steel project at the national level or the establishment of an iron and steel project at regional level for Kenya and Swaziland.

(a) Domestic projection and market

Domestic consumption of steel both semi-finished and finished are estimated at 103,300 tons of merchant bars and 129,600 tons of flat products for 1978. By 1999 the consumption is projected to reach approximately 220,000 tons and by the year 2000, some 680,000 tons.

The planned installed capacity for non-flat product is 141,000 tons per annum. By mainly produced by semi-integrated plants operating on scrap melting in electric furnaces and rerollers operating on rolling of imported billets. Products include bar steel, wire rod and light sections.

The total installed capacity for non-flat product is 141,000 tons per annum. By 1985 production is expected to reach 165,000 tons and 226,700 and 293,000 tons by 1995 and the year 2000 respectively. It is evident that the quantities of the steel products corresponding to the projected demand deficit will have to be imported if no new steel plants are built.

(b) Raw materials and energy

There are several iron ore deposits in Kenya. Recorded deposits are less than 40 million tons. The ore deposits are generally of very low grade. Further analysis of ore contents are needed. The proposed steel plant would therefore require large importation of iron ore. Limestone deposits of about 8-10 million tons have been recorded. Other fluxing materials include fluorspar (15 million tons) silica (1,382,240 tons) and manganese ore (443,000 tons).

Metallurgical coal is not available in Kenya. Charcoal is suggested as an alternative in the study. Heavy fuel oil which is available from the Mombassa oil refinery is to be used as fuel and redudant in the direct reduction process. With regard to energy, no detailed survey has been carried out. However, the type of energy that would be required for the production of steel would depend on the technological process to be agreed upon.

(c) Production and production process

In brief the production capacity of the proposed steel plant is as follows:

		Crude steel	Total flat and non flat product
1st Phase	1987-1990	332,000 tons	297,700 tons
2nd Phase	1990-1995	570,000 "	510,850 "
3rd Phase	1995-2000	896,000 "	805,650 "

The type of technology to be used for production of both flat and non flat products which invariably is governed by the product mix and quality is yet to be determined. Two main process routes are under consideration:

(i) the making of liquid steel and casting of semi-finished products;

(ii) the shaping of finished products.

In the production of liquid steel, three types of production techniques have been pre-selected namely:

(i) the blast furnace (BF) followed by oxygen steelmaking;

(ii) the direct reduction followed by electric arc steelmaking; oil gasification;

(iii) the electric arc furnace only.

The continuous casting method is being recommended for the casting of semi-finished steel products and for the production of finished steel product, hot rolling and cold rolling of these will be carried out on reversing mills.

Investment Cost

The total investment cost (without interest and cost for land acquisition for the basic plants is as follows:

- conception - DR/EAF Route (i)	-	$ 489.2 million
- investment cost for the BF-LD Process Route (ii)	-	$ 562.4 "
- investment cost for the BF-LD Process (iii)	-	$ 868.5 "

Manpower and Social Infrastructure

No detailed survey are available in the study.

Location

Mombassa has been identified.

Justification for an Iron and Steel Plant

(i) downstream processing of iron-ore would stimulate the growth of related industries;

(ii) various input industries and small workshops will find new development and expansion;

(iii) aggregate value added will be higher than the export of the basic raw materials;

(iv) establishing an iron and steel plant would generate employment and income and create more industrial skills and expertise;

(v) it would make an essential contribution to overall technological development, the base for more R & D activities and strengthen the technological capacities;

(vi) it would encourage more infrastructural development such as: ports, roads, energy etc.

Summary of Problem Areas Identified

(i) the size of the proposed iron and steel plant, given the quantity and quality of the iron ore deposit would require large importation of iron-ore from the world market to justify the sustained operations of steel production;

(ii) metallurgical coal is not available in Kenya. An alternative such as: charcoal from Eucalyptus trees) would have to be used in large amounts to meet the demand of a growing iron and steel plant.

(iii) the inadequacy of water supply for the proposed steel plant at the initial stage;

(iv) high investment cost of the project and access to a ready and reliable market

2. SWAZILAND

Regional iron and steel project for Swaziland & Kenya

Background

In 1977 the EEC as part of its ACP/EEC Indicative Aid Programme commissioned Centre for Metallurgical Research in Leige, Belgium to carry out a prefeasibility study on the technical aspects of the construction of a steel mill in Mombassa (Kenya). The objective of the study was to assess the possibility of processing the low grade local iron ore of Swaziland into a product suitable for sale as a raw material for the steel plant in Kenya.

It has been pointed out in existing studies that the export of pellets is uneconomical. However an extensive pilot plant study undertaken by Anglo American

Corporation of South-Africa Ltd. have shown that by selective flocculation and reverse flotation techniques applied on the 59 million tons of Mgwenya Mines at an estimated recovery of 85 per cent a yield of 33.6 million tons of pellets with 64 per cent Fe can be expected.

The world consumption of coal has increased as a result of the energy crisis. Total world trade of non-coking coal which was 60 million tons in 1975 is expected to increase to 112 million tons in 1985. The main part of this increasing market relates to high volatile coal. Swaziland coal has low sulphur content and could provide a source of supply for different applications. The low volatile coal which is produced can be utilized in the following possible application:

- power plant fuel;
- steam generation;
- direct reduction;
- coal gasification.

Raw materials

Swaziland has large deposits of low grade iron ore estimated at about 160 million tons concentrated in two areas in the Western and Southern part of the country. The country is endowed with deep coal mine resources of over 11,290 million tons 100 million tons of which are workable by open cast methods. Deposits of fluxing and refractory materials have been recorded.

Energy and water supply

No study has been done since the project is basically for the supply of raw material input to the proposed Kenyan iron and steel plant.

Economic justification for the integrated iron and steel plant (Kenya/Swaziland)

The case for regional co-operation in the production of iron and steel include:

(i) sharing of the high cost of operation;

(ii) greater comparative advantage in the production and marketing of the complementary inputs;

(iii) additional income and foreign exchange for both countries especially Swaziland whose iron ore mines need to be reactivated on commercial lines.

3. TANZANIA

As a result of favourable geological investigations carried out during the past twenty years, the Tanzanian Government commissioned the Government of the Federal Republic of Germany, under its Technical Co-operation Programme to carry out a proper feasibility study on the proposed iron and steel plant. The object of the study was to determine the technical and operating conditions as well as the cost of mining, the coal of Mchuchuma for smelting the titaniferious iron ore of Liganga for the establishment of an iron and steel plant.

Demand projection and markets

The consumption of iron and steel products in Tanzania depends on the growth of manufacturing, agriculture and construction industries. The consumption of steel (primary and semi-finished steel) in 1975 were as follows:

- marchant bars (wires, rods, angles etc.	21,280 tons
- flat products (sheets, plates strips) etc.	24,787 "
Total	46,067 "

The domestic demand for semi-finished and finished steel products which was 46,067 tons in 1975 has been projected to 139,300 tons in 1985 and 248,000 tons by 1995. These projections were based on the average growth rates of these sectors namely, monetary agriculture 4 per cent, manufacturing industry 7 per cent and building construction 5 per cent.

