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METALLURGICAL INDUSTRIES IN ZAMBIA

Studies on the rehabilitation of African industry*

No. 10

Prepared by

Regional and Country Studies Branch

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PREFACE

As part of the programme of the Industrial Development Decade for Africa, the Regional and Country Studies Branch of UNIDO is issuing a series of studies concerning the major problems of African manufacturing and the potential for its regeneration. The purpose of these studies is to outline policies and measures that can be applied at the national, sectoral and plant level in order to bring about the rehabilitation of the industry in general and of specific individual plants which have been selected for more detailed study.

The purpose of this report is to provide a brief general review of the metallurgical industries in Zamiba in the context of their rehabilitation potential. The report therefore provides an overview of the existing situation, including the general economic and institutional background, linkages to other sectors, obstacles to increased production, and an outline of available policy options.

The report starts with an overview of the Zambian economy as a whole, with the aim of assessing the present state of the metallurgical industries and presenting some selected issues which are crucial for the rehabilitation and further development of the metallurgical industries. Chapter 2 focuses on an ongoing rehabilitation programme in Zambia's copper mining industry at the industry level, such as in Zambia's Consolidated Copper Mines Ltd.

Chapter 3 examines whether the ambitious plans for establishing an integrated mini-steel mill in Zambia are justified by the availability of iron, coal and electricity in the country. Chapter 4 considers the availability of ferrous scrap in Zambia, which affects the size and competitiveness of Zambia's engineering industries and the capital goods sector.

Chapter 5 examines on the basis of concrete projects what kind of steel mill might be built in Zambia, considering also whether there is justification for a steel-making facility. Chapter 6 shows how existing foundries and forging shops, despite their low utilization rates, can support the manufacture of original equipment, and how foundries and forges are linked to the development of Zambia's metallurgical industries as a whole.

Chapter 7 discusses the potential and prospects of Zambia's agricultural machinery and equipment sector in the present African context. Chapter 8 examines prospects of non-ferrous metal industries presently suffering from underutilization and mismanagement and also looks at chances for the promotion and diversification of the copper-mining and copper-processing industry.

This report does not offer a substantial overview regarding the extent and type of mineral deposits and other natural resources, or of areas developed or potentially to be developed for metal-related industries, nor does it assess the nature of existing metallurgical industries at the plant level. The report was prepared as a basis for a UNIDO rehabilitation mission to Zambia and as a first step toward a more comprehensive study of the relevant factors affecting plans and projects for the rehabilitation of these industries.

This report, together with a companion report on metallurgical industries in Angola (PPD.133, 28 September 1989), was written by Fujio John Tanaka, in co-operation with other staff members of the Regional and Country Studies Branch, Industrial Policies and Perspectives Division.

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LIST OF ABBREVIATIONS

ANFO	Ammonium nitrate and fuel oil explosive
BF	Blast furnace
CAPCO	Central African Power Company
CCR	Continuously cast rod
DR	Direct reduction
DRI-EF	Direct reduced iron-electric furnace
EAF	Electic-arc furnace
ECA	United Nations Economic Commission for Africa
FEMAC	Foreign Exchange Management Committee
GDP	Gross domestic product
GNP	Gross national product
IED	Improved explosive device
INDECO	Industrial Development Corporation
NCCN	Nchanga Consolidated Copper Mines Limited
ODA	Official development assistance
PTA	Preferential Trade Area
RCCM	Roan Consolidated Mines Limited
SADCC	Southern African Development Co-ordination Conference
SCCC	Société de Coulé Continué de Cuivre
TAZARA	Tanzania-Zambia Raiiway
UNDP	United Nations Development Programme
UNIDO	United Nations of Industrial Development Organization
ZAMEFA	Zambian Metal Fabricators Limited
ZCCM	Zambian Consolidated Copper Mining Company
ZESCO	Zambian Electricity Supply Commission
ZIMCO	Zambian Industrial and Mining Corporation
ZISCO	Zimbabwe Iron and Steel Company
ZK	Zambian kwacha
ZSBS	Zambia Steel and Building Supplies Ltd.

CHAPTER 1

THE ZAMBIAN ECONOMY

1.1 General economic trends

Zambia has an area of 752,000 square kilometres and a population of about 6.67 million (1985 estimate) which is growing at about 3.3 per cent per year. In 1985 mining remains the dominant industrial subsector in Zambia's economy, and the mining industry is a major employer, accounting for over 14 per cent of total employment.[1/] As such, the Government is dependent on mining revenues to finance its investment programmes for the development of other sectors of the national economy and for the diversification of the country's economic base. Of all minerals produced in the country, copper, with linkages to the rest of the domestic economy, is by far the most important, accounting for about 79 per cent of Zambia's total mineral export value, despite the downward trend both in the volume and unit values of copper exports. It represents 90 per cent of the overall mineral production in Zambia. The production of other minerals, such as cobalt and coal, is associated with the production and refining of copper.[1/]

Zambia's economy has been on a declining path since the mid-1970s when copper prices collapsed. It seems that Zambia's dependence on the copper industry for virtually all its export earnings is one of the causes of the country's current financial and economic difficulties. Most observers agree that Zambia's major problem over the last 25 years has been its inability to diversify away from copper.

Due to the collapse of copper prices, Zambia's economy registered its last positive growth rate in 1975. Low copper prices and high prices of oil led to balance-of-payments problems. Between 1974 and 1978, only a five-year span, Zambia's terms of trade deteriorated by 52 per cent. Industrial production has been on the decline since the mid-1970s.

The decline of mining results from deterioration in the grade of ore, scarcity of skills, and shortage of spare parts owing to foreign exchange constraints, which also caused growing capacity underutilization in the manufacturing industry due to a lack of financing for the importation ofraw materials and spare parts.

The Government in recent years has introduced a number of economic policy and institutional reforms which are significant steps towards a programme of rehabilitation and diversification in the Zambian economy. Rehabilitation and diversification projects were initiated with the objective of returning manufacturing industries to competitive economic strength, in view of the fact that a declining copper industry cannot be counted on to provide the domestic and external resources, which would be necessary to develop new sources of income, employment and foreign exchange. The lack of diversification and the high capital and import intensity of production, as table 1 shows, made the economy vulnerable to the prolonged scarcity of foreign exchange caused by low real copper prices. In the foreseeable future, real copper prices are not expected to recover to the levels that prevailed in the first half of the 1970s. Moreover, economically exploitable reserves of copper ore can only maintain present levels of production for another 15 to 20 years.

1/ Zambia, Country Economic Memorandum, Economic Reforms and Development Prospects. The World Bank, 1986.

Table 1: Import intensity in a sample of firms, by branch of industry, 1981
(Percentage)

Industry branch (number of firms)	Imported inputs as share of Gross output	Imported inputs as share of All intermediates	All inputs as a share of output
Food (5)	24.7	44.3	55.8
Textiles and footwear (4)	16.9	36.0	46.8
Wood and paper products (3)	24.2	71.1	34.1
Chemicals (6)	13.4	63.9	21.0
Metal products (6)	39.7	80.9	49.2
Total sample (24)	23.4	49.4	47.4

Source: World Bank, Zambia: Issues and Options in the Energy Sector, 1983.

Figure 1: Supply routes in southern Africa

Source: Africa Research Bulletin, 1988

The key to economic transformation will clearly be the expansion of agricultural production, which has been adversely affected by past policies and which now has significant potential in the form of a large land area suitable for both crops and livestock and an already substantial commercial agricultural sector. Agricultural surpluses are important both as a possible source of export earnings in the short as well as long run and for supporting industrial expansion based on local materials rather than on costly imported inputs.

The industrial sector also has an important role to play in Zambia's future economic development. If the economy is to become more independent both of imported goods and of copper exports, industrial and agricultural production must expand in a balanced, integrated way so as to meet a larger share of demand from domestic sources and to generate new export revenues. Prospects for industrial exports other than through processing are somewhat limited by the high cost of imported inputs imposed by Zambia's land-locked nature, by the lack of past export experience, and by competition from other industrial exporters in the region. The domestic market is also limited as well by its small size, with a population under 7 million, with a level GDP just over $2 billion in 1985 ($3.34 billion in 1983) and declining income per capita in recent years ($527 in 1983 and $400 in 1985).[1/]

In summary, the overriding issues are growth and capacity utilization. The basic problems are of a macro-economic nature: on the demand side, falling income per capita and declining production in mining and construction; on the supply side, lack of growth in foreign exchange earnings needed for imported inputs and weak incentives to domestic producers of raw materials.[2/]

In the future, the economy will have to rely more heavily on growth and diversification of exports and on direct private investment. However, a long-term strategy for growth and diversification will require both high levels of savings and productive investment and greatly increased efficiency in exporting and import-substituting activities. Zambia not only faces substantial debt problems but also suffers from a very low level of savings and capital formation as well as continued direct and indirect capital flight. These factors indicate the imperative need to rapidly increase the non-traditional exports of the country. Hence, foreign exchange earnings must increasingly originate in the non-mineral domestic economy. This need for structural change must be met by policies designed to promote balanced industrial and agricultural development. Only by steady improvement in economic efficiency and total factor productivity will it be possible for Zambia to meet the challenge of restoring sustained economic growth.

1/ World Bank, Zambia, Country Economic Memorandum, Economic Reforms and Development Prospects, 1984.

2/ See The regeneration of Zambian manufacturing industry with emphasis on agro-based industries (PPD/R 19, 14 October 1988) for a description of issues affecting agro-based industry in particular.

The first priority for the Zambian industry in the short- to medium-term must be to strengthen the performance of existing firms vis-à-vis rehabilitation and modernization of industrial facilities whose overall capacity utilization still hovers between 40 and 50 per cent during 1987. As table 2 indicates, capacity utilization of metal products, machinery and equipment is especially low, in comparison with other industrial sectors.

Table 2: Capacity utilization in parastatal manufacturing by branch of industry, 1972-1973 and 1982-1983
(Percentage of capacity)

ISIC Code	Industry Branch	Unweighted, Subsample a/		Unweighted all firms b/	Weighted, Subsample a/,c/		Weighted all firms b/,c/
		1972/73	1982/83	1982/83	1972/73	1982/83	1982/83
31.	Food, beverages and tobacco	45.5	60.0	55.6	45.5	53.3	65.8
32.	Textiles, wearing apparel and leather	67.0	80.0	80.0	67.0	80.0	80.0
33.	Wood & wood products	n.a.	n.a.	47.4	n.a.	n.a.	57.4
35.	Chemicals & chemical products	43.5	33.0	52.8	30.1	37.7	54.0
36.	Non-metallic mineral products	n.a.	n.a.	54.6	n.a.	n.a.	60.2
38.	Metal products, machinery & equipment	27.1	44.0	34.1	27.1	65.2	46.6
	ALL FIRMS	42.7	51.7	50.9	46.2	59.5	64.1

Source: ZIMCO, Corporate Budget, 1982/83, and 1983/84, and data provided to the mission. Data are not available for firms in industry branches 34, 37 and 39

a/ Subsample consists of eight firms for the unweighted average and seven for the weighted average; the eight represent 22 per cent of value added in all INDECO industrial firms in 1982/83.

b/ Twenty-five firms, nine of them in industry 31, representing 81 per cent of total INDECO value added in industry.

c/ Represents actual value added as a percentage of estimated value added at full capacity.

1.2 Economic situation in Zambia

1.2.1 Regional overview

African developing countries achieved only very modest economic growth in 1987. According to estimates of the United Nations Economic Commission for Africa (ECA), the continent's combined gross domestic product grew by just 1.5 per cent, only half the rate of population growth, and economic analysts fear that a slowdown in the already sluggish growth rate of the world economy could make African recovery even more difficult in 1988. The ECA figures show GDP per capita declining by about 1.5 per cent in 1987, continuing a contraction that has averaged 3.4 per cent a year since 1980. Living standards have continued to deteriorate in Zambia. The decline in GDP of 0.6 per cent per year since 1980 has led to a fall in the per capita real income index from 100 in 1980 to 84.2 in 1986. This trend continued through 1987.[1/]

Since the early 1980s, governments across Africa have been making far-reaching adjustments in their economic policies to cope with depressed commodity earnings and huge debts. According to World Bank figures pertaining to 1986, Zambia's long-term debt amounted to $3.5 billion and its total foreign debt reached $5.3 billion at the end of 1986. This debt is about three times as high as current GDP and exports of goods and services, as table 3 indicates.

However, the region's economy did not significantly improve in 1987 due to the unabating negative influence of exogenous factors and constraints on African economic performance, although some African subregions performed better than others in 1987 (North Africa had the highest growth rate, 2.5 per cent, followed by East Africa, 2.2 per cent, while both West and Central Africa saw their economies decline by 1.5 and 1.2 per cent, respectively).[2/]

Among these adverse factors were unfavourable weather, which damaged harvests in many countries, the continent's insupportable debt burden, the depressed level of capital flows to Africa, and continuously weak prices for most of Africa's export commodities despite the partial recovery for some commodities in depreciating dollar terms. Zambia has been affected by this environment, in that there were marked improvements in the export earnings as a result of higher copper prices in 1987, which peaked at $1,700 per ton during November/December. They are estimated to have gone up from ZK 4,294 to 5,247 million, or by 48 per cent. However, the positive developments that occurred during 1987 did not continue to the same extent in 1988, since the decline in demand and slower growth in major industrialized countries have had a dampening effect on prices of primary commodities. Most commodity prices are expected to fall by the first quarter of 1988. The Government expects copper prices to fall and therefore will have to envisage measures to contain shortfalls in the Government budget and deterioration in the balance of payments.[3/]

1/ Economic Report 1987. National Commission for Development Planning, Lusaka, Zambia.

2/ ECA 1988.

3/ Economic Report 1987, op. cit.

Table 3: External debt and debt service of African countries
(Millions of US dollars)