Raw materials, energy and water supply

Tanzania's iron-ore resources occur in three districts. The deposits at Liganga is estimated at 49 million tons. The coal reserves in Mchuchuma are estimated at 1,511 million tons with ash content of 24.9 per cent. Some quantities of limestone fluorspar, etc. have been recorded.

Energy supply is not a constraint to the effective implementation of the proposed iron and steel works. By 1982 the Government plans to install in the Mbeya Region, two thermal power plants with a capacity of 25 Mw and 50 Mw. The capacity of the plants would be increased to 100 Mw by 1985.

Availability of adequate water supply may cause a problem if no new additionaal water supply installations are made.

Production and production process

The production figure of finished steel is 140,000 tons which is regarded as being too conservative. Production capacity or output of castings is 152,000 tons.

The production operations for the proposed iron and steel works will be carried out in six different stages namely: ore open pit mine; coal mine and power plant; ore concentration plant; pelletizing plant; direct reduction plant and the steel works.

For the ironmaking process, the conventional blast furnace process is not recommended for the Liganga ore which has a high titanium content and therefore is not suited for the blast furnace process; the Mchuchuma coal is also not suitable as it does not allow a conventional production of blast furnace coke. Therefore the Codir Process of KRUPP and the SL/RW process of Lurgi are being recommended.

Investment cost and the international rate of return

The total investment cost is 1,608 million Tsh. 957,295 of which is the foreign exchange component. Comparatively this capital cost is high particularly because other

raw materials and infrastructural inputs to be used in production of iron and steel have not been investigated and therefore their cost elements have been excluded in the final cost estimates of the iron and steel works.

The internal rate of return has been given as 3-4% for the production of 300,000 tons per year of Mchuchuma coal. For the production of billets the rate of return is between 3.8 - 15.3% for prices between $300-$400 per ton at an interest of 5 per cent on preproduction investment and 3.4%-14.5% at an interest of 7 per cent on pre-production investment. The actual earning power of the project varies between 3-7% which renders the project marginal. No detailed cost benefit analysis has been carried out, therefore the economic viability of the project is difficult to determine.

Transport and location of plant

Transport cost is an important determinant of the location of a steel plant. Mchuchuma and Liganga are two mining sites to be connected by road. The consultants have recommended that because of the nature (bulk) of the raw materials, a branch line of the Tazara Railways from Makumbako to Luponde linking Mchuchuma and Liganga be constructed. The recommended locations of the plants are as follows:

- ore concentration plant - Mutindi
- direct reduction plant - Liganga
- steel plant - Njombe

Manpower requirements

The colliery at Mchuchuma will require 285-385 local personnel and 77 expatriates at its initial stage of operations. The iron and steel works will require a total of 954 people.

Justification of project

(i) The industrial growth rate of Tanzania makes it imperative that the domestic market for industrial minerals and processed products should be on the increase.

(ii) Value added by primary manufacture of iron and steel is greater than that of iron-ore concentrates.

(iii) Export of iron and steel products might generate more income than the export of crude iron-ore.

Limitations

It is extremely difficult to evaluate the macro-economic aspect of the iron and steel project in Tanzania as there are still uncertainties in the technical concept. Secondly no cost benefit analysis and market evaluation have been carried out as a result of which the actual cost of the project cannot be determined.

4. ZAMBIA

In 1964 the Zambian Government commissioned the Industrial and Processing Engineering Consultant of Great Britain to do a feasibility study on the establishment of an iron and steel works. Since then several studies relating to the project have been carried out.

Demand projection and market

The annual consumption of wire rods, angles, small shapes etc. will reach 60,000 tons in 1979 and at an expansion rate of 6% per annum, 120,000 tons by 1992.

Zambia being one of the few African countries with iron and steel production facilities produces an average of between 26,174 mt per annum and 34,842 mt per annum. In 1978, 31,788 mt at a value of 8,533,736 (k) were produced. The increase in consumption of iron and steel products is a major factor in the decision by the Government to establish an iron and steel complex in Zambia. Existing plants are scrap based.

Raw materials

Iron ore occurences are scattered all over the country. These resources are estimated at over a billion tons. The average Fe content is between 40-69%. The coal deposits which have been worked since 1965 are now estimated at about 58 million metric tons. Major fluxing and refactory materials such as limestone, fluorspar ferro manganese and quartz are available.

Energy and water supply

Electrical energy which is usually the type of energy required for iron and steel production is adequately available in the Zambia. The main source of water supply for the steel works is the Kafue River which lies on a high rainfall area.

Production and production process

Production capacity at the initial stage is estimated at 60,000 tons with facilities for an increase to 120,000 tons by 1992.

Investment cost

Several studies carried out over the years have indicated different process routes among which are the BF, ELKEM and HYL. The capital cost for these are ZK 109.16, ZK 51,53 and ZK 55.50 million respectively. The actual process route for production is still to be determined and the total capital cost would of course depend on the process route selected.

Manpower requirements

No study has been undertaken.

Infrastructure and location

The iron and steel works was originally at the Kafue Industrial Development area. For environmental reasons it was decided to re-site the steel works approximately 32 Km south-east of Sanje.

A new road and a single track railway will have to be constructed from kafue and Sanje respectively to the steel works.

Several possible sites have been identified for the location of the plants namely Chisasa, Chingola, Kapiri, Mumbwa, Lusaka and Kaue.

5. ANGOLA

(Project description based on discussion held with the Director of Heavy Industries in Angola)

The project involves the rehabilitation of the existing steel plant in Angola for the production of 36,000 tons per year of rolled products. The plant is semi-integrated based on scrap and producer rolled merchant products. The cost of this exercise is estimated at US$ 20 million. The second phase of the project is the production of pelletizing products mainly for export; the estimated cost is US$ 110 million. The third phase of the project relates to the production of sponge iron at an estimated cost of US$ 130 million. The final stage involves the expansion of rolling mills and the installation of a new electric furnace to meet the demand for iron and steel products. It is expected that at the completion of the project 15,000 tons of crude steel will be produced.

6. MOZAMBIQUE

(Project description based on discussion held with officials of the National Directorate for Planning)

The initial phase of steel development is aimed at satisfying the domestic steel demand. The proposed steel project covers mining, sponge iron electric steel making, continuous casting and rolling mill. Production capacity of the plant is 200,000 tons.

By 1990 an integrated plant is to be established at Nacala with an installed capacity of 2 million tons per year of sponge iron.

CHAPTER III

AVAILABILITY OF RAW MATERIALS, ENERGY AND WATER SUPPLY

A. Raw materials

One of the major problems on the establishment of an iron and steel industry is the availability of raw materials. The basic raw materials for iron and steel production are a deposit of iron-ore, coal, fuel oil, fluxing materials such as limestone, fluospur etc, steel scrap and plenty of water.

(a) Iron ore

Iron-ore occurs in a number of places in the Eastern and Southern African sub-region. Many of the deposits have adequate reserves to justify the capital expenditure required to exploit the mines and set-up iron works. In general the iron-ore reserves of the region are of rich ore containing 50 per cent or more Fe. Lower grade ore deposits are found in Ethiopia, Kenya, Madagascar, Somalia and Swaziland. Although high ore content is preferable in steel production, lower quality ore can frequently be up graded by benefication.

Zimbabwe has a total known reserve of about 3,738 million mainly located in the Salisbury area and to the South. The ore content varies between 40-66 per cent Fe. In the Zambia, iron-ore occurrences are scattered all over the country. The resources are estimated at about a billion tons with ore content of 40-69 per cent Fe. Large deposits are also found in Angola. The reserves currently recorded at 1,270 million tons are mainly of the Lake Superior primary type, the enriched superior hematite and the eluvial ore with contents ranging from between 40-60 per cent Fe.

The resources of Madagascar and Mozambique are estimated at 251 million tons and 309 million tons with average ore content of 24-45 per cent and 45-67 per cent respectively. Iron ore deposits in Somalia are estimated at 170 million tons with ore content of 30 per cent Fe. Other deposits with adequate reserves are in Uganda 98 million tons with Fe content of 60-90 per cent. The deposits of Swaziland are of low grade - 35 per cent Fe.

In Tanzania iron-ore resources occur in three districts namely Njombe, Mparada and Murogoro. The deposits at Liganga estimated at 49 million tons with Fe content of 50 per cent are by far the most important. Other deposits of 8 million and 6 million tons have been identified recently at Mundusi and Manporo respectively.

Iron-ore deposits of less than 40 million tons are recorded in Kenya, Ethiopia, and Malawi. Botswana has iron-ore reserves in sixteen known deposits. These deposits are scattered all over the country and are estimated at millions of tons with grades ranging from 30-60 per cent Fe. (Details of the size and chemical composition of iron-ore resources for the countries of the subregion are in Table I.

(b) Coal

The coal deposits of Eastern and Southern Africa occur in the Karoo basins. In general the Karoo coals are bituminous with high ash content. They also contain important reserves of anthracite. In terms of economic importance, which very often reflects to a great extent the size of the geological reserves, the enormous deposits found in the Karoo basins are clearly in the lead in the whole of Africa. The reserves of the customs Union of Southern Africa including Botswana, Lesotho, Namibia and Swaziland are estimated at 80 billion tons.

In iron and steel production, coal is used mainly in the Blast Furnace process, gassification process and in the Direct Reduction process. It can also be used to generate electrical energy.

Iron oxides will be reduced to metallic iron by means of carbon. The carbon required for smelting iron is obtained from the destruction distillation of selected coking coals. The physical properties of metallurgical coke as well as its composition, depend mainly upon the coal used and the temperature at which it is carbonized. Not all coal will form coke and not all coking coals will give the same firm cellular mass that is characteristic of coke suitable for iron and steel production. The chemical analysis of the coal deposits for each country are in table II.

The customs union of South Africa which includes Botswana, Lesotho, Namibia and Swaziland is by far the major coal producer in Africa. In 1978 for example, the region produced 88,940 million tons of coal which is about 94.8 per cent of Africa's total production. Zimbabwe is the second largest producer. The known reserves of Zimbabwe are estimated at 22,000 million tons, 6,855 millions tons of which are commercially exploitable. The reserves are mainly in the Wankie - Entuba basin. The main seam is bituminous coal with coking properties, the ash content is between 5-30 per cent at the top but the average ash content for more than half of the seam is 12.83 per cent. With an annual production of 2.5 million tons, the life span of the reserves is estimated at 1,760.

Botswana has an enormous occurrence of very large coal deposits estimated at several billions of tons. 708 million tons of this are commercially exploitable. The annual production capacity is now 0.300 million tons.

In Mozambique, prospects are good. The known coal reserves are estimated at several millions. Approximately 700 million tons are commercially under exploitation at Maotize. Production is expected to begin on the Tete or Zambize Basin. Coal in the region is of good coking quality and with an annual production of 0.500 million tons.

In Swaziland the deposits are estimated at about 11,290 million tons. Production per annum is currently at 0.130 million tons.

The United Republic of Tanzania is endowed with known reserves of about 1,511 million tons with an ash content of about 24.9 per cent. The annual production is 0.001 million tons. The Chinese have recently discovered a 50 million tons deposit of coal at Igogo which may be used primarily to generate electrical energy.

There are about 500 million tons of commercial coal reserves in Madagascar. The actual known reserves are about 600-800 million tons. The ash content is 15-28 per cent and annual production is approximately 0.002 million tons. Malawi also has known coal reserves of about 500 million tons.

In the Zambia coal deposits have been worked industrially since 1966. Production per annum stands at 0.710 million tons. The reserves are estimated at 38 million tons with a life span of only 13 years.

Angola and Ethiopia have known recoverable reserves of 8-10 million tons respectively. These deposits are not yet under exploitation.

(c) Fluxing Materials

The major fluxing materials and additives used in iron and steel production are limestone, dolomite, fluorspar, quartz, feromaganese etc. Limestone is known to exist in large quantities in all countries of the Eastern and Southern region of Africa. However, precise estimates of possible reserves are not available and no systematic analysis of the quality has been carried out in most countries.

Zimbabwe is endowed with over 200 million tons of limestone and a good quantity of the other fluxing materials. Other large deposits which are being exploited are to be found in Botswana, Kenya, Ethiopia, Malawi, Madagascar, Uganda and Tanzania. Smaller quantities exist in the other countries.

A wide variety of fluxing and refractory materials also exist in the subregions. These include among others dolomite found in Ethiopia, Zambia and Zimbabwe (550 million tons). Manganese is found in Zimbabwe, Kenya and Tanzania in large quantities and in much smaller quantitites, Ethiopia, and Uganda. Fluorspar is found in Botswana, Kenya and Mozambique.

(d) Steel Scrap

Production of steel in the region is in most cases based on the melting of available steel scrap. Reprocessing scrap makes an important contribution to a country's steel requirements. These scraps are of three types.

i. Process scrap from iron and steel works;
ii. Factory scrap from other engineering processes;
iii. Capital scrap from demolition of building structures and worn-out equipment and vehicles.

Plants making steel by using locally available scraps are found in Ethiopia, Kenya, Malawi, Madagascar, Tanzania, Zambia and Zimbabwe. In all these countries the annual quantity of scrap available is over 10,000 tons. Somalia's supply of scrap is negligible.

Table 1: Iron ore - Reserves and chemical composition

	1	2	3	4	5	6	7
	Measures Resources In million tons	Contained Iron million tons	Type	Mineral	Fe	Slag	Refining
Angola	1 000 d 2 000 u.p	320 200	Lake Superior	Hematite "	32% 40%		
Botswana							
Ethiopia	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Kenya	17 15	17 15	Sulphide Residual	Pyrite Goethite	30% 7-35%		
Madagascar	105 u.p. 70 u.p.	37 28	Lake Superior	Magnetite Hematite Magnetite	35% 40%		0.50
Malawi	-	-	-	-	-	-	-
Mozambique	12 u.p. 309	6	Taberg	Hematite Magnetite	48%	7.8	-
Swaziland	130 d	45	Lake Superior	Hematite Magnetite	35%		
Tanzania	49 u.p	25	Tabert	Magnetite	50%	1.3	13.2
Uganda	45 u.p 30 u.p	45 30	Lake Superior	Magnetite Hematite	62% 78%	1.1	2.6 0.5
Zambia	15 u.p 60 u.p	9 36	Bilbao Lake Superior	Magnetite Hematite	58% 60%		
Zimbabwe	200 d 134 d	118 84	Lake Superior Lake Superior	Hematite Hematite	59% 63%	10.0	
Somalia	120	47	Bedded	Hematite	39%		

d. - developed
u.p. - unprocessed
n.a. - not available

Source: 1. United Nations Survey of World Iron Ore Resources Occurence and Appraisal, Report of a Panel of Expert 1970
2. Minerals Yearbook, Volume III by United States Department of Interior 1973
3. Other ECA Publication on the Iron and Steel Industry.