	Debt, end 1986						Debt service paid, 1986 [a]				Debt service due [a,b]	
	Long term	IMF credit	Short term	Total	% of GNP	% of exports of goods & services	Principal	Interest	Total	% of exports of goods & services	1987	1988
Algeria	14,777.0	--	3,152.1	17,929.1	30.4	178.9	3,905.3	1,249.7	5,155.0	51.5	5,320.8	4,901.4
Benin	780.6	—	109.0	889.6	61.8	321.6[c]	35.8	21.8	57.6	9.2[c]	115.9	107.5
Botswana	355.1	—	3.0	358.1	36.5	34.9	17.4	27.0	44.4	4.3	58.5	68.5
Burkina Faso	615.7	—	49.0	664.7	45.1	286.5	22.5	11.8	34.3	14.8	47.8	51.3
Burundi	527.7	—	23.0	550.7	46.1	336.8	19.1	12.1	31.1	19.0	40.8	42.2
Cameroon	2,772.2	—	760.8	3,533.0	32.4	132.1	178.9	120.6	299.6	11.2	353.1	366.4
Cape Verde	107.4	—	5.3	112.7	72.1	. . .	2.4	1.9	4.2	. . .	10.0	10.8
Central African Republic	392.6	33.1	27.0	452.7	45.9	236.4	9.0	9.0	17.9	9.4	33.2	36.9
Chad	171.8	8.6	7.0	187.4	23.1	154.2[c]	1.6	1.6	3.2	7.5[c]	7.4	7.5
Comoros	156.0	—	5.0	161.0	99.4	561.1	1.0	0.8	1.8	6.4	9.2	9.3
Congo	2,860.7	11.6	661.8	3,534.1	178.1	494.4	232.3	78.6	310.9	43.5	634.1	805.5
Côte d'Ivoire	9,455.2	622.9	787.0	10,865.1	122.7	293.4	253.3	531.9	785.3	21.2	968.1	1,148.8
Djibouti	119.1	—	6.0	125.1	. . .	. . .	4.2	3.0	7.3	. . .	12.2	13.0
Egypt	23,735.2	30.6	4,789.0	28,555.8	74.3	349.6	1,033.8	702.5	1,736.3	21.3	3,339.7	2,909.2
Equatorial Guinea	141.0	6.6	3.9	151.6	. . .	. . .	3.1	1.4	4.5	. . .	17.9	17.2
Ethiopia	1,989.1	66.4	83.0	2,138.5	38.3	260.5	125.2	51.6	176.8	21.5	215.4	217.6
Gabon	1,094.7	33.5	439.7	1,568.0	53.1	128.9	147.8	61.2	209.1	17.2	319.8	324.1
Gambia, The	228.0	21.0	24.0	273.0	158.1	290.5	5.4	5.3	10.6	11.3	15.1	20.4
Ghana	1,412.9	747.6	224.0	2,384.6	42.3	291.3	60.3	28.3	88.7	10.8	106.0	105.4
Guinea	1,421.1	25.4	69.0	1,515.5	. . .	. . .	84.2	18.8	103.0	. . .	162.0	164.7
Guinea-Bissau	293.8	2.3	10.9	306.9	190.1	1,906.5	6.7	2.0	8.7	54.1	27.5	29.6
Kenya	3,700.5	431.1	372.0	4,503.6	67.6	243.4	255.8	174.1	429.8	23.2	469.4	462.0
Lesotho	182.1	—	4.0	186.1	29.8	56.9	9.6	4.2	13.8	4.2	13.0	18.0
Liberia	1,001.8	251.3	50.0	1,303.1	128.8	280.8	13.2	14.6	27.7	6.0	114.9	115.2
Madagascar	2,634.5	183.9	80.4	2,398.9	116.2	708.4[c]	50.9	62.4	113.3	29.9[c]	357.1	334.7
Malawi	909.7	124.0	80.0	1,113.7	90.4[c]	412.8	72.0	36.0	108.0	40.0	90.9	88.4
Mali	1,565.7	84.9	65.0	1,715.6	104.9	692.1	22.6	12.6	35.2	14.2	63.5	66.9
Mauritania	1,637.2	36.1	87.8	1,761.1	234.6	387.1	46.2	31.0	77.2	17.0	194.8	215.4
Mauritius	448.6	157.6	38.0	644.2	47.9	72.9	36.1	28.3	64.4	7.3	69.5	83.5
Morocco	14,610.3[c]	1,026.4	2,189.0	17,825.7[c]	103.9[c]	413.9[c]	699.2	742.3	1,441.5	40.8	2,317.7	2,503.0
Niger	1,250.5	88.1	120.8	1,459.4	72.5	393.3	55.4	36.6	92.1	24.8	107.4	133.0
Nigeria	21,546.3	—	330.0	21,876.3	45.5	309.2	1,233.2	391.2	1,624.4	23.0	1,875.9	5,426.7
Rwanda	411.9	—	27.0	438.9	23.9	185.9	12.6	5.2	17.9	7.6	23.3	22.9
São Tomé and Principe	74.2	—	1.0	75.2	174.1	692.1[c]	1.2	0.6	1.8	36.9[c]	9.4	8.8
Senegal	2,471.2	246.6	272.0	2,989.8	84.3	302.2[c]	110.9	98.0	208.8	10.9[c]	267.4	352.1
Seychelles	67.3	—	38.9	106.2	47.5[c]	81.5	6.2	2.8	9.0	6.9	10.1	11.0
Sierra Leone	459.1	71.7	59.0	589.8	51.9	339.0	10.5	4.0	14.5	8.4	28.5	50.9
Somalia	1,414.8	145.2	20.0	1,580.0	84.1	975.3	53.9	18.1	72.0	44.4	198.7	99.9
Sudan	7,057.0	740.4	474.5	8,271.9	113.6	1,145.7	23.6	31.8	55.4	7.7	668.6	871.5
Swaziland	207.7	6.9	17.0	231.6	50.9	66.2	14.9	9.9	24.8	7.1	26.6	29.8
Tanzania	3,649.7	45.3	260.2	3,955.3	92.5	864.4	42.8	26.4	69.2	15.1	274.7	331.5
Togo	882.0	80.8	87.0	1,049.7	110.6	264.0	85.9	42.4	128.3	32.3	145.2	125.2
Tunisia	5,251.3	183.1	553.0	5,987.4	70.1	218.6	506.8	286.5	793.2	29.0	930.1	981.4
Uganda	928.8	229.3	34.9	1,193.0	. . .	271.5	16.1	12.6	28.7	6.5	114.0	108.2
Zaire	5,429.9[d]	786.4	318.0	6,534.3[d]	96.8[c]	266.8[c]	141.7	228.1	369.7	18.2	788.4	819.0
Zambia	3,574.7	825.0	900.0	5,299.8	356.5	326.1	69.1	54.5	123.6	7.6	520.1	488.1
Zimbabwe	1,757.6	233.7	489.0	2,480.3	46.9	145.9	221.4	117.1	338.6	19.9	403.5	361.7

[a]On long term, public and publicly guaranteed debt, excluding IMF. [b]Debt service due on contractual obligations as of end 1986, i.e. exclusive of subsequent rescheduling or new borrowings. [c]1985. [d]Excluding private, non-guaranteed debt. [e]For public and publicly guaranteed long term debt only.
Source World Bank, *World Debt Tables*

The main objectives of the 1987 Annual Plan, according to the Government's Economic Report 1987, are to improve agricultural production, create alternative employment opportunities, stabilize prices, diversify exports, reduce the Government budget deficit, readjust technical and local manpower administrative procedures, and attain a 3.2 per cent growth rate in real GDP. However, the implementation of the Annual Plan for 1987 was abandoned due to the unfavourable economic situation. In order to attain this growth rate target in the years to come, however, Zambia requires substantial change in the investment and consumption/saving behaviour of both the public and private sector.

Real GDP nevertheless declined by 0.2 per cent in 1987, while GDP at current prices grew by 39.6 per cent as compared to 0.6 per cent and 83.2 per cent growth, respectively, in 1986. The other negative development was the further increase in money supply which encouraged inflation in 1987. During 1986 the inflation rate averaged 83 per cent; sectoral inflation rates were 113 per cent for mining, 82 per cent for manufacturing and 63 per cent for agriculture. No sector had an inflation rate lower than 11 per cent. The inflation rates increased in 1987, although the inflation rate for the sector fell to 80.9 per cent in 1987 compared to 114.5 per cent in 1986. This has been caused by past and present deficit financing, which absorbs a large share of domestic credit.

The pattern of distribution of gross domestic consumption worsened during 1987, despite the increased share of private consumption. Gross capital formation and the share of Government consumption both fell in real terms. Net export of goods and services rose slightly, from 0.6 per cent in 1986 to 1.8 per cent of GDP during 1987.

In order to restore economic growth, Zambia urgently needs to realize a positive rate of savings and capital formation, which have been negative for quite some time. Once a country has started a growth process again, a substantial part of the increment in GDP should be reserved for savings and investment, rather than consumption purposes and interest payment on past debts. The interlinkage with the debt problem goes further, because a large part of investments can only be realized by importing capital goods from abroad. Further increases in export proceeds will therefore be needed not only for interest payments, but also for imports of capital goods. For both reasons exports have to grow rapidly and imports of consumption goods have to be kept to a minimum. Production needs to be restructured towards diversification, with more exports of non-mineral goods, as well as greater use of domestic raw materials and successful import substitution.

1.2.2 Sectoral overview

The foundation for Zambia's structural adjustment effort has been laid in the 1987 Annual Plan. The process of restructuring productive enterprises and realizing new investment in economic ventures, particularly in the major productive sectors of agriculture, mining and manufacturing can now proceed in a manner that reflects an internationally competitive and efficient allocation of resources.

Table 4 shows growth rates in constant prices for six major sectors of the economy except for services from 1984 to 1987.

Table 4: National accounts in Zambia, 1984-1987

	1984	1985	1986	1987
(Percentage change in GDP over previous year, in constant prices)				
1. Agriculture, forestry and fishing	5.6	3.5	8.7	-1.3
2. Mining and quarrying	-9.8	-7.1	-5.0	1.3
3. Manufacturing	1.2	8.3	0.9	2.3
4. Electricity, gas and water	-1.8	2.5	-2.2	-2.7
5. Construction	0.0	-13.0	5.2	-4.7
6. Transportation, storage and communication	-2.7	-6.0	0.8	-2.3
7. Others	-2.0	1.8	-1.6	-0.9
Total gross domestic product	-0.4	1.6	0.6	-0.2
(Percentage distribution by sector)				
1. Agriculture, forestry and fishing	16.5	16.8	18.2	18.0
2. Mining and quarrying	9.9	9.1	8.6	8.7
3. Manufacturing	1[illegible]4	20.6	20.7	21.2
4. Electricity, gas and water	[illegible].5	3.6	3.5	3.4
5. Construction	4.4	3.8	3.9	3.8
6. Transport, storage and communication	5.8	5.3	5.4	5.2
7. Others	40.5	40.8	39.7	39.7
Total gross domestic product	100.0	100.0	100.0	100.0

Source: Government of Zambia, National Commission for Development Planning, Economic Report 1987, Lusaka.

In agriculture, the growth rate declined by 1.3 per cent in 1987 in real terms. This is attributable to continuous drought, lack of spare parts, untimely delivery of fertilizer, rapid policy changes, etc. Notwithstanding the recent production increases and some shift in the sources of output growth, the development of Zambia's agriculture remains far below its estimated potential of an estimated 60 million ha. Only about 12 million ha, or 20 per cent of the arable land, is currently cultivated, even though the climate is generally favourable for the cultivation of a wide range of crops.

Consequently, the agricultural sector's contribution to the diversification of the economy has remained minimal, as indicated by its small share of real GDP and the lack of development of significant new export commodities.[1/]

Clearly the agricultural sector will play a crucial role in providing the local resources needed for the full realization of the reforms recently introduced by the Zambian Government. Zambia certainly does have the potential to become a relatively large net exporter of agricultural products, although the realization of its agricultural potential requires further changes in existing policies and institutions[2/] since land is freely available and the national economic cost of land utilization is zero. The costs of cultivating unutilized arable land are limited to the development costs (clearing, etc.). This advantage over other countries indicates that Zambia has a potential comparative advantage in exporting agricultural products. However, there is substantial underutilization of animal-drawn agricultural tools and machinery used mainly by small farmers.

According to the World Bank's analysis of comparative advantage in the agricultural sector[3/], small farmers, despite the dualistic structure of the agricultural sector, are generally more efficient users of domestic resources than large-scale farmers (commercial and state farms) which tend to be highly dependent on imported inputs (fertilizer, machinery, manpower). This analysis concludes that direct state involvement in production, in the form of state farms, is very difficult to justify on the basis of static comparative advantage. Large-scale commercial farming should concentrate on production of commodities in which they appear to have an obvious comparative advantage, namely oil-seeds, wheat, dairy products and tobacco. On the other hand, small farmers are efficient producers of almost all export and import-substitution crops, and future long-term policies should be directed at maximizing production from this resource. At present, the main constraint for the commercial, large-scale farming sector is the general scarcity of foreign exchange for spare parts and imported inputs. The main constraint for the small farmer sector is the lack of appropriate technical packages.

Constraints on the development of the agricultural sector have been imposed by the commercial sector's falling growth rate over the past several years. There is also a relatively high degree of capacity underutilization in the large-scale farming sector. Both smallholder and large-scale farming suffer from inadequate supply of imported inputs such as spare parts and machinery, in addition to unavailability of irrigation equipment.

1/ World Bank, Zambia Country Economic Memorandum - Economic Reforms and Development Prospects, 1986.

2/ World Bank, Zambia Country Economic Memorandum - Issues and Options for Economic Diversification, 1984, p.33.

3/ Ibid.

These problems can be partially solved through the development of new projects and the rehabilitation of existing industries for the production of agricultural machinery and implements. Foundries and forges are the main metallurgical industries needed for the promotion of agriculture.

Foundries and forges can in fact create an industrial base for the manufacture of a wide range of agricultural and irrigation machinery and equipment. Unlike Ethiopia, which does not produce any basic machinery and equipment related to water supply and irrigation requirements as well as agricultural implements, due to lack of core metal-working industries, Zambia has enough foundries. Substantial rehabilitation would however be required, at the same time increasing the number of forging shops for the manufacture of a wide range of agricultural implements, irrigation equipment, etc.

The Zambian Government aims at achieving food self-sufficiency and at boosting agricultural exports and inputs to industry as part of the process of restructuring the economy away from dependence on copper. The agricultural sector, which has perhaps the greatest unfulfilled potential, is receiving public attention. However, agriculture still has the difficult task ahead of more than doubling its share of GDP in order to have any chance of eventually replacing the mining sector.

The following constitutes a sector-wide analysis of industries as suggested by the Economic Report 1987.

The mining sector grew by 1.3 per cent in 1987, as compared to a decline of 5 per cent in 1986. The main factors responsible for the sector's growth include the completion of the Tailings Leach Plant III, stabilization of exchange rates and a 20 per cent rise in copper prices, which had been depressed in the international mining market for a long time. The Tailings Leach Plant III is expected to add an additional 44,000 tons per year to exports. It is now well on its way to achieving a planned throughput of 50,000 tons of tailings, and is expected to yield 550,000 tons per year over a period of 15 years.

In the coal mining industry, 552.2 tons of coal were produced in 1986 and 365.5 tons by the third quarter of 1987. In 1986 coal exports amounted to 8,600 tons, and rose to 36,000 tons in 1987, the increase being accounted for by exports to Tanzania.

The total production of coal is expected to decline in 1987. However, output for the domestic market is expected to increase due to improvements in equipment availability achieved through the rehabilitation programme. The commissioning of a new coal washing plant has enhanced the quality of output. The demand for coal within the country was met, and coal sales to Tanzania, Zaire and Malawi increased from 9,000 tons in 1986 to 35,000 tons in 1987. Exports of coal earned the country $1.7 million in 1987. Coal output is expected to reach levels in excess of 600,000 tons in 1988.

In 1988, the Mineral Resource Development Programme is expected to continue along the lines of 1987. Furthermore, an in-depth study of the TAZARA Corridor is planned, as well as a detailed feasibility study on exploitation of Nambala iron ore, for exploitation together with Naamba coal and local lime inputs is planned. The establishment of an image processing centre, a full-scale computer-assisted mineral inventory, gemstone evaluation and pegmatite studies are also expected. In addition, the report says, the Government will continue to tackle outstanding problems which presently block mining development. These problems concern such issues as inadequate funding of mineral resource development activities, inadequacy of transport in key areas and shortage of pollution control equipment which is especially required in the mining area.

As for pollution control, especially in the copper mining activities as in other mineral mining, copper mining can affect the water resources of the area. The water table can be changed by mining activities, and there is also a problem of water contamination. The most conspicuous environmental hazard is the large-scale emission of sulphur dioxide, which accompanies the smelting of sulphide ores. In old plants emission control is technically difficult and solutions would be very costly. Modern smelting techniques allow the capture of the sulphur dioxide, usually as sulphuric acid, economic short-term profit might have to be carefully weighed against long-term environmental investment although economically it does not always make sense.

The manufacturing sector[1/] grew by 2.3 per cent in 1987, an increase over the 0.9 per cent growth rate in 1986. Consequently, this sector's contribution to GDP rose from 20.7 per cent in 1986 to 21.2 per cent in 1987. The main factors responsible for the sector's improved performance are the judicious allocation of foreign exchange by the Foreign Exchange Management Committee (FEMAC) which led to improved capacity utilization in selected industries; the stabilization of exchange and interest rates; and the ongoing managerial programme for state and parastatal organizations. FEMAC continues allocating foreign exchange with a view to increasing capacity utilization of existing industrial facilities.

In the manufacturing sector, capacity utilization was 45 per cent in 1986/87, as compared to the 42 per cent rate achieved in 1985/86. Increased allocation of foreign exchange for importation of raw materials and spares contributed to improved output in the sector in 1986/87. The marked sensitivity of domestic manufacturing production to fluctuations in the availability of foreign exchange is reflected in Zambia's unbalanced industrial pattern; very few manufacturing enterprises were designed to utilize domestic material and to develop linkages with other sectors of the economy, such as agriculture and capital goods.

Table 5 shows the performance of some of the manufacturing branches for the period 1983 to 1987. The index of industrial production shows a relatively poor performance for basic metal industries in comparison with other manufacturing industries. A relative decline in production output was registered in other metal products (-2.1 per cent). The aggregate figures show an improvement of total manufacturing output (+10.4 per cent) in 1987 as compared to 1986.

1/ See Regeneration of Zambian manufacturing industry with emphasis on agro-based industries (PPD/R. 19) for additional information on the manufacturing sector, including concrete recommendations addressing the problems identified.

Table 5: Index of industrial production, 1983-1987
(Base year 1973 = 100)

Subsector	1983	1984	1985	1986	1987
Basic metal industries	95.0	97.1	93.2	88.5	57.1
Other metal products	67.7	82.5	96.8	92.1	90.8
Total manufacturing	95.1	91.9	103.0	101.9	112.3

In the context of the present report it is particularly relevant that the share of fabricated metal products increased from 12 per cent in 1965 to 18 per cent in 1974, as shown in Table 6. This indicates a diversification in the manufacturing sector, with an increasing share of intermediate and capital goods production. The setback of fabricated metal products after 1974 was partly due to the fact that the processing of local raw materials for the manufacture of semi-finished copper and alloy goods (sheets, bars, profiles and pipes) of the copper and copper-alloys programme did not materialize as in the past.

Table 6: Composition of manufacturing production, 1965-1987
(Percentage shares of GDP in producer's values at current prices)

Subsector	1965	1974	1985	1986	1987
Basic metal products	9	2	1	1	1
Fabricated metal products	12	18	18	18	18
Non-metallic mineral products	13	4	7	7	6
Rubber products, chemicals etc.	8	16	10	10	9
Paper, paper products	4	4	5	5	6
Wood and wood products	5	4	3	3	3
Textiles and wearing apparel	8	10	14	14	15
Beverages and tobacco	27	35	34	34	34
Food manufacturing	14	6	8	8	8
Total manufacturing	100	100	100	100	100

Sources: National Accounts Statistics, various issues; Economic Report 1987.

The electric, gas and water sector in 1987 further declined by 2.9 per cent, as compared to 2.2 per cent in 1986. The main reasons for this poor performance included loss of the Zimbabwean market, shortage (or high prices) of domestic electrical appliances and high unit price of electricity, which forced consumers to cut down on consumption. Table 7 shows the electricity generation for a comparable period of ten months from 1985 to 1987 (these figures exclude small hydro and diesel generators).

Table 7: Electricity generation, 1985-1987
(Megawatts)

	1985	1986	1987
Kafue Gorge	4,553	4,763	2,645
Victoria Falls	586	560	364
Kariba North	3,064	2,653	1,568
ZCCM	143	10	18
Total	8,346	7,986	4,578

Source: Economic Report 1987.

Table 7 shows that in 1987 electricity generation fell to 55 per cent of the 1985 level. The greatest decline came from Kariba North which reduced output by 48 per cent, as opposed to 42 per cent for Kafue Gorge. These reductions are accounted for by drastic cuts in power exports to Zimbabwe. Power exports fell by 11.6 per cent in 1986 to 68.5 per cent in 1987 over the 1985 levels. The reduction not only shows a drastic loss of export revenue to ZESCO, but overinvestment in hydroelectricity. Zambia should therefore consider how to optimize the use of electricity generated by this source. The serious deterioration of power demand and the adverse operational conditions, coupled with a general rise in the price of spare parts power equipment, call for the localization of power equipment production and for boosting the domestic consumption of electric power in the medium term.

Zambia has a gross hydroelectric generating capacity of 58.3 million KWh per year. Present capacity uses only about 35 per cent of the potential of the Zambezi and Kafue rivers. Installed generating capacity is 1,728 MW, all hydro, apart from a small coal and diesel-fuelled thermo-generating capacity of 190 MW, and hydroelectric power accounted for 98 per cent of the 9,806 million KWh of electricity generated in 1984. Most of the electricity is generated by the Zambia Electricity Supply Commission (ZESCO), which operates two hydroelectric power stations, and the Central African Power Committee (CAPCO), jointly Zambian-Zimbabwean operator of the Kariba hydro stations on both sides of the Zambezi. ZESCO incurred a loss in 1985/86 due to lower power exports to Zimbabwe, reduced demand from the mining industry and arrears from CAPCO.

The construction sector also declined by 4.7 per cent, as compared to a 5.2 per cent growth rate in 1986, because of a continuing fall in real Government consumption as a proportion of GDP.

The transport, storage and communications sector declined by 2.3 per cent in 1987, as compared to 0.8 per cent growth in 1986. Shortage of foreign exchange to import spare parts and new vehicles, and management problems of TAZARA and Zambia Railways contributed to the bad performance. Furthermore, Zambian Railways latter seriously suffered from accidents.

Zambia is land-locked and nearly 2,000 kilometres from the nearest port. The country suffers difficulties with the import routes for its vital spares and equipment and with the export routes for its metals. The main route for imports and exports is via the Tanzanian port of Dar es Salaam, and the link to Dar es Salaam is the Tanzania-Zambia Railway (TAZARA), built in the early 1970s and commissioned in 1974. It provides a direct link of approximately 1,860 kilometres length between the port and Kapiri Mposhi in the Zambian midlands, where it joins the Zambia Railways system for routes to the Copperbelt as well as to Zimbabwe and Zaire. The railway is currently benefiting from a $160 million rehabilitation programme financed by the European Development Fund, designed to resolve its operational problems. Since the initiation of this scheme in 1984, the work done on rehabilitating the tracks, re-powering the locomotives and refurbishing the rolling stock has enabled the railway to perform to acceptable levels. The arrival of 17 new locomotives and 365 new railwagons over the next two years should increase TAZARA's capacity. TAZARA's upgrading has been a priority project of the Southern African Development Co-ordination Conference (SADCC), of which Zambia is a member, in line with the organization's aims of reducing economic dependence on South Africa (see Figure 1). The route is now carrying an average of 85 per cent of Zambian exports, of which 90 per cent are copper. Import tonnages are lower, at around 40 per cent, reflecting in part the fact that many of Zambia's imports come from South Africa itself. Imports directly sourced in South Africa have, however, proved more difficult to reduce, in part due to Zambia's foreign exchange shortages which force companies into emergency situations in which delivery times become the paramount consideration.

The Zambian Consolidated Copper Mining Company (ZCCM), in an effort to improve transit times to the ports and save on transport costs, decided in 1986 to utilize the port of Beira, which used to be the main outlet for Zambian metals before the commissioning of the Dar es Salaam route. ZCCM is currently undergoing rehabilitation which will go a long way towards improving Zambian export and import management. The recent introduction of unit trains has reduced the average travel time to Dar es Salaam and Beira to six and ten days, respectively, thereby expediting receipt of sale proceeds.

A third highway programme is also in progress, aimed at upgrading and rehabilitating the national road network, which was expanded to a total of over 37,000 kilometres by 1984, of which about 40 per cent were all-weather roads. Zambia has 18 commercial airports, with Lusaka International Airport opening in 1967. It is in serious need of rehabilitation and modernization, and a pertinent Japanese-financed feasibility study is in progress.

1.3. Plant level information

Detailed information is given below on the seven metal-working companies in Zambia for which information is available.

In 1987, LENCO manufactured 7,832 pieces of metal/tubular furniture, 885 trailers and 11 buses and bus bodies. The major reason for this low production is the heavy cash outlay required to import raw materials. LENCO planned to produce 12,600 metal/tubular furniture, 982 trailers and 33 buses and bus bodies during 1987/88.

Zambia Metal Fabricators Limited (ZAMEFA) has an installed capacity of 10,000 tons of copper rod, 2,200 tons of copper wire cables and 1,300 tons of copper aluminium shapes per year. In 1987 it produced 6,899 tons of copper rod, 1,382 tons of wire cables and 217 tons of copper aluminium shapes. The major constraints on production output are high transport costs, high maintenance costs due to the wear and tear on machinery, severe competition in the export market, and reduced buying activities by Zambia's Consolidated Copper Mines. For 1987/88, ZAMEFA planned to manufacture 74,000 tons of copper rod, 1,950 tons of wire cables and 360 tons of copper aluminium shapes.

MONARCH manufactures welded wire products, geysers, cans and wheelbarrows. The company has an installed capacity of 57,600 rolls of welded wire products, 4,000 geysers, 3 million cans and 13,200 wheelbarrows per year. In 1987 it produced 15,000 rolls of welded wire products (26 per cent of the utilization rate), 3,000 geysers, 221,000 cans (7 per cent of the utilization rate) and 3,000 wheelbarrows (23 per cent of the utilization rate). The company's major constraints are stagnation of real estate investment (which reduces demand for window/door frames and geysers) and severe competition from the private sector, especially for cannned products. The targeted production for 1987/88 was 14,150 rolls of welded wire products, 6,350 geysers, 600,000 cans and 3,000 wheelbarrows.

NATIONAL DRUM AND CAN MANFUACTURERS has an installed capacity of 500,000 drums, 1.4 million regular cans and 6 million 84-mm cans. In 1986/87, 13,000 drums (3 per cent of the utilization rate), 464,000 regular cans (33 per cent of the utilization rate) and 166,000 84-mm cans (3 per cent of the utilization rate) were manufactured. The company faced stiff competition from Zimbabwe and had insufficient funds to import raw materials. The plan for 1987/88 was to produce 75,000 drums, 600,000 cans and 2 million 84 mm cans. Other metal products include those manufactured by assembly plants and small equipment producers.

The LIVINGSTONE MOTOR ASSEMBLERS COMPANY has an installed production capacity of 2,000 saloon Fiat cars, 300 Peugeot cars and 300 for refurbishing. In 1987 it assembled 97 Fiat cars, 49 pick-ups and 196 Peugeot cars; 32 cars were refurbished. The major reasons for this low production output are the inadequacy of Kwacha for obtaining foreign exchange, inflexible models and scarcity of consumable materials like thinners and paints. The planned production level for 1987/1988 was 288 saloon Fiat cars, 48 pick-ups, 288 Peugeot cars and 48 cars for refurbishing.

LUANDA INDUSTRIES has an installed capacity of 80,000 standard men's 22-inch bicycles. In 1987, only 12,696 bicycles were assembled. Inadequate working capital, ineffective dealer network and poor factory location prevented optimum machine utilization and thereby contributed to the low production. The target for 1987/88 was to produce 18,000 standard men's 22-inch bicycles and 9000 carriers.

KAFIRONDA Limited produces nitroglycerine explosives, ammonium nitrate and fuel oil (ANFO) explosives, capped fuses and improved explosive devices (IED). The installed capacity for nitroglycerine explosives is 762,000 cases, 762,000 bags of ANFO, 8,890,000 capped fuses and 2,540,000 IEDS. The production in 1987 was 512,000 cases of explosives, 613,000 bags of ANFO, 6,088,000 capped fuses and 2,547,000 IEDS. The continuous inadequacy of

raw materials and lack of spare parts for maintenance operations are some of the problems affecting production at the plant. The targeted production for 1987/88 is 475,000 cases of nitroglycerine explosives, 650,000 bags of ANFO, 5,336,000 capped fuses and 2,500,000 IEDS.

1.4 Conclusions

Among the factors which have hindered economic growth are inefficiency in the management of enterprises, and scarcity of raw materials, spare parts and machinery, all of which could be improved through rehabilitation and modernization of and investment in the productive sectors. This means that Zambia's prospects for growth in the productive industries heavily depend on thoughtfully selected investment. Economic rehabilitation and growth depends not only on the amount of official development assistance (ODA), but also to an increasing extent on direct foreign investment, which bears the advantages of technology transfer and exemption from debt service as such.

While trying to expand its export base by encouraging non-mineral exports such as agricultural products and manufacturing goods, Zambia must obtain a sustained flow of foreign exchange from its declining copper industry in order to carry out the restructuring of its economy over the next decade. It is essential that high levels of efficiency be restored to enable both the copper mining and the copper product industry, significantly underutilized over the last ten years, to become profitable again. Without a rehabilitated copper industry, the Government's efforts would fail for lack of financial resources, since mining value added has been on a downward trend since the mid-1960s. As shown in table 8, the share of mining in GDP dropped from over 40 per cent in 1965 to about 14 per cent in 1986, in contrast to the relatively improved performance of other industries and services.

Table 8: Structure of production between 1965 and 1986
(Percentage share of current GDP)

	1965	1970-1974	1975-1979	1980-1984	1985	1986
Agriculture	14	12	15	14	15	15
Mining	40	30	15	14	14	14
Other industries[a/]	13	21	25	24	25	25
Services	33	37	45	48	46	46
GDP, market prices	100	100	100	100	100	100

Source: The World Bank, Economic Development Report, 1987.

a/ "Other industries" includes manufacturing, construction, electricity, gas and water.

The shift in production structure which is indicated in table 8 is not, however, an indication of significant diversification in industries neither in terms of value added nor of export earnings. First, the agricultural sector, which has the greatest potential for employment, income and export growth, has remained of limited importance with its contribution to GDP varying between 12 and 15 per cent over the past two decades. Second, mining has continued to provide more than 90 per cent of foreign exchange earnings since 1965, and currently contributes 14 per cent of GDP.

However, the overriding long-term constraint on copper mining is the depletion of economically recoverable ore reserves. Despite extensive mineral surveys, there are no known ore bodies in the Copperbelt large enough to offset the natural depletion of existing mines in the 1990s. In spite of this, Zambia has to rely on copper revenues to finance its investment programmes for the development of other sectors of the national economy and for the diversification of the country's economic base.

To this end, ZCCM prepared a Five-Year Production and Investment Plan to guide its rehabilitation efforts during 1986-1990. In order to maximize the company's long-term contribution to the development of the country, ZCCM launched an export, rehabilitation and diversification project to direct the company's plans. The objectives of export rehabilitation were to arrest the deteriorating production output of the company, to restructure manpower and to rationalize operations and rehabilitate plant and equipment. The introduction of a Five-Year Production and Investment Plan has facilitated the rationalization of Zambia's copper mining industry and has shown its first positive results in 1987.

CHAPTER 2

REHABILITATION OF THE COPPER MINING INDUSTRY

Copper is the most important mineral resource in Zambia, which produces and exports about 500,000 tons of copper per year. Reducing this dependency will be a long-term process. Meanwhile, the country badly needs foreign exchange to pay interest on its foreign debt, to restructure the economy and to import capital goods. Priority should therefore be attached to deriving the highest possible return from the copper sector.

2.1 Identification of problems

In the early 1980s, in view of the increasing problems facing the Zambian mining industry and the need to rationalize operations and administration, Nchanga Consolidated Copper Mines Limited (NCCM) and Roan Consolidated Mines Limited (RCM) were merged to form Zambia Consolidated Copper Mines Limited (ZCCM). A thorough review of the company's operations was also made, and an export, rehabilitation and diversification project was initiated in 1980 with the objective of returning the industry to competitive economic strength.

Three consulting firms were employed to carry out studies of ZCCM's operations: Fluor Mining and Metals Inc. for the mining sector, Bechtel Civil and Minerals Inc. for metallurgical operations, and SRI International for investment decisions, maintenance and replacement of plant, materials, management, and accounting. In addition, ZCCM investigated the scope for improving information and reporting systems and the need for a comprehensive training programme with the assistance of Booz, Allen and Hamilton, Inc.

The consultants recognized the many serious problems facing ZCCM - low metal prices leading to reduced foreign exchange receipts, heavy taxation and a heavy debt servicing burden. The reduced earnings had eroded the company's productive capability by decreasing the availability of funds for repairs and equipment replacement. Shortage of spares and inputs and deferral of normal replacement programmes had reduced underground development and surface overburden removal to critically low levels, placing the future production capability of ZCCM in jeopardy. There was a scarcity of skilled personnel, and an imbalance in numbers between skilled and unskilled labour.

2.2 Rehabilitation plan for ZCCM

Six elements were identified as being necessary to ZCCM's survival:

(a) restoration of productive capacity;
(b) allocation of resources to areas of greatest financial return;
(c) government support in the removal of external constraints;
(d) improvement of employee productivity;
(e) reinforcement of cost reduction and income generation efforts;
(f) continuation of the diversification programme.

The bulk of spending is directed at rehabilitation and occurs in the first two years of the plan. Much of the financing for these projects was provided by loan facilities already in place. The remainder is covered by internally generated funds. A cash shortfall in the first three years is more than offset by surpluses in the fourth and fifth year of the plan and the agreed abolition of the much criticized mineral export tax will have a favourable impact on the cash flow of the plan from January 1988 onwards. A rise in the copper price over the minimum required by the plan, combined with higher than budgeted production, has optimized the first year's results.

ZCCM achieved an operating profit in 1986/87. Under the plan, projected copper output peaks in 1988/89 at over 580,000 tons, while output of cobalt will be tailored to the market at something over 4,000 tons/year. The Nchanga open pit remains the most critical factor to the achievement of the company's production plans and a significant build-up of fully developed reserves is needed to match increased production rates from the underground mines. Achievement of the projected improvements is dependent on the continuing successful implementation of the action plans relating to operating performance. These include continuous monitoring and updating of plans to streamline the corporate management structure; increased responsibility and accountability of divisional management; improved mining efficiency; tightened up materials management; review of engineering maintenance systems; and reduced manpower needs resulting from more effective training.

In order to maximize ZCCM's contribution to economic development, rationalization was found to be necessary. This involves closures and cut-backs at a number of installations. Konkola no. 3 shaft, Chambeshi mine and the Kansanshi open pit have been temporarily closed because of insufficient availability of foreign exchange to fully service all ore sources. Metallurgical plants are also affected, with the Luanshya smelter, Ndola copper refinery tankhouse, Cahmbeshi concentrator and Nkana oxide concentrator all being placed on care and maintenance. The Kabwe mine was to be closed upon depletion of ore reserves in late 1987. The available financial resources are used first for those critical production areas that are essential to disrupt ZCCM's ability to maintain copper output at planned levels and then to areas that offer the greatest financial return. Accordingly, overburden removal at Nchanga open pit and the refurbishment of the Nkana smelter and acid plants are at the top of the list, to maximize output at the lowest-cost mining operation and to ensure adequate supplies of sulphuric acid to the massive tailings leach plants at Nchanga.

ZCCM's production comes from ten underground mines and three open pits at the company's following five producing divisions:

(a) The Nchanga Division

This division is ZCCM's biggest producer of copper, comprising Nchanga, Chambeshi and Konkola underground mines, the Nchanga open pit and its two satellites, the Luano and Chingola B open pits. Ore from these sources is treated at concentrators situated at Nchanga, Konkola and Chambeshi mines, and the resultant concentrates are processed at various plants in the Copperbelt. The open pit output is crucial to achievement of the Five-Year Plan, as it contributes some 25 per cent of ZCCM's projected output of copper.