Table 2: Coal - Reserves and chemical composition

	1	2	3	4	5	6
	Reserve in million tons	Type	Combustion Va	Volatility	Ash Content	Coking N/Coking
Botswana	41,500 k		22 to 24 J/Kg	22 to 30%	19 to 25%	Non Coking
	708		23 to 24 MJ/Kg	24 to 25%	15 to 19%	N/Coking
Ethiopia	10 k		n.a.	n.a.	n.a.	n.a.
Madagascar	500 c.r.		n.a.	25 to 35%	15 to 28%	n.a.
Malawi	500 k		n.a.	n.a.	n.a.	n.a.
Mozambique	200,000 k 700 c.r	Bitumanus	n.a			Coking
Swaziland	1,129 k 5,150	Anthracite	26.11-31.4 MJ/Kg	5.7-12.6%	9.1-23.1	Coking
Tanzania	1,511 k 400 c.r 50	Anthracite	44.9-7.1 MJ/Kg	n.a.	24.9	Coking
Zambia	38 k.r 20 c.r			16.6-17.2	16.8	
Zimbabwe	22,500 k 6,855 c.r				9.77% 18-36% 12-18%	Coking
Somalia						
Angola	8 k					

c.r. - Commercial Exploitable Reserves

n.a. - Not available

k - Known Reserves

Sources: Energy Resources in Africa. Joint OAU/ECA paper
Mineral Resources in South and Central Africa - R.A. Pelletier 1964
U.N. Report. Development of Iron and Steel Industry in East and Central Africa - ECA Publication.

B. Energy

(a) Principal energy requirement

The total energy requirement in iron and steel production depends on the process route selected. Generally the type of energy required is electrical.

(b) Actual power requirement

The actual power requirement for an integrated iron and steel works are entirely dependent on the processes selected for the production of iron and steel, the latter is generally governed by the product-mix and production quantities. For example, in electric smelting and electric steelmaking, the power requirements for a complete works could be as high as 2000 kwh per ton of finished products. On the other hand if the Blast Furnace Process and the LD convertor processes are used for steelmaking, the minimum power requirement would be about 500 kwh per ton of the finished product. An integrated iron and steel works producing 300,000 tons of steel without electric smelting and steel making would therefore require a minimum of 22 Mwh. If electric smelting and steelmaking are included, the works would require 77 Mwh.

Iron and Steel Process Routes

Plants	Route I	Route II
Iron-making	Blast Furnace	Direct Reduction
Steelmaking	LD Convertor	Electric Arc Furnace
Casting	Ingot Caster	Continuous Caster
Rolling	Rolling Mill	Rolling Mill
Central Plant Utilities	Utilities	Utilities

(c) Electrical energy - installed capacity, production and potential resources

The development of electric energy in the Eastern and Southern Subregion of Africa has surged forward in recent years mainly as a result of the structural changes in the economies of the member States and the flexibility of the kind of energy produced. The eastern and southern subregion has an appreciable scale of energy resources which could provide a support for its development activities for a fairly long time to come. It has solid fuels, hydrocarbons, hydro-energy and a wide range of renewable sources of energy. Table III contains details of the installed capacity and actual production of Electrical Energy in the Subregion.

(i) Coal

Africa's coal reserves, commercially exploitable are estimated at 89.5 billion tons. Of this amount 79 billion tons are estimated to be located in the eastern and southern subregion. However very few of these countries produce coalfired thermo-electricity. Tanzania is to establish a coal powered station of 24 Mw under Technical Co-operation agreement with Chine.

(ii) Fuel oil and natural gas

The primary sedimentary basins of this subregion have numerous traces of oil and gas as well as bituminous rock deposits. Areas of petroleum potential have been located in the subregion and research and exploitation continues to discover oil and gas. Angola currently produces an average of about 700,000 tons of crude per diem. Oil exploration so far carried out have registered good prospects for commercial production of oil in Mozambique.

In 1979 research and exploration on the coastal basin of the United Republic of Tanzania indicated commercial showings of gas with a proven reserve of 1.5 billion m^3 of gas. Mozambique has proven commercial gas deposit of about 17 billion m^3. Natural gas is also available in Ethiopia and Angola.

(iii) Hydro-electricity

The production of hydro-electricity has grown substantially over the last 20 years more than any other energy sources. A summary of the hydro-electric production of the region and the potential reserves of hydro-electricity is in Table IV. Eastern and southern Africa have 22 per cent and 17 per cent respectively of Africa's hydro-electric potential. This potential is almost entirely concentrated in the high rainfall areas or in the vicinity of large waterways such as the Nile, Zambezi, Segani, Shire and Ruzzi Rivers, the Limpopo and the orange.

(d) Possibility of co-operation in the field of energy

In the region, Mozambique, Zimbabwe, Uganda and Zambia are exporters of electrical energy. Member States of the region in accordance with the OAU Lagos Plan of Action on the development of energy resources are to make all efforts to draw up an exhaustive inventory of their electricity potential with a view to making better planned national use of all their resources, hydro-carbons, solid fuels and hydro-electricity. Most of the current energy programmes are at national level, but countries of the region could work together to facilitate the financing and building of some large hydro-electric projects or thermo-electric or nuclear reactor project likely to play a major role in the future interconnection of electrical networks of the region.

(e) Water supply

The plant in a steel works may be cooled by water using a direct or recirculating system. The latter will require more water treatment plant but less water. It is estimated that in a direct system, 60 tons of water are required for each ton of steel produced. In a recirculating system however only 6 tons of water will be required. The choice made is of course dependent on the availability of water and the cost of transporting water. The eastern and southern subregion with the exception of a few places have plentiful supplies of water. Although the water supply is subject to wide seasonal variations, they are proved to be adequate for the requirements of the iron and steel industry.

Table 3: Installed capacity and actual production of electrical energy in the Eastern and Southern African subregion

* Southern African Customs Union

	Hydro electric (In Mw = 1000 Kw)	Actual production	Coal fired	Actual production	Gas fired	Actual production	Fuel oil	Actual production		
	Capacity	Gwh million of Kwh	Thermo-electric capacity mln. m/t	Million metric tons	Thermo-electric capacity mln. m/t	Million metric tons	Thermo-electric capacity mln. m/t	Million metric tons	Total thermal installed cap. 1000 Kwh	Total Installed capacity in 1000 Kwh
Angola	368	950 (82.3% of electric demand)	-	-	-	0,068	-	8,200	155	525
Botswana*	-	-	-	-	-	-	-	-	114	320
Ethiopia	206	374 (47.7% of electric demand)	-	-	-	-	-	-	183	356
Kenya	173	750 (58.5% of electric demand	-	-	-	-	-	-	55	95
Madagascar	40	181 (52.9% of electric demand)	-	-	-	-	-	-		
Malawi	72	257	-	-	-	-	-	-		
Mozambique	1117	6750	-	0,340	-	-	-	-	280	1397
Swaziland	-	-	-	-	-	-	-	-	-	-
Tanzania	100	620 (65.6% of electric demand)	-	0,001	-	-	-	-	80	180
Uganda	156	705	-	-	-	-	-	-	7	163
Zambia	1438	8546 (76.8% of electric demand)	-	0,483	-	-	-	-	272	1710
Zimbabwe	705	3460	-	1,701	-	-	-	-	487	1192
Somalia	-	-	-	-	-	-	-	-	18	18

Source: World Energy Supplies 1973-1978. United Nations Statistical Papers Series J.M. 022
Joint OAU/ECA Paper - Energy Resources of Africa 1980.