The Konkola mine has the richest mineable reserves in the Copperbelt. Proposals are being studied for a 250,000 ton per day shaft from surface to the 1,200 metre level to exploit reserves thought to be in excess of 50 tons grading 4.5 per cent copper. In the meantime, production from Konkola no. 3 shaft has been suspended as part of the current austerity programme. The Nchanga Division produces 58 per cent of ZCCM's total output of copper and a sizeable proportion of its cobalt.

(b) The Mufulira Division

Of current ore reserves, some 55 tons grading 3.1 per cent copper are situated in the eastern portion of the mine, between the 880 and 1,540 metre levels. These reserves will be exploited at a rate of 4.2 tons per year for the rest of the life of the mine, which will last well into the next century. The completion of the 14-shaft extension and new sub-vertical Musombo shaft was due in May 1988. It will permit mining below the 880 metre level in the centre section of the mine in about 12 months' time. The construction of a new surface tailings dam, rehabilitation of the concentrator and a rebuilding of the electric furnace are all underway or scheduled to meet medium-term forecasts.

(c) The Nkana Division

The Nkana Division produces copper and cobalt from four ore sources: Mindola, the central shaft, the south ore body and Chibuluma. Its process plants include concentrators, cobalt plants, a smelter and a refinery, together with major sulphuric acid producing facilities on which the Nchanga tailings leach plant is virtually totally dependent. Further deepening of the Mindola subvertical shaft has commenced from the 4,440 metre level to the 5,660 metre level shaft bottom, a scheme which will be completed in 1993. Nkana has the largest complex of processing plants in the Copperbelt, but requires some of the most difficult mining operations in terms of depth, grade and developed reserves.

(d) The Luanshya Division

Luanshya was the first deep mine to be established in the Copperbelt. The adjacent Baluba mine started production in 1973. Both mines produce similar outputs of similar grade, except that Baluba ore also contains cobalt/iron. With the Luanshya smelter on a care and maintenance basis as a result of ZCCM's austerity programme, copper concentrates are treated at Mufulira and Nkana smelters and cobalt concentrate is routed to the Nkana cobalt plant. Combined output of the two mines is 5 million tons per year at an average grade of 1.45 per cent copper. Both mines have not yet fully developed their reserves yet due to a shortage of trained labour.

(e) The Kabwe Division

The Kabwe lead/zinc mine is in the final stages of exhaustion of economic reserves and will close before 1990. The small Nampunowe pyrite mine produces some 4,000 tons per year of concentrate for roasting at the Nkana acid plant.

CHAPTER 3

SUPPLY OF OTHER MINERALS AND SOURCES OF ENERGY

In order to more fully explore the potential and limitations of metallurgical industries and other ferrous materials, as well as the potential of combining them with other metals and non-metallic materials, there is a need to examine the availability of mineral and energy resources. For example, Venezuela is rich in natural resources, with the fifth-largest iron ore reserves in the world, mostly high grade ore, the thirteenth-largest natural gas reserves in the world and one of the largest hydroelectric dams in the world. All of these resources are close to each other, and together give Venezuela a competitive advantage for production of DRI (direct reduced iron). By comparison, Zambia does not have natural gas and oil (which are under exploration) but is rich in natural resources, including iron ore, coal, copper and electricity.

It is very important to know what is available for the development of metallurgical industries domestically, if a country wants to develop upstream and downstream industries in order to promote and encourage the effective utilization of local resources in metallurgical and related industries. Such an integrated approach to the development of the industry as a whole would help Zambia to improve the management of mineral resources, increase industrial production efficiency, and diversify industrial production in relation to metallurgical industries.

3.1 Iron ore

The objectives of mining development are, among other things, to expand small-scale mining operations in the country, to explore the raw materials base for production and to boost exports of mineral products. Zambia's iron ore reserves are estimated at 7 per cent of the total for Africa. Other essential raw materials for steel production - limestone and coal - are also available. The prohibitive cost of overland transport and of shipping to overseas consumers renders exploitation of most Zambian iron ore resources for export purposes unprofitable at present, as it is in many other African countries.

Zambia is, however, considering the establishment of a mini-steel plant for the production of steel rods, bars and light steel sections, using its own iron ore, to meet the requirements of the domestic market. There is a shortage of scrap, and steel supplies from Zimbabwe and Tanzania are unreliable. Due to lack of foreign exchange, metal-working industries are unable to import scraps/billets from overseas. The establishment of a steel-making plant based on domestic raw materials would solve these problems, and would also save foundries and forges from making basic metal products for among others, agricultural machinery and implements.

Any decision as to the exploitation of iron ore for the purpose of iron and steel production would be predicated on such considerations as: (a) economic extractability; (b) content of iron ore; and (c) viability of commercial-scale operations.

The most important iron minerals are the oxides - magnetite and hematite - and to a lesser degree hydrated (water-containing) oxides - limonite and goethite. The major known iron ore reserves in Zambia amount to 307 million metric tons, located at Nambula and Sanje (hematite 57 to 67 per cent iron), at Mpmba and Namantombwe (hematite and magnetite 44 to 60 per cent iron) and at Changwe (Magnetite 62 per cent iron).[1] These are considered economically extractable and the content is sufficient iron, but commercial-scale operations have not been tested.

The iron ore deposits of hematite and magnetite in Zambia, however, require different ore benefication/concentration technology and flow sheets. On the other hand, the magnetite iron ore will basically need wet magnetic separation treatment to reduce its silica content. Hematite iron ore, on the other hand, may need washing and gravity separation and possibly heavy media separation to produce high-grade concentrate. All these benefication/ concentration/pelletizing treatments need to be fully investigated, and a pilot plant must be established.

In 1987 samples from Zambia's indigenous steel raw materials (iron ore, limestone and coal) were collected and dispatched for metallurgical laboratory tests in the USSR. An agreement on the terms of economic co-operation between the Government of Zambia and a Soviet company was concluded.[2] A report on the feasibility of the integrated mini iron and steel plant in Zambia was expected by the end of the Interim National Development Plan, in late 1988.

3.2 Coal

Zambia has abundant coal resources. Currently coal is mined only at Maamba in the mid-Zambezi Basin where proven reserves are about 58 million tons of high ash coal. Coal deposits have also been identified in the Luangwe Valley in the northern province and in the western basin. Three coal deposits have been located, at Nkandabwe, Siankondobo and Mulunga,[3] but these reserves have not been explored. Estimated reserves at Nkandabwe are about 80 million tons and at Mulunga about 100 million tons. The Maamba colliery has designed to produce 1.5 million tons per year of "run of the mine" coal and 1.2 million tons per year of washed coal. Reserves are thought to be sufficient for 33 years.

Table 9 shows coal production in Zambia between 1972 and 1987. The production of saleable coal decreased from 820,000 tons 1972 to 452,000 tons in 1983, less than 50 per cent at Maamba's capacity. Since 1983, the production of coal has been on an upward trend, but has still not reached levels typical of the 1970s.

1/ A Survey of the Iron and Steel Sector in PTA and SADCC Countries (UNIDO/IS/R.44), 1986.

2/ Economic Report 1987, op. cit.

3/ World Bank, Zambia: Issues and Options in the Energy Sector, 1983.

a/

Table 9: Coal production, 1972-1987
(Thousands of tons)

Year	Run of the mine	Saleable coal
1972	937	820
1973	940	710
1974	900	810
1975	814	780
1976	762	670
1977	708	610
1978	615	530
1979	771	573
1980	842	610
1981	n.a.	603
1983	n.a.	452
1984	n.a.	510
1985	n.a.	471
1986	n.a.	552.2
1987	n.a.	363.5 (9 months)

Source: World Bank, Monthly Digest of Statistics; British Geological Survey, World Mineral Statistics 1981-1985.

a/ Data apply to the Maamba Collieries, whose ratedcapacity is 1.2 million tons.

The major consumers of coal are the copper mines, the cement factory and the fertilizer plant, which consumed respectively 326,000, 98,000 and 64,000 tons in 1982. Since then, there have been various expansion programmes of coal-using industries, such as the fertilizer, cement and pulp industries. Substitution of coal for imported oil is also preferred for copper smelting. Thus the demand for coal is expected to increase in 1990.

In order to satisfy increased demand (see table 10), the Government must improve the mining operations at Maamba. The cost of producing coal at Maamba colliery is very high, due in part to inefficiency, lack of proper management, and a poor transport system. The high production costs result in unnecessarily high delivery prices to consumers, despite the fact that open-pit mining conditions are relatively easy. Reducing production costs is important for the expansion of coal-using industries.

Table 10: Projected coal consumption in selected years
(Thousands of tons)

		1980	1985	1990	2000	Growth rate 1980-1990 (Percentage)
High-growth scenario (without fuel substitution)	Mines	320	320	320	320	-
	Industries	291	410	523	852	6.0
	Total	611	730	843	1172	3.3
High-growth scenario with fuel ubstitution)	Mines	320	320	600	600	6.5
				(150)	(150)	-7.3
	Industries	291	410	523	852	6.0
	Total[a/]	611	730	1123	1452	6.3
	Total[b/]	611	730	(673)	(1002)	1.0
Low-growth scenario	Mines	320	320	320	320	-
	Industries	291	320	371	499	2.5
	Total	611	640	691	819	1.2

Source: The World Bank, Zambia: Issues and Options in the Energy Sector, 1983

Notes: a/ Implies coal substitutes in the mines after 1985.

b/ Implies electricity (or oxygen flash furnace) substitution in the mines after 1985.

Several factors are responsible for this low productivity. One is the reduction in the demand for coal by the copper mines in 1974 when, with the construction of Zambia's oil refinery, the mines were compelled to substitute fuel oil for coal. Other factors were shortage of experienced management and skilled manpower, poor maintenance, and lack of foreign exchange to purchase spare parts and replacements. The mining equipment is old, and the number of workers engaged in engineering services and administration seems disproportionately high compared to those engaged in production activities. The railway system for transporting coal is in poor shape.

In early 1984 the World Bank approved a $4.3 million loan to finance the purchase of urgently required spares, mining and transport equipment and a feasibility study on the colliery's rehabilitation, investment needs and coal demand over the next 20 years. A $27 million rehabilitation programme was initiated in 1985.

3.3 Electricity

Hydropower is the most important domestic electric energy source. Installed hydroelectricity capacity in Zambia is well in excess of current domestic and export demand. Table 11 shows electricity production and trade from 1981-1985.

Table 11: Zambia: Electricity production and trade, 1981-1985
(Gigawatt hours)

	1981	1982	1983	1984	1985[b/]
Production					
ZESCO	5,567	6,517	5,948	5,749	6,172
of which:					
Kafue Gorge	4,925	5,703	5,075	4,912	5,338
Victoria Falls	551	719	774	741	738
Kariba North Bank (CAPCO)	3,953	3,827	3,886	3,837	3,542
Copperbelt Power Company	60	24	31	39	25
Other	273	213	2[illegible]	180	202
Total production[a/] (Gigawatt hours)	9,853	10,581	10,075	9,805	9,941
Imports	8	16	6	10	6
Exports	3,355	3,950	3,384	3,385	3,611

Source: Economist Intelligence Unit, Monthly Digest of Statistics, 1988.

Notes: a/ Excluding internal consumption.

b/ Estimates based on six months.

Currently, system losses are high. In the interconnected system of ZESCO and CAPCO, losses are estimated at 3.5 per cent in transmission and 18.2 per cent in distribution. In rural areas, total losses on transmission lines and the distribution system are about 20 per cent. This condition has existed for several years since the 1980/81 survey[1/] and is largely due to lack of funds, especially foreign exchange, for proper maintenance. Vehicles are old, and equipment and spare parts cannot be purchased in sufficient quantities. In particular, ZESCO's ability to maintain the power system is in jeopardy and the system will continue to deteriorate unless ZESCO's financial position improves.

1/ The World Bank, Zambia: Issues and Options in the Energy Sector, 1983.

The combined effect of loss of revenue from exports and reduction in generation of power in 1986-1987 led to a rise of domestic power tariffs in December 1987.

Repeated upward revisions of power tariffs (including a 75 per cent increase in 1985) provides only short-term solutions to operational problems in the energy sector. In the medium term, the search for structural solutions is therefore needed.

The main bulk consumer is the copper mining industry. As of 1984, 69 per cent of the electricity generated was utilized by the mining and industrial sector, as table 12 shows.

Table 12: Electricity supply in Zambia, 1981-1985
(Gigawatt hours)

	1981	1982	1983	1984	1985[a/]
To Copperbelt	4,265	4,253	4,298	4,255	4,146
To other areas	1,710	1,849	1,907	1,928	1,946
Total ZESCO	5,975	6,102	6,205	6,183	6,092
Other suppliers	273	236	239	219	228
Imports	8	16	6	10	6
Total supply to Zambia consumers[b/]	6,244	6,344	6,444	6,405	6,326

Source: Economist Intelligence Unit, 1987

Notes: a/ Estimates based on six months' results.

b/ Power losses of some 4 per cent are experienced between Kariba or Kafue Gorge and the Copperbelt.

CHAPTER 4

AVAILABILITY OF FERROUS SCRAP IN ZAMBIA[1/]

4.1 Factors affecting availability of scrap

In mini-steel mills, foundries and even integrated steel works, scrap is one of the principal ferrous materials which can be remelted for making steel and, in some cases, even directly fabricated or rolled if suitable. It thus helps to reduce the need for iron ore, coal and fluxes, and is therefore considered an economic asset rather than an industrial waste.

For the development of metallurgical industries in Zambia, availability of ferrous scrap is important. Scrap is used to produce agricultural machinery, capital goods and spare parts for all other metal-working industries. In Zambia, there are no steel-making facilities and rolling mills to produce bars, high tensile deformed bars and light sections. There is even no single rolling mill for steel products based on the use of imported billets. Scrap is therefore at present the only raw material for the production of the above-mentioned goods.

Scrap comes from three different stages: steel making, steel processing and steel consumption. In the process of making and shaping steel, scrap takes the form of pit scrap, ingot butts, rejected ingots, crop ends, shear cuttings from flat-rolled products, cut ends from bars, etc. This is known as circulating scrap, as it is generally concerned with steel within the plant itself. The next stage of the steel cycle is processing in the engineering industries. During this processing, a certain amount of scrap is generated in the form of plate or sheet cuttings, trimmings, forging flash, turnings, borings and off-cuts. This is called process scrap. Finally, after the steel product has been discarded, it forms capital scrap. Such scrap comes from demolished structures and discarded machinery, rolling stock, ships and consumer durables.

The potential supply of capital scrap is related to the amount of steel products used during previous years. In industrialized countries, the potential supply of capital scrap is linked with that of process scrap availability in terms of a predetermined ratio, but this is not appropriate for a developing country such as Zambia.

The availability of process scrap depends on various factors. In comparison with highly industrialized countries, Zambia has lower manpower skills, less automation and a lower level of standardization, which would tend to increase the proportion of process scrap to steel consumption.

The best method to assess availability of scrap is in terms of past steel consumption. However, even this has a limited validity in the case of Zambia, in the absence of steel-producing facilities. All capital equipment is imported and data pertaining to steel consumption norms and life of equipment have not been developed.

1/ See Report on Availability of Ferrous Scrap in Zambia. TATA Export Company, Lusaka, 1986.

On the other hand, the steel-based engineering industries are very limited in number and small in size, as a result of which would limit process scrap. One more important point is that there is no systematic way of collecting capital scrap in Zambia. Presently almost all capital scrap collected goes to the copper mine industry to make borings (about 30,000 - 40,000 tons yearly). The efficiency of scrap collection sources is 52 per cent on average. In the case of automobiles, however, scrap is expected to be scattered and, therefore, the efficiency of collection would be lower, as will be pointed out later. Regional scrap collection/processing centres which cater to local small metal-working factories such as foundries and forges would be required.

4.2 Scrap collection efficiency

Projections by sector of potential annual scrap generation during 1986-1995 are given in table 13. The bulk of scrap generation can be attributed only to a few sectors. These are the automobile, defence, engineering, mining, power and railways sectors. The types of scrap generated are the heavy melting scrap from discarded machinery, redundant rolling stock, road transport equipment and worn-out track materials and processed scrap arising from engineering units.

Table 13: Production by sector of annual potential scrap during 1986-1995

Sectors	Projected Scrap Generation (Tons)									
	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Automobile	4,400	2,700	2,500	4,100	3,900	4,000	3,500	2,800	2,600	2,000
Defence	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000
Engineering	6,000	6,600	7,200	7,800	8,300	8,900	9,500	10,100	10,700	11,100
Mining	13,000	10,500	6,100	6,500	7,300	7,900	6,300	3,300	2,200	7,200
Power	300	350	400	450	500	550	600	700	750	800
Railways	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
Others	1,600	1,400	1,200	1,300	1,400	1,400	1,400	1,200	1,200	1,400
TOTAL	33,300	29,550	25,400	28,150	29,400	30,750	29,300	26,100	25,450	30,500
Effective scrap availability	19,145	17,235	14,440	15,625	16,485	17,335	16,460	14,535	14,105	17,750

Source: Report on availability of ferrous scrap in Zambia, Tata Exports Limited, 1986

The estimated scrap collection efficiency factor for each sector of the Zambian economy is given in table 14.

Table 14: Scrap collection efficiency for selected branches of industry

Sector	Collection efficiency (Per cent of total availability)
Automobile	30
Defence	50
Engineering	60
Mining	70
Power	75
Railways	60
Others	25

The actual scrap availability based on the above scrap collection efficiency factor corresponds with the figures on effective scrap availability in Table 13. The engineering and power sectors are the only sectors which would produce scrap at an increasing rate until 1995. Effective scrap availability averaged between 15,000 and 19,000 tons yearly during the period 1986-1995.

According to the above-mentioned 1986 study, the total scrap collection cost would be about $72 per ton, if Zambia sets up and efficiently operates scrap collection and processing centres. In comparison with the average landed cost of $90 per ton for imported scrap, indigenous process scrap is only about $20 per ton.

CHAPTER 5

IRON AND STEEL PRODUCTION PLANTS

The ability of mini steel mills (EAF-Rolling Mills) or integrated mini-steel mills (DR-EAF-Rolling Mills) to operate at a relatively small scale made it attractive to developing countries like Zambia seeking to establish an iron and steel industry to satisfy local demands for reinforcing bars, structural steel and similar products essential to developing sectors such as the agro-based and construction industries.

In countries which have ore and coal resources, the coal-based direct reduction mills have proved successful. Developing countries (rated total capacity 16.84 million metric tons) produced 10.42 million metric tons in 1987.[1/] Zambia has ample supplies of quality iron ore, coal and electricity in addition to limestone. So, direct reduction could form a very attractive base for the development of a steel industry.

5.1 Energy and ferrous inputs for iron and steel production

Production costs in iron and steel production are usually divided between materials (including energy), labour and financial charges. In 1987, both in industrialized and developing countries these cost components, on average, split up as follows:

Materials	58 per cent
Labour	23 per cent
Financial charges	19 per cent
	100 per cent

While factor costs tend to differ from country to country, it is evident that material costs are generally the most important ones, with ferrous inputs and energy as the major elements of these costs.

Less than half of the total energy required to produce a ton of steel by the conventional coke oven-blast furnace (BF) and the basic oxygen furnace (BOF) route is needed to produce the same amount of steel as the electric arc furnace (EAF) process. Although the electric-arc furnace route consumes more electrical energy than the conventional BF-BOF route, the overall energy balance is greatly in favour of the EAF, even when the inefficiencies of generating power from coal-fired stations is taken into account.

With regard to energy, the blast furnace and basic oxygen furnace (BF-BOF) route uses mainly coke for iron production and oxygen for steel-production. The directly reduced iron - electric furnace (DRI-EF) route uses electricity, together with coal or natural gas for iron-production and electricity for steel production. The prices of these forms of energy tend to vary not only over time, but also between countries - and between different locations within countries.

1/ MIDREX Corp. 1988

The relatively high quantity of energy required by the electric furnace generally translates into higher energy costs relative to the oxygen system (see table 15). About one fifth of the total cost of producing liquid steel is accounted for by energy use in the electric furnace, the lower cost of the ferrous inputs (scrap) nevertheless making this system competitive with the oxygen furnace. Other considerations - such as capital investment and pollution costs - also tend to work in favour of the electric furnace. Capital costs for the EAF are lower by approximately $20/ton of steel produced and operating costs are comparable to the BF-BOF route. A modern EAF furnace using up-to-date practices such as supplementary fuel burners, water cooler sections and ladle refining can produce steel at about $150/ton (assuming $85/ton for scrap), although 170-180/ton is more common. This compares with 190/ton for the BF-BOF route.

It is evident from table 15 that the cost of ferrous inputs is very high relative to total costs in both steel-making systems, and much higher than energy costs in both cases. Cost efficiency in steel-making therefore depends largely on the price of the metallic inputs (which will include the cost of embodied energy).

Table 15: Energy and ferrous material costs in oxygen and electric furnaces

	Price assumption (US$/unit)	Quantity used per ton of steel		Share in total cost of production (%)	
		Oxygen furnace	Electric furnace	Oxygen furnace	Electric furnace
Ferrous materials				89	55
Pig iron	144/ton	0.857	-	74	-
Scrap	85/ton	0.286	1.081	15	55
Energy				2	19[a/]
Oxygen	55/1000 m^3	0.050	0.024	2	1
Electricity	0.025/Kwh	-	545.0	-	18[a/]

Source: ECE/STEEL/41, tables 3.4.3. and 3.4.4. in 1988.

Note: a/ Including cost of electrodes.

Another process used to make iron is direct reduction. In this process, iron ore is reduced at relatively low temperatures - without fusion - and is subsequently melted. The resultant product, known as sponge iron or DRI, is used as an input to steel-making in the electric furnace where it competes directly with scrap. The cost of producing iron has therefore to be low in relation to scrap prices in order to make the process economically viable. Since the direct reduction process is mainly based on electricity and natural gas or coal, the prices of these inputs, together with that of iron ore, determine the cost of production. The ideal location for direct reduction facilities is in a region endowed with both natural gas or coal and iron ore resources, together with electricity. Zambia has an advantage here.

With a view to the future, one should note the introduction of new smelting reduction processes. These processes have as a common characteristic their large flexibility and low requirements as regards the quality and the quantity of energy inputs. In some cases, the flexibility with regard to the quality of ferrous raw materials is also increased compared to traditional processes. Although the new processes have not been tested beyond the pilot plant stage yet 1/, their introduction could have significant consequences for both the structure, the market and the raw material requirements of the iron and steel industry.

5.2 Iron and steel projects in Zambia

Diversification and lessening of Zambia's dependence on copper has been one of the Government's most important objectives, in view of the general economic stagnation which followed the steep decline in copper prices in 1975 and which also affected the performance of the industrial sector as a whole, as table 16 indicates.

If the economy is to become more independent of both copper exports and imported goods, industrial and agricultural production must expand in a balanced and integrated fashion. This will help to reduce the import bill and to generate new export revenues. Domestic resources of all kinds will be exploited more efficiently, to the extent that the iron and steel industry is able to achieve its potential role in Zambia's future economic development.

Presently many PTA countries rely on Zimbabwe Iron and Steel Company (ZISCO) steel (rated capacity 850,000 tons of BF-BOF route) for their steel products, but Zimbabwe consumed 295,000 tons internally out of 674,000 tons produced in 1986. This means that if demand in steel products increases at the rates indicated in table 16, Zambia will eventually need its own steel plant.

1/ Some companies such as Kawasaki Metals, Japan, and Nucor, USA, have developed a new thin-slab continuous caster. They have been operating pilot plants for their new market, flat products, and have now begun to commercialize technology.

Table 16: Projected development of apparent steel consumption by country

Country	1981 - 1983 Population (million)	1981 - 1983 Annual steel consumption (thousand tons)	1981 - 1983 Annual steel consumption (per capita)	1995 Population (million)	1995 Annual steel consumption (thousand tons)	1995 Annual steel consumption (per capita)	Annual per cent increase in consumption 1981-83 to 1995
Angola	7.5	56.9	8	10.6	80.8	8	2.7
Botswana	0.8	25.3	32	1.4	38.9	28	3.4
Burundi	4.5	12.4	3	6.6	37.0	6	8.7
Ethiopia	33.3	70.7	2	51.2	162.9	3	6.6
Kenya	17.9	258.2	14	31.3	369.8	12	2.8
Lesotho	1.4	13.0	9	2.1	21.9	10	4.1
Madagascar	9.3	32.4	3	13.4	29.3	6	7.1
Malawi	6.6	25.1	4	10.2	51.1	5	5.6
Mauritius	1.0	34.8	35	1.2	71.6	60	5.7
Mozambique	11.1	26.9	2	15.9	100.2	6	10.6
Rwanda	5.2	24.7	5	8.3	43.4	5	4.4
Somalia	5.0	7.9	2	6.5	15.8	2	5.5
Tanzania	19.2	84.1	4	29.1	122.9	4	3.0
Uganda	14.1	19.7	1	22.4	115.6	5	14.5
Zambia	6.2	96.4	15	9.8	156.9	16	3.8
Zimbabwe	8.0	379.3	47	12.8	705.6	55	4.9

Source: A Survey of the Iron and Steel Sector in PTA and SADCC Countries, UNIDO/IS/R.44, 1986.

The iron and steel industry can produce intermediate goods as well as raw materials for the manufacturing and agro-based industries which are badly needed in Zambia for the development of the manufacturing and agro-based industries. Foundries and forges can provide these industries with spare parts, metal coating and fabrications to maintain their continuous operation.

Table 17 shows steel imports, apparent steel consumption and share of capital goods in manufacturing value added in Zambia. The level of steel consumption, one of indicators of industrialization in developing countries,[1/] has on the whole been decreasing since 1974, from 230,000 tons to 26,000 tons in 1986. There has, however, been a light recovery in recent years.

1/ Steel Intensity and GNP Structure, IISI 1974.

Table 17: Crude steel imports and consumption
(Kilograms)

Year	Steel imports Zambia	Steel consumption Zambia	Steel consumption per capita	Steel consumption in Zaire	Steel consumption in Angola
1965	45,600	12,000	3.32	55,000	61,000
1966	..	17,000	4.57	83,000	93,000
1967	..	26,000	6.78	67,000	133,000
1968	..	42,000	10.63	87,000	168,000
1969	..	42,000	10.32	120,000	122,000
1970	85,000	59,000	14.08	161,000	109,000
1971	..	171,000	39.66	163,000	130,000
1972	..	107,000	24.11	142,000	95,000
1973	93,000	126,000	27.59	13,800	123,000
1974	172,000	230,000	48.93	198,000	172,000
1975	49,000	68,000	14.05	97,000	52,000
1976	32,000	40,000	8.02	51,000	50,000
1977	42,000	52,000	10.11	75,000	59,000
1978	24,000	30,000	5.66	48,000	39,000
1979	38,000	47,000	8.59	58,000	52,000
1980	23,000	28,000	4.96	73,000	81,000
1981	12,000	15,000	2.57	67,000	17,000
1982	9,000	11,000	1.82	62,000	53,000
1983	8,000	9,000	1.44	59,000	15,000
1984	11,000	13,000	2.02	86,000	72,000
1985	23,000	27,000	4.05	28,000	57,000
1986	24,000	28,000	2.23	22,000	50,000

Source: International Iron and Steel Institute (IISI), Japan Iron and Steel Federation (JISF), UNIDO Data Base 1988.

The Zambian Government has given priority to the establishment of an iron and steel industry in order to reduce costs and safeguard supplies of metal goods.[1/] The spur to such projects has been the unreliability of steel supplies from Zimbabwe and Tanzania. Several projects were initiated but later abandoned.

In 1985, UNIDO sent a delegation to Zambia to provide advisory services on a sponge iron plant based on indigenous raw materials. In 1986, TATA Exports Limited, India, was commissioned for the study on the proposed steel mill project. Zambia Steel and Building Supplies Ltd. (ZSBS), a parastatal organization in Zambia dealing in steel and other construction materials, prepared a report on a feasibility study on a Zambian steel rolling mill, to be based on the use of imported billets and capable of producing bars, high tensile deformed bars and light structurals. It concluded that, at the planned annual capacity of 60,000 tons, the rolling mill would be capable of producing bars including wire rods and light structurals at a total cost of $16 million and recommended that the mill be set up at Lusaka for its favourable location near iron ore, coal and scrap resources.

1/ Economic Report 1987.

As an alternative for the production of steel, the TATA report suggests the installation of an electric furnace based on local scrap, a continuous caster and a semi-continuous mill at a total cost of $22 million (1985 estimate) in 1985. The mill's annual capacity was initially envisaged at 27,000 tons, increasing in stages to 120,000 metric tons. It also prepared a plant layout for a 25,000 tons per year steel rolling mill and the blueprint of a system for the collection, transportation, processing and storage of scrap metal in Zambia. Furthermore, it provided broad specifications of the equipment requirements for a semi-continuous mill type.

According to TATA Exports' report, the annual requirement of scrap for the proposed steel mill and yearly availability of scrap (including the one from mines) are given in table 18 below.

Table 18: Scrap balance
(Tons)

Year	Accumulated/ yearly availability (excluding mining)	Circulating scrap from mill	Total availability	Requirement	Cumulative Surplus (+)/ Deficit (-)
1	69,000 *] 10,000]	..	79,000	..	+ 79,000
2	9,900	..	9,900	..	+ 88,900
3	10,200	2,700	12,900	27,000	+ 74,800
4	11,100	3,000	14,100	30,000	+ 58,900
5	11,400	3,400	14,800	34,000	+ 39,700
6	11,800	3,800	15,600	38,000	+ 17,300
7	12,000	4,400	16,400	44,000	- 10,300
8	12,200	4,700	16,900	47,000	- 40,400
9	12,600	4,700	17,300	47,000	- 70,100
10	12,700	4,700	17,400	47,000	- 99,700

Source: Report on Availability of Ferrous Scrap in Zambia, TATA Export Company, Lusaka, 1986.

* accumulated

Notes: 1. Figures rounded off to the nearest hundred.
2. Circulating scrap @ 10 per cent of requirements.

The accumulated scrap is primarily in the form of discarded capital equipment, since very little process scrap has been accumulating the report concludes that, since scrap supplies would be adequate only for a period ranging from four to eight years (depending on the level of supplies from the mining sector), the possibility of setting up a sponge iron plant should be explored.

UNIDO's suggestion for the establishment of a sponge iron plant, on the other hand, centres around the integrated mini-mill which produces steel bars, rods and light sections to meet the growing requirements of the domestic market. It also discusses the establishment of a mini-steel plant/steel rerolling mill with captive steel-making capacity, to meet the shortage of local steel scrap and the limitations on scrap imports. It suggests direct reduction/sponge production in the country based on indigenous raw material: iron ore, coal and limestone etc., UNIDO's technical assistance report speaks of a "demonstration plant for the production of sponge iron based on direct reduction of iron ores using coal as the reductant, the objective being to undertake the demonstration scale, three-shift operation of a DRI sponge plant based exclusively on Zambian raw materials and with an annual capacity of 10,000 to 12,000 tons of DRI, much the same way as the demonstration plant for the production of sponge iron DRI with UNDP/UNIDO technical assistance at Poloncha (Kothagudem) in India".[1/].

It concludes that the sponge production project based on the direct reduction of Zambian iron ores and coal in rotary kiln operations is fully feasible. Such a highly metallized DRI/sponge iron would be an excellent feedstock for the electric arc furnace for steel-making along with the steel scrap available in the country. The analysis was made assuming that the EAF and a rolling mill have been established prior to the project. The sponge-iron plant project has been prepared as an eventual backward integration programme.

If we add the sponge iron capacity to the scrap availability, it amounts to a production of 30,000 tons on average to 1995. If steel demand increases as forecasted in table 13, this project is too small. However, the merit of the DR plant is that the DR plant module can be added comparatively easily. Therefore in this project gradual DR capacity increase is also to be considered.

The studies of UNIDO and TATA Export Inc. both take full account of the present conditions of the domestic market where demand has been fluctuating in the past due to political conditions and resulting economic stringency.

It may, however, be more realistic to plan a mini-steel plant with a higher capacity to meet the projected market growth over the next decade, considering that the expansion of the mini-steel plant or an additional plant in future years would cost much more in capital expenditure, since the capital equipment costs have been escalating each year since 1983. An optimum should be found considering the current market needs on the one hand and the possibly inflated market projections on the other. In either case, a detailed project feasibility report is to be conducted.

1/ Report of the Short Technical Advisory Mission to Study the Possibilities of Establishing Sponge Iron Plant Based on Direct Reduction through Technical Assistance Programme of UNIDO/UNDP in the Republic of Zambia.

CHAPTER 6
FOUNDRIES AND FORGES

6.1 Foundries

For an industrial concern to function effectively, it is imperative that the various resources invested and utilized in the production activity be optimized. To achieve this, the existence and development of ancillary industries and back-up support facilities plays a vital role. The major back-up and support facilities required for the development of machine tools, agricultural machinery, tractors, commercial vehicles, etc., are foundries, forges and tool rooms along with heat treatment, metal forming and fabrication and metal coating.

The supply of equipment and spare parts by foundries, furges and other back-up facilities plays a vital role in promoting accelerated, rational and integrated development of the industrial sector, since the existence and development of sound ancillary industries and back-up support facilities leads to greater horizontal integration at the country level. This can even be extended to the regional level, in cases like the Preferential Trade Area (PTA).