Table 4: Hydro-electric production and potential reserves

Country	Production gwh million of kwh	Potential hydro-electric billions Kwh	% of electric Demand
Angola	950	230	82.3
Botswana	-	-	-
Ethiopia	374	45	47.7
Kenya	750	50	58.5
Madagascar	181	114	52.9
Malawi		3	-
Mozambique	6,750	45	-
Swaziland*		-	-
Tanzania	520	75	65.6
Uganda	705	45	-
Zambia	8,546	19	-
Zimbabwe	3,460	14	66.8
Somalia	-	1	-

* Members of the South African Customs Union

Source: Joint OAU/ECA paper on Energy Resources in Africa

In 1979, the following new facilities for hydro-electric production were under construction or being studied:

Country	Source	Capacity
Ethiopia	Wabe Shebelle Omo	-
Kenya	Kamburu Gtaru	60 Mw 84 Mw
Tanzania	Strieglers Gorges	2,080 Mw
Malawi	Shire	-
Zambia	Victoria Kariba	68 Mw-318 Gwh 600 Mw-3,500 Gwh per year
Uganda	Tanjah Murchisonfalls	140 Mw-700 Gwh per year 500-600 Mw.

CHAPTER IV

THE SIZE OF THE MARKET AND DEMAND

As regards domestic and subregional markets, the current and future steel demand consists of direct and indirect demand components for the principal steel product lines: carbon steels, special steels, flat products and tubes, and speciality stainless steel, other alloy steels, cast iron and finished steel products.

Present direct steel demand

The direct demand for iron and steel is represented mainly by wire rods and round bars used in building and construction industry: this sector consumes more than 80 per cent of all imported iron and steel products in the subregion. The demand for direct steel consumption is closely associated with the growth of per capita GDP through the growth of the economy.

During the period 1970 to 1976 average annual imports of steel to the Eastern and Southern African subregion were approximately 684,000 tons. Moreover, Table V shows a sharp decline in the level of crude steel imports by the subregion from 1972 onwards. Two of the crucial reasons were the perpetual increase in oil prices and socio-economic conditions in countries of the subregion.

If we take a look at some of the major steel importing countries of the subregion, we will find that Kenya steadily increased its imports of steel products from 130,000 tons in 1976 (see Annex I). Whereas imports of Zambia were uneven during the same period. In 1976, 56,000 tons of steel was imported by Zambia. Imports consisted of mainly heavy and light sections, sheets and plates. Madagascar imported mainly sheets and sections, whereas significant part of Malawi's imports consisted of rails and railway track materials, wheel tyres and axles. Finally, Tanzania's imports consisted of mainly flat products and the long ones.

Present indirect steel demand

As a matter of strategy and fuller perception of the size of the market the development of iron and steel industry should be concerned in a long-term framework with indirect demand as one of the instruments for installation of internally self-sustaining social-economic development to facilitate the growth of the engineering industry for production of capital goods and spare parts for priority sectors: food and agriculture, transport and communications, building materials, the energy sector and the core of the engineering industry: machine tools, foundry, forging, heat treatment, especially production of inputs for small-scale and rural industries.

Effective indirect steel demand for the Eastern and Southern African subregion has been derived by converting the imports of priority end-use engineering goods such as manufactures of metals; power generating machinery bodies; agricultural machinery; machines for specific industry; electrical machinery and apparatus; and transport equipments into approximately 492,000 tons of crude steel has been annually imported by the subregion in the form of machinery and equipment which constitutes 42 per cent of total steel imports (direct and indirect, see table and Annex 2 for details).

Table 5: Actual direct and indirect demand for the iron and steel in the Lusaka MULPOC (Metric tons)

Subregion		1970	1971	1972	1973	1974	1975	1976
Direct x/ (SITC)								
671	Pig iron	3,849	6,579	5,891	5,055	5,697	-	-
672	Ingots	37,562	52,060	35,127	39,504	49,504	37,512	13,841
673	Bars and profiles	135,473	264,355	153,628	143,163	194,492	127,051	70,996
674	Plants and sheet	172,510	355,264	286,638	312,329	393,110	198,566	192,865
675	Hoop and strip	5,794	10,724	10,996	17,948	35,420	16,781	18,051
676	R.W. rails	34,721	86,845	76,212	105,203	65,714	51,242	49,058
677	Wire	34,587	40,758	28,665	35,504	61,601	30,365	24,108
678	Tubes and pipes	31,730	102,250	128,615	76,343	81,744	69,554	97,068
679	Castings	3,664	3,220	2,818	-	2,850	1,188	2,560
Subtotal		519,890	922,055	725,590	734,812	884,435	532,259	469,547
Indirect y/								
691-8	Manufacturing of metals	170,053	209,989	206,358	180,441	173,744	151,335	80,148
711	Power generating machinery boeis	5,323	6,534	11,314	8,353	6,709	8,027	7,917
712	Agricultural machinery	19,677	17,580	16,117	23,773	23,184	20,725	20,378
718	Machine for special industry	11,905	15,960	22,786	14,743	10,509	13,627	12,100
722-4	Electrical machinery and apparatus	30,419	30,427	32,334	25,693	26,024	21,620	17,124
731-3	Transport equipment	214,286	283,567	215,625	190,982	231,420	316,467	289,598
Subtotal		451,663	564,057	505,584	443,955	521,590	531,801	427,265

x/ excluding Botswana, Zimbabwe, Seychelles and Reunion

y/ excluding Botswana, Lesotho, Swaziland, Seychelles, Reunion and Zimbabwe

CHAPTER V

INSTITUTIONAL ARRANGEMENTS AND CONSULTING ENGINEERING SERVICE

The institutionsl arrangement in the subregion for industrial and technological development is inadequate to effectively implement any major programme or project aimed at self-reliant and self-sustained economic development. The proposed iron and steel projects in order to be meaningful, require technical support services which invariably should be available locally.

Various forms of consultancy services exist in the region but their role in the development process is limited to project preparation and matters relating to construction and the acquisition and transfer of technology. There is however inadequate engineering design services and limited number of research and development institutions.

The feasibility studies on iron and steel industry which are available in the subregion have been carried out by foreign consulting firms mainly because of the absence of firms or institutions with the technical know-how and training relating specifically to the operations and the methods of long-term planning of the iron and steel industry in the subregion. These studies are a preliminary analysis of the economic and technical feasibility of the projects. The analysis covers the production resources to be used, the manufacturing techniques, investment cost and location but says very little about the size of the market, manpower requirement, the economic, financial and technical issues which are the key factors in determining the profitability of the projects.

For some countries in the subregion there are numerous feasibility studies available on the iron and steel industry prepared of course by different foreign firms commissioned by the Government 1/. In most of these studies there are no clear definition of or proposal on the basic technical, economic, financial and organizational structure. The selection of production process for all the iron and steel projects is yet to be determined. A number of options have been made available by the consultants thereby making it extremely difficult for the Governments to select the right production process.

1/ In the Zambia for example foreign firms commissioned to do the study include the following:

1. Industrial and Processing Engineering Consultants of Great Britain (1964)
2. Geoz Avod Agency of Yugoslavia - Survey of iron (1965)
3. W.S. Atkins and Partner of London (iron and steel making process (1967)
4. Bechtel International Co-operation Management Services (1968)
5. INDECO Market Study for 1965-1966 and 1968
6. INDECO Market Study for 1965-1974
7. International Construction Company Ltd. of London 1969
8. Elkem Norway
9. Voest of Linz, Austria

In the context of the implementation of the projects it would have been an advantage if there exist in the region, consulting engineering capabilities, to help formulate and monitor the Governments policies on the iron and steel industry. In the absence of such capabilities, the Governments have resorted to the services of foreign firms which may not necessarily give an unbiased advice on the choice of technology and production routes for iron and steel production. Such an unbiased advise which is best available locally very often helps to minimize the risk of cost over-runs and may determine what part of the construction work can be handled by the local industry.

Other institutions of relevance which are sadly absent in most of these countries relate to quality control, standardization, engineering design and information.

CHAPTER VI

MAJOR PROBLEMS AND BOTTLENECKS

The most important factors for the creation and development of the iron and steel industry are the present and future supply and demand, the availability of raw materials, energy and infrastructure, qualified manpower and the financial resources for investment.

Although the subregion is endowed with the basic raw material inputs for iron and steel production, some countries do not have sufficient proved reserves to supply the plants for at least 25 years. In some cases, the domestic raw materials are of low quality with a very high percentage of impurities. This low quality of raw materials can have a siginificant effect on the process selection, production techniques and cost. In the absence of non cooking coal in some countries the blast furnace based on charcoal is being recommended. However the continuing existence of an iron and steel plant using charcoal in the BF system would depend on the availability of a constant supply of charcoal, and suitable iron ore.

The size of the market is another important factor determining the size of a steel plant to be established in a given country. In most cases the size of the market is not large enough to justify the establishment of an optimal size plant. On the other hand, the proposed plants in the small capacity ranges are likely to be more susceptible to economies of scale than plants in the large capacity range. In planning for the iron and steel industry therefore careful consideration is to be given to this factor.

Another factor which is a major constraint to the establishment or development of the iron and steel industry is that of the availability of utilities such as energy, water supply and supportive physical infrastructures. These factors need to be examined carefully so as to determine the location of the plant and the actual cost of investment for the proposed iron and steel projects. In most cases, no detailed study has been done.

Availability of manpower of the appropriate description and skill is a critical factor in the decision to establish iron and steel plants in the subregion. The countries of East and Southern Africa are considerably short of skilled technicians, experienced steel workers and managers. In the feasibility study available the manpower factor has not been thoroughly examined by the contractors.

The iron and steel industry is highly capital intensive. The trend towards using and developing equipment of large capacity has led to the creation of integrated plants mainly for production to large markets. Capital costs at each stage of production vary considerably. Accordingly it is believed that in order to be productive, an iron and steel plant should have a minimum production capacity of 100,000-150,000 tons for a direct reduction plant. The feasibility studies also propose alternative combinations of technological routes indicating broad estimated capital and production costs. No in-depth studies on the technical, economic and commercial aspects of the proposed technological combinations have been carried out to facilitate the selection of the most appropriate technology for various operations.

The high cost of investment may create a strain on capital which is a scarce factor for the countries of the subregion. The benefits to be derived from the production of iron and steel in any of these countries would depend on the country's ability to compete in international markets for refined ore and fabricated products. Its ability to compete at the international level further depends on the cost of exploration and the quality of the product. The type of technology that is used and the location of the mines and steel plants are also relevant factor determinants of the rate of return on the investment.

Finally, it is to be pointed out that at this stage it is extremely difficult to evaluate the macro-economic aspects of the project as there are still uncertainties in the technical concept and consequently the actual cost of the projects. Information on the technical and economic components of the projects is very scanty thereby making it extremely difficult for the authorities to take a decision on their implementation. Detailed socio-economic study has to be carried out for each of these projects to ascertain a more quantitative and meaningful macro-economic project analysis.

Annex 1

Apparent direct consumption of iron and steel industry in Lusaka MULPOC (in metric tons)

		1970	1971	1972	1973	1974	1975	1976
Angola	671	3849	6579	5891	5055	5697	-	-
	672	6500	19054	643	807	1071	1000	1000
	673	17965	19455	16898	18926	18691	4830	480
	674	32400	31762	35208	48385	46021	8200	470
	675	1200	700	2270	11600	2430	380	220
	676	2844	17930	11060	10966	2206	4640	40
	677	2978	1623	2121	2378	4783	920	100
	678	19617	18803	22330	14310	28643	16460	180
	679	1422	38	243	1830	1130	260	200
		87775	115944	96659	104255	110672	36690	2690
Ethiopia	671	-	-	-	-	-	-	-
	672	9054	9500	619	3309	5821	2337	4580
	673	6716	7483	6018	6341	7569	2076	3470
	674	28855	27296	21372	23710	22954	16467	13823
	675	1100	3100	1100	100	210	50	250
	676	400	-	-	240	-	-	-
	677	300	100	300	290	570	230	320
	678	6348	5661	3151	2000	4069	4059	1195
	679	-	-	-	-	-	-	-
		52773	53140	32560	35990	41193	25219	23397
Kenya	671	-	-	-	-	-	-	-
	672	6949	18461	22152	20389	9169	13496	38700
	673	31603	51477	21970	16438	23372	11716	17080
	674	60648	73131	60324	90508	127222	49665	85363
	675	2000	2600	4100	4750	3650	3120	2970
	676	282	4927	2074	9402	6573	3744	5920
	677	12327	9460	7676	12685	29234	8599	12533
	678	15433	14416	22433	7489	8404	6302	41250
	679	300	1700	500	540	60	300	500
		129542	176172	141229	162401	207684	96942	204316
Madagascar	671	-	-	-	-	-	-	-
	672	-	-	-	-	-	-	-
	673	21316	16669	12132	8239	8666	12797	6680
	674	18663	20323	21217	20248	26088	21408	16420
	675	-	100	-	-	-	110	290
	676	1600	467	548	443	4147	1947	350
	677	2379	3060	1918	2338	2872	2557	1130
	678	8614	4949	4047	2239	1893	3166	1220
	679	2242	3182	2575	1189	24	100	110
		54814	48750	42437	34696	43684	42085	26200