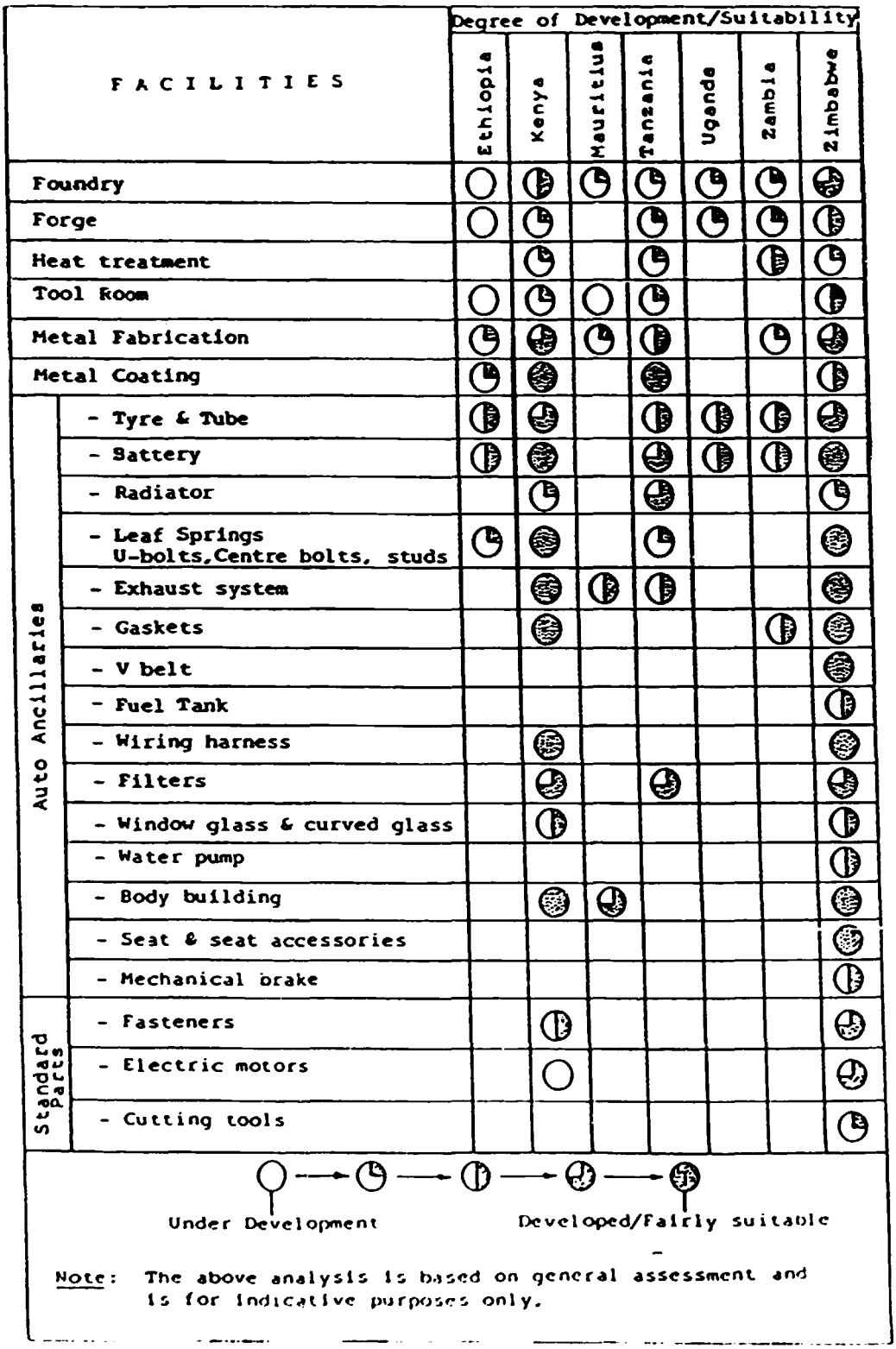
However, existing foundries and forges in Zambia as well as in other PTA countries require upgrading in order to support the integrated development of the industrial sector, since capacity utilization is low and inefficient operations prevail.

Figure 2 provides a general assessment of existing back-up support facilities in Zambia as well as in other PTA countries. According to the ECA mission report on the engineering-industry development programme for selected eastern and southern African countries of the Preferential Trade Area,[1/] there are only a few foundries in Zimbabwe, Kenya and Zambia which have the requisite facilities for producing quality castings, though there are numerous foundries in these countries. Many sectors of industry require metal components.

The percentage of total castings by weight to total raw materials used for the manufacture of a few representative machine tools and tractors is given in table 19. Of the various types of ferrous castings, grey cast-iron castings (about 60 per cent) are the most extensively used. Other types of ferrous castings are ductile iron, malleable iron and steel.

1/ ECA, Subregional Report on Identification and Upgrading Existing Engineering Industries: Executive Summary, September 1985.

Figure 2: General assessment of back-up support facilities



Source: ECA, Subregional Report on Identification and Upgrading Existing Engineering Industries: Executive Summary, 1986

Table 19: Major materials for ferrous castings

Material	India	Japan	U.K.	U.S.A.
Grey cast-iron	70.5	55.8	67.9	67.3
Ductile iron	2.2	28.6	17.9	18.9
Malleable iron	21.7	10.6	9.1	10.8
Total	100.0	100.0	100.0	100.0

Table 20 shows the installed capacity of major foundries. The total foundry capacity in Zambia stands at 9,050 tons for cast iron, 42,000 tons for steel and 1,490 tons for non-ferrous metals.

Table 20: Installed capacity of major foundries in Zambia
(Tons)

	Company	Cast-iron	Steel	Non-ferrous
1.	Scaws Ltd., Kitwe		42,000	-
2.	Vulcan Foundry, Lusaka	750	-	-
3.	Foundry & Engineering Co. Ltd., Lwanshya	300	-	200
4.	Zambia Railways, Kabwe	3,000	-	500
5.	United Machining Works, Chingala	-	-	540
6.	Non-ferrous Metalworks, Ndola			250
7.	ZCCM Workshops		n.a.	
	Total	9,050	42,000	1,490

Source: A. K. Mitra, Brief Report on Spare Parts and Tractor Assembly Products in Zambia, 1985

Table 21 shows what each company produces, the nature of castings, their installed capacity, present production and major facilities. A more complete profile of Zambian foundries may be found in Annex table 2.

The largest steel casting foundry in Zambia, the Scaws Ltd. in Kitwe, is running only at 40 to 50 per cent utilization. A similar case are the cast iron foundries, e.g. the Vulcan Foundry in Lusaka, the Foundry and Engineering Ltd. in Luanshya and Zambia Railways in Kabwe. No figures are available from ZCCM regarding their existing foundries in repair workshops in the Copperbelt, but due to lack of foreign exchange the companies are unable to import scraps/billets from abroad (there is also an acute shortage of engineering manpower, too). Lack of scrap is a serious problem as well.

Table 21. Details of Foundries in Zambia

Name of Foundry	Products	Nature of Castings	Installed Capacity	Present Production	Major Facilities	Observations
Vulcan Foundry & Iron Works Co. Ltd.	Manhole covers, gear blanks, industrial spares, pipe fittings, aluminium castings	Cast iron and Non ferrous	750 tons/yr.	500 tons/yr.	Cupola 3.5T/hr. & 4T/hr, moulding machines, sand muller, small pattern shop	Well maintained foundry, could cater to the spare parts market still more effectively
Scaw Ltd.	Mill balls, steel castings, standard range of valve/ hydrant boxes, manhole covers, aluminium and bronze castings	Cast iron, steel mill balls, steel castings and non-ferrous	5000 tons/yr. 3000 tons/yr. 12000 tons/yr.	1080 tons/yr. 2800 tons/yr. 3840 tons/yr.	Induction furnace 3T, arc furnaces 5T, 3T, 2.5T, oil fired crucible furnaces 250kg, moulding m/cs, core making m/cs, sand muller 200kg, sand mixing plant, computer controlled spectrometer/ quantometer hardness testing sand testing lab.	Largest steel foundry in the region with low utilization at 40%, can serve as a source for all mining spare parts, good scope for expansion but for the limitations on foreign exchange
United Machinery Works Ltd.	Spare parts for Symon's crushers like bushes etc. made of lead, bronze, spare parts for Harnish ferger shovels made of aluminium, bronze, spare parts for sulzer pump of phosphor bronze, centrifugal cast, bronze castings	Non-ferrous	540 tons/yr.	120 tons/yr.	Crucible furnaces 800kg/400kg, rotary furnaces 2.5T, 1T, centrifugal casting machine, vertical centrifugal casting machine	It is a well equipped foundry producing specialised castings to laid down specifications for mining equipment including sulzer pump etc. Has a well equipped machine shop, have plans to manufacture pipe fittings for mines and general engineering
Non Ferrous Metal Works (Zambia)Ltd.	Aluminium, brass, bronze, white metal, lead and zinc alloy ingots for spare parts and jobbing	Non-ferrous	250 tons/yr.	132 tons/yr.	Oil fired furnaces 800 kg, centrifugal casting machine, rotary kiln 1T/hr, sand muller 500kg/ batch/10 mts, pattern shop	Though the existing facilities are outdated, with the proposed expansion programme, could serve as a potential spare parts manufacturing unit
Foundry & Engineering Ltd.	Pipe fittings, pump castings, general engineering spare parts, manhole covers, bronze	Cast iron and Non ferrous		96 tons/yr. 84 tons/yr.	Elec. carbon rod resistor heating furnace 600 kg, induction furnace 300kg, oil fired crucible furnace 150kg/650kg, pit type furnace 650kg, rotary kiln for burning swarf centrifugal casting machine, jolt squeeze pin lift, snap flask machines, sand plant, pattern shop	Needs improvement in foundry layout and technical inputs
Zambia Railways	Brake blocks, white metal bearings, other railway spares	Cast iron and Non-ferrous	1500 tons/yr.	400 tons/yr.	Induction furnace 4T, cupola 3T/hr, non-ferrous crucible furnaces - 150kg(for brass), 50kg (for aluminium) crucible furnaces for white metal and tin moulding machines, core shooters, core sand mixer, core drying oven, mechanical sand conveying equipment, shot blasting machine, pattern shop	Induction furnace not working for want of spares. Recently bought one induction furnace for steel castings. Have plans to add 2 nos. of cupola 3T/hr. and introducing metallic moulds for brake shoes. Should undertake spares/jobbing orders from various other engineering/automobile sector for better utilisation.

Source: ECA, Engineering Industry Development Programme for Selected Eastern and Southern African Countries of the Preferential Trade Area, 1986

The types of castings made in Zambia are:

- mill balls and steel castings;
- industrial and agricultural spares;
- manhole covers;
- railway spares including brake blocks;
- non-ferrous bearings, brushes, etc.

Scaws Ltd. in Kitwe is the largest foundry in Zambia, producing ball mills and steel castings. This company has good facilities like medium frequency induction furnaces, various capacities of arc furnaces, moulding machines, core-making machines, sand plant and computer-controlled spectrometers/
grantometers. Scaw Ltd. is a foundry capable of producing quality castings with technical assistence.

The Vulcan Foundry and Iron Works Ltd. is a well maintained foundry manufacturing cast iron and non-ferrous castings. It disposes of cupolas, moulding machines, sand mullers and a sand pattern shop.

6.2 Forging

Forging is one of the basic metal-forming processes. Forging improves the granular structure of critical load-bearing components such as connecting rods of automobiles. Where large amounts of material have to be removed from bar stock due to the configuration of the components, like gear blanks, crank shafts, main spindles, etc., forging achieves economies of manufacture both by saving in material and machine time. Though the requirements for forging are be very high, they form an essential pre requisite for achieving overall economy in any engineering industry. Forging facilities can either be part of a particular industry or be a centralized facility catering to the requirements of a number of industries.

The different components that can be forged are :

Machine tools
- bolts and nuts;
- mill balls for the cement industry;
- main spindles;
- gear blanks;
- hydraulic cylinder blocks;
- levers;
- shafts;
- cams; and
- camshafts, etc.

Tractors and transport vehicles
- leaf springs;
- coil springs, steel springs;
- overhaul of engine;
- repair of rolling stock;
- railway spares;
- lorries, bench vices (screws);
- connecting rods;
- crankshaft;
- hubs;

Table 22: Profile of foundries in Zambia

	Industries visited	SECTOR																	
		Machine tools	Agricultural implements	Tractors	Commercial vehicles	Low cost transport vehicles	Foundry	Forge	Heat treatment	Cold forming	Metal forming & fabrication	Metal finishing	Auto ancillary	Electrical engineering	Others
	ZAMBIA														
1.	Apollo Engineering Works Limited													⊗	
2.	Beatobell (Zambia) Limited		⊗												
3.	BMS Engineering Limited										⊗			⊗	
4.	Boart-Zambia, Dia-Carb Division								⊗					⊗	
5.	Domar Engineering Limited		⊗					⊗						⊗	
6.	Foundry and Engineering Limited						⊗								
7.	Grippo Engineering Limited													⊗	
8.	Leyland Motors (Zambia) Limited				⊗						⊗				
9.	Livingstone Motor Assemblers Limited				⊗						⊗				
10.	Lusaka Engineering Company Limited										⊗				⊗
11.	Maxcon Limited										⊗				
12.	Northland Agricultural Limited		⊗								⊗				
13.	Non-Ferrous Metal Works (Zambia) Limited						⊗								
14.	Record Engineering Limited													⊗	
15.	Rotex Machine Engg. (1972) Pvt.Ltd.													⊗	
16.	Scaw Limited						⊗								
17.	SKF (Zambia) Limited														⊗
18.	Tata Zambia Limited				⊗										
19.	United Machining Works Limited						⊗							⊗	
20.	Vulcan Foundry and Iron Works Co.Ltd.						⊗								
21.	Zambia Railways						⊗	⊗						⊗	

Source: ECA/UNIDO/PTA Mission on Engineering Industry Development Programme, Zambia, 30 May 1985, ECA

- hydraulic cylinders;
- valves;
- axles;
- shafts;
- camshafts;
- levers; and
- shift forks, etc.

Agricultural equipment
- hand tools (hammer, spanners, hoes, shovels);
- animal-drawn implements;
- pickaxes, hatchets;
- plough shares;
- plough beams;
- tines;
- cultivators;
- double-face sledge hammers; and
- crowbars and cold chisels.

In the PTA member countries, some of the industries have set up captive forging facilities and their activity is mostly restricted to in-line manufacture of specific products like leaf springs, hand tools, etc. Furthermore, general forging facilities exist in most railway workshops and a few private units. In most industries, the utilization rate is very low.

In Zambia there are two major forging companies, DEMAR Engineering Limited and Zambia Railways. DEMAR Engineering Limited is manufacturing animal-drawn implements, leaf springs, bolts and nuts. They have captive forging facilities required in process. Zambia Railways' forge shop is set up as a captive facility to meet the requirements of the Zambian railway workshop.

The present needs of Zambia could be met by the forging facilities existing in Zambia Railways. However, if the manufacturing facilities for tractors and commercial vehicles are increased, forging shop catering exclusively for these industries could be considered.

6.3 Other back-up support facilities

6.3.1 Heat treatment

The desired physical and mechanical properties of components/tools, their hardness, wear resistance and strength are obtained mainly as a result of proper heat treatment operation. Heat treatment is required to enhance the life cycle of manufactured components, tools and implements. In machine tools and spare parts, major heat treatment operations are normalizing, carbonizing, surface-hardening and through-hardening and tempering.

As concerns tractors, transport vehicles and agricultural implements, major heat treatment operations are surface-hardening, tempering and induction-hardening. In Zambia, there is one heat treatment shop, BOART Zambia, DIACARB Division, which is engaged in the manufacture of sounding drills, diamond fittings and bar couplings. There is a heat treatment

facility comprising pit-type wild-bar field furnaces for carbonizing, hardening and tempering. It has enough spare capacity to take up job orders.

6.3.2 Tool rooms

Any engineering industry requires special tooling to manufacture products; production lines can be kept active only by a constant supply of proper toolings. The tool room manufacturing the special toolings required by various industries is vital for the growth and sustenance of engineering industries. The tool room facility can be either reserved for a particular industry or can be a central facility catering to the needs of various types of industries at the national or regional level.

In the PTA countries, tool rooms are set up as captive facilities. The activity is limited to manufacture and maintenance of simple toolings only, and even these facilities are important only in Kenya, Tanzania and Zimbabwe. Zambia has no tool rooms.

6.3.3 Metal forming and fabrication

Metal fabrication is the process by which metals are cut to size or shape by cold forming or shearing and jointed together by welding, rivetting or bolting. In any country, be it small or large, the development of the metal-working sector is generally dominated by metal fabrication industries. Sheet metal fabrication in one form or another can be found even in villages. One reason for such rural activities is their simple operation, which does not call for close tolerance limits.