		1970	1971	1972	1973	1974	1975	1976
Malawi	671	-	-	-	-	-	-	-
	672	-	-	-	-	-	-	-
	673	2260	3825	3113	2175	5079	9066	4325
	674	8816	9634	11588	12055	11470	9990	11711
	675	-	100	-	-	10	10	50
	676	327	1607	1446	4384	7487	8387	15972
	677	842	1588	1042	1995	2480	3870	2511
	678	3135	2769	2987	2352	3518	4372	22913
	679	-	-	-	370	-	-	-
		15380	19423	20176	23331	30044	35695	57332
Mauritius	671	-	-	-	-	-	-	-
	672	4566	3511	5651	8843	11568	3790	6320 xx/
	673	5802	4670	7438	7932	14494	13624	8990 xx/
	674	5494	3831	4381	6053	6006	7446	5610 xx/
	675	-	-	-	-	-	-	-
	676	-	-	-	-	-	-	-
	677	-	-	-	-	-	-	-
	678	1609	3099	3072	3380	6596	2589	3390 xx/
	679	-	-	-	-	-	-	-
		18371	15111	20542	26208	38664	27449	24310
Mozambique	671	-	-	-	-	-	-	-
	672	10429	-	-	20	4900	4900	-
	673	14134	30028	23234	30264	14514	1980	1760
	674	37274	47112	35120	46407	34934	5350	5320
	675	3629	5996	6480	6729	6212	670	80
	676	13365	2781	2859	11486	10488	8196	21540
	677	2000	2900	4339	3130	3419	220	170
	678	8600	7100	3920	3825	1650	460	160
	679	2500	1800	1420	670	1310	380	420
		91931	97717	77372	102531	77427	22156	29750
Somalia	671	-	-	-	-	-	-	-
	672	64	1534	1225	667	1503	162	860 xx/
	673	1146	2006	3679	3707	13385	1598	4250 xx/
	674	3247	1676	2861	2793	3095	4761	3070 xx/
	675	-	-	-	-	-	-	-
	676	-	-	-	-	-	-	-
	677	-	-	-	-	-	-	-
	678	435	1654	1215	1073	1301	1494	1195 xx/
	679	-	-	-	-	-	-	-
		4892	6870	8980	8240	1928	8015	9375 xx/

xx/ UNECA estimates

		1970	1971	1972	1973	1974	1975	1976
Uganda	671	-	-	-	-	-	-	-
	672	100	1400			200	200	150
	673	11146	17287	2197	940	1281	1049	659
	674	16111	25576	14420	4223	5800	3571	852
	675	2706	1462	399	954	510	300	260
	676	2074	542	1574	1248	464	768	361
	677	3737	4210	2762	1014	994	421	558
	678	9340	7389	3381	6391	1389	3512	200
	679	-	-	-	-	-	-	-
		45214	57866	24733	14770	10638	9821	3040
Tanzania	671	-	-	-	-	-	-	-
	672	100	-	4837	6260	15272	11617	17919
	673	24887	29779	16955	15319	19103	9940	8372
	674	27738	36972	39168	31386	43524	20708	27056
	675	3088	3266	4117	10265	15188	8222	11031
	676	15829	58691	56651	67274	32569	18880	175
	677	6630	8757	4521	7041	5881	6458	4386
	678	12222	16270	46589	21137	13217	16334	18735
	679	100	200	200	200	30	170	1170
		90594	153935	173032	158882	144784	92329	88844
Zambia	671	-	-	-	-	-	-	-
	672	-	-	-	-	-	10	1460
	673	30594	81676	40004	32882	68359	58375	14930
	674	29380	77951	37979	26562	66002	51000	23170
	675	400	1100	1200	5470	7210	3919	2900
	676	2300	8420	6200	8980	1780	4680	4700
	677	5694	9160	4286	4523	11368	7090	2400
	678	14977	27240	19410	12147	11064	10806	6330
	679	100	100	200	260	300	320	110
		83448	205647	109280	90824	166063	136200	56000
Eastern Subregion	671	3849	6579	5891	5055	5697	-	-
	672	37562	52060	35127	39468	49504	37512	14841
	673	135473	264355	153628	143163	194492	127051	70996
	674	172510	355264	283638	312328	393110	198566	192865
	675	5794	10724	10996	17948	35420	16781	18051
	676	34721	86845	76212	105203	65714	51242	49058
	677	34587	40758	28665	35304	61601	50365	24108
	678	91730	102250	128615	76343	81744	69554	97068
	679	3664	3220	2818	-	2850	1188	2560
		519890	922055	725590	734812	884435	532259	469547

Excluding Botswana, Zimbabwe, Seyshelles, Reunion

Apparent indirect consumption of iron and steel industry in Lusaka MULPOC (in metric tons)

		1970		1971		1972		1973		1974		1975	
		Q	V	Q	V	Q	V	Q	V	Q	V	Q	V
Angola													
691-8	Manufacturing of metals	21065	13357	30478	19904	21011	14931	30472	21805	21994	23073	5624	4274
711	Power Generating Machinery	1888	5452	1553	5250	2785	9245	1540	6811	1742	8887	1742	8887
712	Agricultural Machinery	9540	10625	5228	6268	6282	9497	7443	11751	5419	8983	5419	8983
718	Machines for special industry	960	1273	1516	2658	997	2804	1967	5974	2480	9198	2489	9198
722-4	Electrical machinery and apparatus	4067	13242	4355	14304	4143	14941	4323	20200	3363	18161	3363	18161
731-3	Transport equipment	4901	45124	43874	57163	31686	48040	3433	61851	29736	57867	29736	57867
	Sub total	42421	89073	87004	105544	66904	99508	49178	128392	64743	126169	48373	107370
Ethiopia													
691-8	Manufacturing of metals	13879	7002	11868	6772	8909	6030	8187	6286	8508	7154	6339	6327
711	Power Generating Machinery	68	156	648	1318	95	211	1252	1584	105	255	46	149
712	Agriculutral machinery	3183	3708	3183	3708	2867	4694	1737	3322	3603	5786	1442	3389
718	Machines for special industry	2237	3703	417	594	1534	3418	1284	2371	1625	3869	1748	5701
722-4	Electrical machinery and apparatus	11596	7172	3783	7374	3811	11021	1598	6106	2110	8364	2554	11027
731-3	Transport equipment	1894	20489	17107	22001	18611	27757	19128	29674	18818	32867	15012	37509
	Sub total	32857	42230	37006	41767	35827	53131	33186	49343	34769	58294	27141	64102
Kenya													
691-8	Manufacturing of metals	18486	10770	23906	14789	23069	14396	29365	17449	23456	22698	21418	23485
711	Power generating machinery	534	7776	545	8919	560	8667	711	11258	1041	14534	1381	19340
712	Agricultural machinery	1359	4907	1166	6115	1185	6572	1063	5530	2577	7973	2920	16989
718	Machines for special industry	2844	6787	2844	6787	3950	9387	2645	8366	2451	7780	3671	16376
722-4	Electrical machinery and apparatus	2223	10100	4700	20435	7575	32934	4361	18862	4885	21238	2257	22860

Apparent indirect consumption of iron and steel industry in Lusaka MULPOC (in metric tons)

		1970		1971		1972		1973		1974		1975	
		Q	V	Q	V	Q	V	Q	V	Q	V	Q	V
731-3	Transport Equipment	33778	103430	52137	64357	45174	55770	40784	50350	65605	80993	64350	79446
	Sub Total	109324	143770	85298	121412	81513	127726	78929	111915	100015	155216	95997	178496
Madagascar													
691.8	Manufacturing of metals	10253	8399	12874	10319	9624	8332	6951	7371	7822	8554	7400	14884
1.	Power Generating Machinery	443	1949	882	3126	1025	3752	330	2759	415	2940	456	4115
2.	Agricultural Machinery	1428	1732	1325	1928	900	1380	590	1146	1299	2691	2038	5730
3.	Machines for Special Industries	515	1238	449	863	118	516	118	516	118	516	118	516
4.	Electrical Machinery and Apparatus	1756	7474	3205	11862	2192	10590	1517	11585	1173	10845	1175	12779
5.	Transport equipment	12915	15396	14305	20285	12479	19109	7371	14680	6846	16144	8907	26529
6.	Sub-total	27310	36688	33039	48383	26669	44025	16877	38057	17673	41690	20094	64553
Malawi													
691.8	Manufacturing of Metals	5401	3255	14729	6556	7403	5750	9903	6420	7066	7097	7948	8436
1.	Power generating machinery	456	1009	648	1460	372	1828	826	1929	497	2258	787	2821
2.	Agricultural machinery	292	1457	467	2605	113	1500	180	2072	711	3500	886	6093
3.	Machines for special industries	413	701	754	1257	1593	2345	1286	1707	1420	2927	504	1498
4.	Electrical machinery and apparatus	239	2116	520	12670	712	4038	670	4623	1432	6215	1109	6214
5.	Transport equipment	6380	7876	10750	13273	10341	12768	13399	16543	13276	16934	25033	30905
6.	Sub total	13181	16414	27868	37821	20534	28229	26264	33294	24842	38931	36267	55968
Mauritius													
691-8	Manufacturing of metals	1468	1346	1970	1656	2486	2472	3405	3751	4244	4773	4745	5737
1.	Power generating machinery	243	410	406	816	385	925	660	1352	1347	3107	1273	3654
2.	Agricultural machinery	36	322	44	589	63	388	75	415	75	415	240	3735
3.	Machines for special industries	42	70	415	777	87	198	61	296	61	296	49	593
4.	Electrical machinery and apparatus	359	653	382	1757	1450	5604	758	7000	986	9057	1635	12358
5.	Transport equipment	2192	2707	2429	2299	3607	4453	6120	7573	8207	10131	11051	13643
6.	Sub total	4340	5508	5646	8594	8078	14040	11079	20387	14920	27779	18993	39680

Apparent Indirect Consumption of Iron and Steel Industry in Lusaka MULPOC (In metric ton)

		1970		1971		1972		1973		1974		1975	
		Q	V	Q	V	Q	V	Q	V	Q	V	Q	V
	MOZAMBIQUE												
691-8	Manufacturing of Metals	18255	10504	15763	3568	44204	20393	32967	18051	15207	13937	12432	6838
1.	Steam generating	1106	3759	1106	3759	1192	3926	1697	6957	372	787	454	1421
2.	Agricultural Machinery	1416	1628	1416	1628	1416	1628	7443	11751	1357	2329	1357	2329
3.	Machines for special Industry	235	1070	235	1070	1544	5001	2061	5567	272	719	71	225
4.	Electrical machinery and equipment	2174	5300	2174	5300	1684	8409	1781	35955	1102	23340	1102	23340
5.	Transport equipment	20064	25847	20064	25847	2458	30354	4996	43090	4078	35163	215	1849
6.	Sub Total	43250	48108	40758	41172	52498	69711	50945	121431	22388	75275	15631	35002
	SOMALIA												
691-8	Manufacturing of metals	3006	879	3049	944	4272	2488	6213	2815	7306	3411	7053	3072
1.	Steam generating	127	86	290	695	350	538	778	1166	544	2462	1279	3704
2.	Agricultural Machinery	419	252	289	226	571	668	996	1110	1693	2449	846	1362
3.	Machinery for special Industry	-	-	-	-	-	-	-	-	-	-	-	-
4.	Electrical machinery & equipment	191	431	272	568	723	1898	1006	3189	1222	4126	997	3703
5.	Transport equipment	3193	3949	2905	3586	234	7725	304	12656	671	10114	913	18499
6.	Sub Total	6936	5589	6805	6019	6150	13317	9297	20927	11436	22562	11088	30290
	UGANDA												
691-8	Manufacturing of metals	13775	6516	18168	12293	9870	7157	5197	4747	6392	5898	6834	7551
1.	Steam generating	186	847	91	1365	8	725	9	594	28	1075	10	1101
2.	Agricultural Machinery	279	1420	1515	3245	765	2281	506	1038	1589	3803	573	2244
3.	Machines for Special Industry	966	1843	2045	2993	2875	7511	641	1713	443	978	120	524
4.	Electrical machinery & equipment	1197	5205	2054	8431	1833	7971	1635	7109	1545	672	761	11110
5.	Transport equipment	13674	16882	22803	28153	8361	10321	8043	9930	14518	17923	19911	24582
6.	Sub Total	30077	32713	46676	56480	23712	35966	10031	25131	24515	36398	28209	47112

Apparent Indirect Consumption of Iron and Steel Industry in Lusaka MULPOC (In metric ton)

		1970		1971		1972		1973		1974		1975	
		Q	V	Q	V	Q	V	Q	V	Q	V	Q	V
	TANZANIA												
691-8	Manufacturing of metals	24811	14215	32580	19616	26884	14591	23521	18411	33090	27785	24496	31908
1.	Power generating machinery	178	2416	323	4599	236	4605	266	5627	371	7316	314	8079
2.	Agricultural machinery	1445	4044	2455	4450	1688	5395	2891	6723	4000	7408	3316	9948
3.	Machines for special industry	224	556	4327	5566	2221	4868	1593	4612	1259	4280	3683	16709
4.	Electrical machinery and apparatus	2426	10548	3697	16078	4006	17417	5485	23846	3124	22277	4137	2447
5.	Transport equipment	27824	34351	39617	48910	32756	42908	44933	55474	54139	66839	65533	80905
6.	Sub Total	56908	66130	82999	99219	67791	89784	78689	114693	97983	135905	101479	172028
	ZAMBIA												
691-8	Manufacturing of metals	39654	21756	44604	22430	48626	27714	24260	18056	38659	29097	47046	38465
1.	Power generating machinery	94	9954	42	10221	4386	12748	284	8221	247	11669	285	13254
2.	Agricultural machinery	280	2547	492	1016	267	7686	849	7118	861	7538	1688	14036
3.	Machines for special industry	3649	7423	2959	6292	7536	18504	3087	9389	371	1160	1174	3632
4.	Electrical machinery and apparatus	4091	23593	5285	32913	4255	30262	2559	27092	3082	35588	2530	41286
5.	Transport equipment	37471	46260	57576	71082	49918	61626	42441	52398	65086	80354	75806	93589
6.	Sub Total	85059	11538	110958	146954	114988	158540	73480	122274	108306	165406	128529	204262
	Total (Eastern and Southern Africa	451663	597759	564057	713365	505584	733977	443955	785844	521090	883625	628743	998863