In the PTA member countries, with the exception of Ethiopia and Uganda, metal fabrication has developed to a greater extent than other engineering industries. This is mainly due to the development of auto-ancillary units, which manufacture exhaust systems, radiators, bus and trucks bodies, as well as the development of industries undertaking structural work, manufacturing carpentry hardware and builders' hardware items, mining equipment, agricultural equipment, etc.

In Zambia there are six major metal-forming and fabrication shops, but the fabrication activity at present is limited to bus and truck body building, steel furniture and office equipment, structural works, etc. These six major shops are:

- Lusaka Engg. Co. Limited

  Activities: Manufacturer of office equipment and steel furniture, bus/truck bodies, trailers and tankers.

  Type of fabrication facilities available: Shearing machine, press, press brake, roll benders, ordinary CO_2 welding, arc welding, gas welding.

- B.M.S. Engg. Limited

  Activities: Truck/bus body builders.

  Type of fabrication facilities available: Guillotine shear, press brake, eccentric press and welding equipments.

- Leyland Motors (Zambia) Limited

  Activities: Leyland bus and truck assembly.

  Type of fabrication facilities available: Complete welding line for assembly and painting shop.

- Livingstone Motor Assemblers

  Activities: Assembly of Fiat, Peugeot 504 and Isuzu utility pick-ups

  Type of fabrication facilities available: Complete assembly line and painting.

- Max Com. Limited

  Activities: Mechanical and structural engineering company

  Type of fabrication facilities available: Guillotine shear, press brake, plate bending, section shearing, drilling, profile cutting, section rolling, gas and arc welding.

- Northland Agricultural Ltd.

  Activities: Manufacturers of animal-drawn agricultural implements

  Type of fabrication facilities available: Press brake, nibbler, guillotine shears, profile cutter, power saw, cropper, drilling, disc grinder and welding equipment.

A UNIDO mission report[1/] found that fabrication industries have to be developed in Zambia both for meeting the existing requirements for fabricated parts/sub-assemblies and for meeting the demand for the manufacture of tractors which is planned.

6.3.4 Metal coating

Metal-coating processes were developed basically to prevent the corrosion, improve the aesthetics and in some to cases to harden the surface of a product. There are six types of major metal-coating processes which are generally required in the manufacture of machine tools, tractors, agricultural machinery and commercial vehicles:

1/ ECA, Engineering Industry Development Programme for Selected Eastern and Southern African Countries of the Preferential Trade Area, 1985.

- electro-plating (chromium plating, nickel plating and copper plating);
- galvanizing;
- anodizing;
- phosphating;
- oxidizing/blackoxidizing; and
- organic finishing/painting.

Metal coating is fairly well developed in Tanzania, Kenya and Zimbabwe, but Zambia has no coating facility. In all three countries, the facilities have been set up as captive facilities, but have spare capacity for undertaking jobbing work. For the tractor projects Zambia has to have captive electroplating facilities. These could also cate to the other industries. There are enough facilities to take care of metal coating in the PTA countries as a whole.1/

1/ See table 15.

CHAPTER 7

PRODUCTION OF AGRICULTURAL MACHINERY AND IMPLEMENTS

7.1 The engineering industries and the capital goods sector

Zambia is required to import almost all intermediate goods and capital goods (including agricultural implements) in order to keep its economy going. In 1985, 67 per cent of imports went to capital and intermediate goods, rising to 75 per cent in 1986.[1/] Essential parts for capital goods manufacturing such as heavy steel castings and forgings cannot be supplied by local manufacturers at present, resulting in the importation of these parts at high prices.

The engineering industry, still comparatively undeveloped in Zambia, is likely to be come one of the most important branches of manufacturing, even though it still depends on imported iron and steel products. Since the engineering industry encompasses an extensive range of products, some requiring capital intensive large-scale production units, it is not possible to develop all of them at the same time. The highest priority will therefore be attached to those products for which the domestic market is sufficiently large to make their manufacture viable. Such production lines are mining equipment, agricultural machinery, implements and tools, where concerted efforts could be made to substitute for imports.

There are 21 major engineering companies, 5 of which have foundry facilities. Their engineering capacity is small, as demonstrated in table 23, although Zambia does have a relatively large engineering sector compared to other sub-Saharan countries. Only three engineering companies employ more than 500 employees. The sales volume itself is small for the number of employees. The share of value added at 1980 constant prices in the capital goods industry dropped to 14 per cent in 1984, from a level of 18 per cent in 1967.[2/]

As elsewhere in Africa, agricultural performance in the PTA region is poor The agricultural growth rates of some countries in the PTA region are far below the population growth. The average agricultural production per hectare in the PTA region amounts to only 50 - 60 per cent of the world's average.[3/] Among the factors which affect agricultural production, the inadequate supply of agricultural machinery and the lack of maintenance/service facilities are the main subject of this chapter.

1/ Economic Report 1987.

2/ Ibid.

3/ Ibid.

Table 23: Major engineering companies for metal-working industries in Zambia, 1984

Company	Sales volume (in thousands of Kwacha)	Manpower
1) Appollo Engineering Works Limited	600	37
2) Bestobell (Zambia) Limited	3,360	33
3) BMS Engineering Limited	-	a/
4) Boart Zambia - Diacarb Division	7,000	-
5) Demar Engineering Limited	-	90
6) Foundry and Engineering Limited	-	62
7) Grippo Engineering Limited	700	-
8) Leyland Motors (Zambia) Limited	-	-
9) Livingstone Motor Assemblers Limited	8,160	310
10) Lusaka Engineering Company Limited	11,800	631
11) Maxcom Limited	4,000	81
12) Northland Agricultural Limited	4,000	201
13) Non-Ferrous Metal Works (Zambia) Limited	-	30
14) Record Engineering Limited	1,386	28
15) Rotex Machine Engineering (1972) Pvt. Ltd.	1,000	50
16) Scaw Limited	-	824
17) SKF (Zambia) Limited	-	100
18) Tata Zambia Limited	12,000	85
19) United Machining Works Limited	6,000	95
20) Vulcan Foundry and Iron Works Co. Ltd.	-	95
21) Zambia Railways	20,000 b/	590

Source: ECA, Engineering Industry Development Programme for Selected Eastern and South African Countries of Preferential Trade Area, 1985.

a/ Part of Mutanoi Investment Company.

b/ 1983 figure.

In order to build up an irrigation and drainage infrastructure. Of 46.79 million hectares of arable land in the PTA countries in 1982, only 1.065 million hectares, 2 per cent, are irrigated, which is low as compared to Africa's average of 5 per cent, and the world average of 15.4 per cent. In the case of Zambia, the ratio of irrigated land to arable land comes to 1.2 per cent in 1983. It is therefore, essential to expand the building material industries and the engineering and allied metal-working industries sector. Local manufacture of cement, brick, tiles, fired clay products, steel sections, pipes of various materials, water fittings, harware, hand pumps, diesel engines, electric motors, water pumps, submersible pumps, wind mill pumps, solar energy pumps, animal-drawn pumps, irrigation equipment, agricultural implements, hand tools, etc, in existing small- and medium-scale industries. Good core metal-working facilities such as foundries, forging, heat treatment, machining fabrication facilities and tool rooms are essential here as well. There are, for example, about 100 foundries in Zimbabwe which have created an industrial base for the existing manufacture of a wide range of, among others, irrigation machinery and equipment in that country. In most PTA countries, including Zambia, the situation is less than satisfactory.

In Zambia, Bestobell (Zambia) Ltd., Ndola, in collaboration with Bestobel Zimbabwe Ltd. is presently manufacturing deep-well hand pumps at the rate of 350 per annum against their plan of 1,200/year, to be subsequently increased to 2,500 per year. Manufacturing facilities for pipes and pipe fittings for irrigation purposes are available in Zambia as well as in other PTA countries.

7.2 Agricultural machinery and implements

Although, the manufacture of engineering capital goods in Zambia and elsewhere in the PTA region is still in the initial stages, capacity for agricultural hand tools does exist in the PTA region and in Zambia to meet the demand up to 1990. However, replacement/modernization of the existing units is needed to produce the rated output. Animal-drawn implements are being manufactured in Zambia, but the present level of production in the existing units is around 40 per cent of capacity. This industry needs serious upgrading/rehabilitation. In the area of tractor-drawn implements and simple power-operated machinery, Zimbabwe is the largest manufacturer of tractor-drawn implements in the PTA region, and is the only country having facilities to manufacture discs for ploughs. At present it is working at 40 per cent utilization due to market constraints. In Zambia trailers are being manufactured. Zambia has plans to manufacture tractor-drawn implements in collaboration with an existing Zimbabwean manufacturer.

Equipment technologies in agriculture could be broadly classified as:

(a) Hand tool technology - simple tools and gadgets that are used for carrying out the work manually;

(b) Animal draught technology - using the draught power of domesticated animals such as buffaloes, oxen, horses, mules, donkeys, camels, etc. to drive implements and equipment such as ploughs, etc.;

(c) Mechanical power technology - prime movers such as tractors, IC-engines, electric motors, windmills, turbines, etc, used to drive the machinery and equipment in carrying out various tasks.

The Zambian Government strategy for rural development is to raise the productivity of subsistence farmers, especially with regard to cash crops. Simple machines, animal-drawn implements and hand tools, rather than tractors and other sophisticated and expensive machines, are cheap, easy to handle and repair and thus are likely to make the greatest contribution to the success of this strategy.

7.2.1 Hand tool technology

Hand tools are used by 85 to 90 per cent of the agricultural population in Africa. Manual power presently constitutes the major source of power used in agriculture in different countries of the PTA region, and even by the year 2000 this share is estimated to undergo only a marginal change in favour of animal/tractor power, as table 24 indicates.

Table 24: Power requirements for each type of mechanization in the PTA region

Type of mechanization	Year 1975		Year 1990		Year 2000		Growth rate (%)
	Power (MDE)*	Share (%)	Power (MDE)*	Share (%)	Power (MDE)*	Share (%)	
Manual labour	3676	76.4	4651	76.8	6308	79.8	2.2
Draught animal	998	20.7	1227	20.3	1236	15.6	0.9
Mechanical power	138	2.9	177	2.9	341	4.6	3.7
Total power requirements	4812	100	6055	100	7902	100	2.0

Source: Food and Agriculture Organization, 1985

* Million man-day equivalent

Zambia has two companies, Shonga Steel Co Ltd. and Northland Agricultural Pvt. Ltd. which produce hand tools. They have the following major characteristics:

	Installed capacity	Employees	Production
- Shonga Steei Co. Ltd.	300,000 hand tools	120	n.a.
- Northland Agricultural PVT. Ltd.	1,250 tons of hand tools and animal-drawn implements	201	40,000 hoes

Imports of hand tools in Zambia as well as in the PTA region as a whole are declining because the production capacity for hand tools has been increasing. Zambia imported 1,117,000 hand tools in 1977, 816,000 in 1980, 70,000 in 1981 and 90,000 in 1983.[1/] Production of hand tools by existing companies in Zambia and other PTA countries is shown in table 25. Current annual production capacity in the PTA region is about 18 million hand tools and 60,000 other implements.

Table 25: Production of hand tools by existing companies in Zambia and other PTA countries

Country	Type of tools	Production level (Number/year)
Ethiopia	Hand tools	250,000
Kenya	Hand tools, animal-drawn implements and hardware	488,000
Uganda	Hand tools and spare parts	228,000
Tanzania	Hand tools and animal-drawn implements	2,131,000
Zambia	Hand tools and animal-drawn implements	40,000
Zimbabwe	Hand tools and animal-drawn implements	146,000
		3,283,000

Source: ECA, Engineering Industry Development Programme for the Selected Eastern and Southern African Countries of Preferential Trade Area, 1985.

1/ Ibid.

The manufacture of simple hand tools is fairly well established in Zambia and in most PTA countries at the small- and medium-scale and village blacksmith level. In most countries, higher engineering levels have been achieved. Lines for mass production for hand tools only exist in Ethiopia and Uganda, while in Kenya, Tanzania, Zambia and Zimbabwe, hand tools are generally being produced along with animal-drawn implements and other products. Zambia has enough capacity to meet the demand for hand tools, but capacity utilization is low.

Some of the major constraints in achieving the rated capacity are lack of raw materials, difficulty in procuring machinery spares, limited research and development facilities, lack of skilled manpower and inadequate marketing facilities.

In order to overcome these constraints, it is necessary for PTA countries to create appropriate mechanisms and modalities at intracountry, intercountry and subregional levels.

7.2.2 Animal-drawn technology

Despite its limitations, the animal-drawn system has its own place, owing to social, environmental and economic conditions of the farmers. It will continue to play a major role in the future as well.

A recent study of Zambia reveals that ox cultivation is about three times more effective than hoe cultivation (the farmer's net income is three times greater because he can cultivate a greater area, has higher yields and the marginal cost increases are low). It also shows that animal-drawn implements have a break-even yield of 1,500 kilograms per hectare as compared to 3,600 kilograms per hectare ox cultivation for tractor cultivation.[1/] The demand for animal-drawn implements primarily depends upon the number of active pairs of work oxen and the expected life of the equipment. The total population of cattle in the PTA region during 1983 amounted to 89.5 million, out of which Zambia had 2,380,000 head. If we assume that 10 per cent of the cattle shall be used for animal draught the average within Africa, this works out to 9 million or 4.5 million pairs of work oxen in the whole PTA region and 200,000 heads in Zambia. The demand for implements for 1990 is estimated to consist of 550,000 animal-traction units. In Zambia alone it would be 30,000. Table 26 shows existing capacity and estimated demand for 1990.

1/ Ibid.

Table 26: Existing capacity and estimated demand for 1990 for animal-drawn implements and manually operated machines

(Number)

Country	Current production	Existing capacity	Demand (1990)	Proposed identification/ upgrading
Ethiopia	..	..	120,000	100,000
Kenya	20,000	80,000	140,000	30,000
Uganda	..	n.a.	60,000	30,000
Tanzania	30,000	42,000	170,000	40,000
Zambia	26,000	35,000	30,000	..
Zimbabwe	70,000	200,000	70,000	..
Others	n.a.	n.a.	310,000	..
			1,100,000	

Source: ECA, Engineering Industry Development Programme for the Selected Eastern and Southern African Countries of Preferential Trade Area, 1985.

Presently, Zambia has more than enough capacity to satisfy its demand for these products in 1990. The only producer of animal-drawn equipment is Northland. Its current level of production and installed capacity for animal-drawn and manually operated implements is indicated below:

Northland Agricultural Ltd., Ndola, Zambia:

- Manufacturing activity: Mouid-board ploughs, cultivators, harrows, wheelbarrows, gratings.
- Installed capacity: 1,250 tons
- Production in 1984:

Mould-board/ridger) Ploughs)	21,285
Cultivators	55
Barrows	2,833
Wheelbarrows	1,000

Northland Agricultural Ltd. has developed into a major manufacturer of animal-draught implements, and there are plans to expand from the existing capacity of 28,000 to 34,000 ploughs and harrows, etc. This company also exports to a number of countries in Africa. However, the company should diversify while incresing the capacity so as to cover the full range of implements. Expansion is limited by several factors at present.

Zambia is facing foreign currency limitations, restricting the supply of raw materials. Further, the internal market is restricted due to lack of credit facilities for farmers and to the inflation of machinery cost relative to crop prices.

7.2.3 Material component of agricultural implements

A great part of the basic material required for agricultural implements comes from the steel sector, often 70 per cent or more by value for all parts combined. The materials required are angles, flats, rounds and pipes. Parts like plough beams and frogs are forged and constitute about 20 per cent of the value of materials. Parts like cast-iron wheels for mould-board ploughs, bushes, etc. make up 20 per cent of material inputs, and facilities for making these exist in Zimbabwe, Kenya, Zambia and Tanzania. The quality of cast-iron for the cast-iron wheels is grade 14, which is within the capability of most of the foundries. Standard items such as bolts, nuts, washers, chain springs and tines average up to 5 per cent of implement material input by value. Even though the agricultural implements as such can be manufactured in small volume at individual country level, standard parts such as cast-iron wheels and other specialized items like bolts, nuts, washers, chains, springs and tines would not lend themselves for manufacture at smaller volume due to technological constraints and higher investments required. Therefore, the manufacture of such items should be conceived on the regional/subregional level only.

Table 27 shows the characteristics of the animal-drawn implements and manually operated machines which are produced in Zambia, indicating requirements for product coverage, volume of production, investment and manpower.

Table 27: Characteristics of producing animal-drawn implements and manually operated machines

Artisan/blacksmithy unit	Small-scale units	Medium/large plant
Products		
Simple tillage equipment made of wood or steel, simple manually operated machines	Tillage equipment, sprayers, seeders, manually operated machines (e.g. shellers)	Tillage equipment, sprayers, seeders, manually operated machines, shellers, threshers, mills and pumps
Annual output		
Up to 1000	20,000	more than 50,000
Technology		
Simple customary design, production in small batches, as and when required.	Product design, Production technology including production planning	Product design, Production technology for large batch, production planning
Investment		
$20-50,000	$1-2 million	$3-4 million
Equipment		
Coal-fired hand-blown forge	Material cutting, forging, heat treatment, fabrication, welding	Material cutting, Forging, fabrication shop, welding, press shop, heat treatment, paint shop, quality control, stores and shipping
Manpower		
Up to 10 skilled workers	Skilled labour and management up to 100	Skilled labour, production engineers and management over 200

7.2.4 Mechanical power technology

In conjunction with the motive power of tractors, various agricultural implements have been designed to be specially used with tractors, and this is helping the farmers to increase yields of agricultural produce.

The main tractor-drawn implements which are relevant to the African context are the mould-board plough, the disc plough, the disc harrow cultivator, the chisel plough, the seed-cum-fertilizer drill, and the trailer. In addition, various simple machines, driven by diesel engines or an electric motor or tractor PTO shaft, such as threshers, hammer mills, shellers, decorticators, sugar cane crushers, oil extraction mills, etc. are in use.

The estimated demand for 1990 in the PTA region for each type of equipment is given below:[1/]

	Number
Plough	10,000
Harrows	9,400
Seeder/planter	9,200
Cultivator	7,680
Fertilizer distributor	1,720
Thresher	1,350
Combine harvester/thresher	2,650
Trailers, etc.	8,000
	50,000

The estimated demand broken down by country is as follows:[1/]

Country	
Ethiopia	5,260
Kenya	7,900
Uganda	2,630
Tanzania	5,000
Mauritius	130
Zambia	5,260
Zimbabwe	7,900
Others	15,920
TOTAL	50,000

The above data are based on world consumption patterns. The choice of individual types of equipment will depend on the type of crops grown in the region as well as the horsepower of the tractors used.

The application of various implements and types of equipment for the major stages of crop production is indicated in table 28.

1/ Ibid.

Table 28: Overview of mechanized agricultural operations for major crops

	Agricultural Operations	Implements/ Equipment	Major Crops			
			Maize	Wheat	Cotton	Sugar Cane
1.	Land Preparation					
	a) Ploughing	Ploughs	x	x	x	x
	b) Harrowing	Harrows	x	x	x	x
	c) Ridging	Ridger	x			x
2.	Sowing/Fertilising					
	a) Seed drilling	Seed drills		x		
	b) Seed planting	Planters	x		x	x
	c) Fertilizer application	Seed cut fertilizer drills	x	x	x	x
3.	Pre-harvest					
	a) Spraying/dusting	Sprayer/duster	x	x	x	x
	b) Weeding	Hoe cultivator	x	x	x	x
	c) Fertilizer application	High clearance broadcaster	x	x	x	x
4.	Harvesting					
	a) Harvesting	Harvester		x		x
	b) Reaping	Reaper		x		x
	c) Picking	Picker	x		x	
5.	Post-harvest					
	a) Threshing	Tresher		x		
	b) Shelling	Sheller	x			
	c) Grading mills	Grading mills	x	x		
	d) Crushing	Crushers				
	e) Ginning mills				x	

Source: ECA, Engineering. Industry Development Programme for Selected Eastern and Southern African Countries of Preferential Trade Area, 1985.

Note: The above operations will further depend upon crop rotation combinations.

According to the survey mission conducted in 1985,[1/] tractor-drawn implements are mainly produced in Zimbabwe and Kenya. In order to help in the identification of new projects and in the upgrading of existing projects, the present production, existing capacities and the estimated demand for 1990 are given in table 29.

Table 29: Demand and proposed supply in 1990

Country	Current production	Existing capacity	Demand in 1990	Proposed identification/ upgrading
Ethiopia	-	-	5260	4000
Kenya	600	1500	7900	3000
Uganda	-	-	2630	-
Tanzania	400	1500	5000	10000
Mauritius	-	-	130	-
Zambia	400	1000*	5260	2000
Zimbabwe	5000	10000	7900	2000
Others	-	n.a.	15920	-
Total		14000	50000	21000

*includes Mauritius

Source: Ibid.

Table 29 shows that the existing capacity in the region will have to be increased threefold to cover the expected demand of 50,000 in 1990. However, in some countries, demand is very marginal and the industrial sector is not developed to the desired extent. It would be advisable for them to import from other PTA countries until demand is sufficiently large to justify new investment and manufacturing facilities are sufficiently developed. It should however, be kept in mind that the present capacity utilization in many countries of the PTA region is in the order of 40 to 45 per cent. A well co-ordinated and concerted effort towards better regional co-operation would help to increase the utilization of available capacity by expanding markets for existing plants new capacities are created, regional co-operation should also be kept in mind.

1/ Ibid.

Zambia at present does not have manufacturing facilities for tractor-drawn implements and machinery except for trailers. Considering the estimated demand for trailers 1990 at 5,260, substantial potential exists for growth in this sector. The current production of trailers is in the order of 400 only, which is well below the break-even point.

Trailers are made by the Lusaka Engg. Co. in Lusaka, whose main characteristics are as follows:

Manufacturing activities:	Buses, bus bodies, trailers, metal furniture, etc.
Number of employees:	631
Installed trailers :	750
Production capacity/year:	337

There are two companies which have plans to produce tractor-drawn implements. MAXCOM General Engineering and Fabrication part of a multinational company, with about 30 years of experience in the field has shown interest in tractor-drawn implements such as disc ploughs, harrows, cultivators and threshers. Northland Agricultural Limited also have expressed their desire to manufacture tractor-drawn implements, including discs. These two projects would create a capacity for 2,000 implements.

MAXCOM is presently manufacturing bus bodies, fuel tanks, bumers, vehicle bodies, heat exchangers, and is preparing for the manufacture of tractor-drawn implements in collaboration with Tito Industries Limited, Zimbabwe. Implements include disc ploughs, harrows, cultivators, threshers. Northland Agricultural manufactures engine-driven threshers and maize shellers (prototype stage).

The manufacturing technology for power-operated implements and machinery is similar to that of animal-drawn implements. The basic manufacturing processes, indicated in table 30, include forging, casting, fabrication, welding, pressing, machining, heat treatment, assembly and painting. The main inputs are steel-related products.

Various studies indicate that production of tractor-drawn implements and machinery for PTA needs would range from 3,500 in small-scale workshops to 7,000 to 8,000 in a medium-scale industrial plant. The requirements are summarized in table 31.

The types of steel needed are mild steel, structural steel, plain medium carbon steel, low carbon and medium carbon alloyed steel and spring steel. One of the major constraints in the PTA countries has been lack of steel plates. It is therefore, suggested that ZISCO Steel in Zimbabwe should acquire a plate-rolling mill to improve the supply of steel plates.

Tractors

Tractors are normally available with two-wheel drive arrangement, while four-wheel drive arrangement for high traction advantage in agricultural application is more significant for higher horsepower tractors. For specialized crop applications, tractors with special features (e.g. rice-specific tractor with paddy puddler, sugar cane tractor with extra high clearance, or cotton-specific tractor) are also available.

Table 30: Manufacturing process for tractor-drawn implements and power-operated machinery

Process category	Raw materials section	Components	Operations
Fabrication	Commercial steel profiles	Implement frames Bars Links Levers Spacers Bumpers	- Marking - Cutting - Trimming - Drilling - Bending - Threading - Welding - Cleaning
Hot and cold forming	Plates, bars and sheets	Discs Tines Shovels Shears Blades Sheet metal parts	Hot Forming - Billet cutting/ cutting of parts - Pre-heating - Hot forging - Trimming - Heat treatment - Scale removing Cold Forming - Blanking - Bending/ press forming - Punching - Trimming - Heat treatment - Cleaning - Welding - Spot welding
Castings		Wheels Pulleys Bushes Hubs Spacers Handles Brackets	- Pattern making - Core making - Moulding - Pouring of liquid metal - Fettling - Shot blasting/ cleaning - Weathering - Turning/shaping/ planing - Boring - Milling

Table 30 (continued)

Process category	Raw materials section	Components	Operations
			- Drilling - Threading - Broaching
Machining	Commercial round/square/ hexagonal sections	Shafts Axles Pins Special bolts and nuts Washers	- Part off - Turning - Milling - Drilling - Threading - Heat treatment - Cleaning
Subassembly and assembly			- Manual for smaller volumes - Power tool on conveyors for larger volumes
Painting			- Dipping - Spray painting

Source: ECA, Engineering Industry Development Programme for Selected Eastern and Southern African Countries of Preferential Trade Area, 1985

The number of tractors in use in Zambia has increased from 4,100 in 1974/76 to 4,600 in 1980 and 4,650 in 1981 and 4,700 in 1982.

Table 32 shows the number of tractors, by horsepower range, sold by dealers in Zambia from 1974 to 1983 which comes to a total of 5,127, with an average yearly consumption of 500. (These figures may differ from those of imports given by the Central Statistical Office, as the tractors acquired through bilateral agreements are not always recorded).

There are no tractor manufacturing operations in Ethiopia, Kenya, Mauritius, Tanzania, Uganda, Zambia and Zimbabwe. A few countries have embarked on assembly of tractors with limited local content, confined to the extent of availability of components/subassemblies. Currently, the only source of meeting requirements of tractors is through imports, which are constrained due to limited foreign exchange availability.

Table 31: Tractor-drawn implements and power-operated machinery characteristics of stages

Stage 1	Stage 2	Stage 3
Rural blacksmith	Small-scale workshop units	Medium-scale industrial plants
Products	**Products**	**Products**
Not applicable for tractors driven implements	Plough, seed, drills, cultivators, disc harrows, and some simple powered machinery	Plough, seed drill cultivators, disc-harrows, harvestors and other tractors drawn implements and powered machinery
	Annual output	
	3500 units 500-1000 tons/year	7000 units 4000 tons/year
	Technology	
	Product design	Product design
	Production in batches possible in continuation with animal drawn implements	Production in large batches Production planning
	Investment	
	$3-4 million	$4-5 million
	Equipment	
	Forging, fabrication welding, machine shop	Cutting section, forging fabrication, machine shop, heat treatment, assembly and paint shop, quality control, tool room, stores/ receiving/shipping

Source: ECA, Engineering Industry Development Programme for Selected Eastern and Southern African Countries of Preferential Trade Area, 1985

Table 32: Import statistics for wheeled tractors

Country	1975	1977	1980	1981	1982
Ethiopia	279	462	2,522	186	38
Kenya	1,461	2,737	5,678	1,242	791
Mauritius	150	102	49	70	26
Tanzania	626	349	613	392	748
Uganda	229	650	600	600	600
Zambia	777	692	639	704	1,359
Zimbabwe	1,163	700	1,590	1,212	1,113
TOTAL	4,685	5,692	11,691	4,406	4,675

Source: Ibid.

Zambia is planning to set up an assembly plant for assembly from imported SKD/CKD packs of "ZETOR" T211/T245, "MASSEY FERGUSON" 63/82 hp and "YANMAR" 33 hp tractors. However, it seems that the three different models, and the limited production volume (ZETOR: 1000 units, MASSEY: 600 units and YANMAR: 400 units), will never be economically viable as far as the local production of parts and components is concerned.

Zambia has the highest land per ratio in the region and seems to have considerable scope for increased demand for tractors, which is expected to be in the range of:[1/]

1985: 1,000 - 1,200 (below 50 hp: 400 - 500, above 50 hp: 600 - 700)
1990: 2,000 (below 50 hp: 800, above 50 HP: 1,200).

Zambia, however, already has surplus capacity for the assembly of motor vehicles in Livingstone Motor Assembly Unit, a subsidiary of INDECO Limited. It has therefore, been suggested that if the manufacturing of tractors is to be undertaken, it should be done at Livingstone Motor Assembly, Livingstone (which at present is working at 15 to 20 per cent capacity), with the addition of some special assembly equipment. This would also demand less foreign exchange.

Ancillaries play an important role in the manufacture of tractors, since 80-85 per cent of their components are normally bought-outs. The development of a tractor-manufacturing industry in the PTA region would therefore, depend significantly on the development of ancillary industries making parts and components. Many of the tractor components are common with the automotive components in general. Thus the ancillary industries should be seen in the context of both automotive and agricultural tractor industries.

Table 34 shows the applications and supply conditions of typical raw materials and semifinished components (castings and forgings) generally used for various components required for tractors.

1/ Ibid.

Table 33 Tractor sales in Zambia by horsepower range

	0-10	11-20	21-30	31-40	41-44	45-54	55-64	65-74	75-84	85-94	95-104	105-114	115-124	125-134	135-144	145-154	155-164	TOTAL
Tractor Sales No's in the year																		
1974				12		155		237		17		28		3				452
1975				7		89	2	222	20			1		7				348
1976						211	44	259	42	8					1			565
1977			2			74	19	177	43			8			1			324
1978				30		121	93	120	37			13			1			415
1979			19	15		97	83	252	30	46	10	12			1			565
1980			16	1		142	32	242	61	27	6	36	5	5	6	6	5	602
1981		20	71	12		173	47	196	27	10	2	13	14	9	10	8	14	626
1982		40	43	70		34	110	166	67	14	10	22	11	6	15	6	10	652
1983		66	6	197		38	61	127	62	10		4	8	2	9	2	6	598
TOTAL		126	157	344		1140	499	1998	395	132	28	137	38	32	44	22	35	5127

Source: "Tractor Assembly Project" - A market study by INDECO Ltd., May 1984

Table 34: List of typical raw materials and semi-finished components for agricultural machinery

1	Material 2	Application 3	Supply condition 4
1.	ROLLED STEEL STOCK		
1.1	Medium carbon steel	For general engineering purposes; pins, gear-shift levers, tie rods, etc.	Hot rolled, Normalized
		Gear shifting levers, gear shifting rods and low torque transmitting bars	Cold drawn, bright finished and annealed
1.2	High strength weldable steel	Welded structures, shafts, gear pins, gear-shift levers and pedal shafts, etc.	Hot rolled, Normalized
1.3	Manganese alloy steel	For components requiring hardening and tempering such as coupling gears, bushes, shifting pins, etc.	Hot rolled, Normalized
		High strength pins	Cold drawn bright finished and annealed
1.4	Case hardening steel	Components requiring hardness, toughness and resistance to shock load such as gears, shafts, etc.	Hot rolled and annealed when heat treated As supplied
		Components requiring hardness, toughness and resistance to shock loads such as gears and shafts for high strength	Annealed when heat treated As supplied
1.5	High strength hardening steel	Components subjected to springing load; kingpins, PTO shaft, etc.	Hot rolled and annealed when Heat treated As supplied
1.6	Structural steel weldable quality	Members of welded structures, general machined parts like covers, counter weights etc.	Cold drawn, bright finished and annealed

Table 34 (continued)

1	Material 2	Application 3	Supply condition 4
1.7	Carbon and alloy tool steel	Components to be used without heat treatment such as tenons, thrust races etc.	Annealed Hardened and tempered
1.8	Cold drawn seamless tubes	Weldable tubular members such as tubular column	-
1.9	Medium strength tubes	Non-weldable tubular members such as tie rods	-
1.10	Free cutting steels	For threaded components, fasteners etc.	Cold drawn
1.11	Cold rolled sheets		
	a. Ordinary grade	For general sheet metal work	Cold drawn
	b. Drawn quality	For sheet metal components of normal drawn	Cold drawn
	c. Deep drawn and extra deep drawn quality	For sheet metal components required to be deep/extra deep drawn such as panels, mudguards, bonnets, etc.	Cold drawn
1.12	Spring wires	Patented for springs	
2. FORGINGS			
2.1	Case hardening steel	Gears and shafts where higher loads are transmitted	Normalized to BHN 160-200. Painting: prime coated with oil-resistant stoving red oxide and zinc chrome
2.2	Medium carbon steel	Shift forks, gears of low transmitting torque such as ring gears and levers	Normalized to 170-207 BHN Painting: prime coated with oil-resistant stoving red oxide and zinc chrome

Table 34 (continued)

1	Material 2	Application 3	Supply condition 4
2.3	Hardening and tempering steel	Connecting rods, torsion bars, etc.	Normalized, hardened and tempered to 75-85 kg/mm^2 Painting: prime coated with oil-resistant stoving Red oxide and zinc chrome
3.	CASTINGS		
3.1	Grey iron	Covers, gear-shift bearings, exhaust manifold, cylinder block, cylinder head, valve guides, bearing caps, gearbox housing, hubs etc. Axle housing, portal etc.	Sand blasted, prime coated with oil-resistant stoving red oxide and zinc chrome
3.2	Malleable iron castings	Levers, shifting forks, Bushes, etc.	
3.3	SG iron castings	Front axle brackets	

Source: ECA, Engineering Industry Development Programme for Selected Eastern and Southern African Countries of Preferential Trade Area, 1985

CHAPTER 8

NON-FERROUS METALLURGICAL INDUSTRIES

8.1 General prospects for non-ferrous minerals

Zambia is one of the major copper-producing countries of the world. The mining industry is controlled by the Zambia Consolidated Copper Mines (ZCCM), of which 60 percent is owned by the Government holding company Zambia Industrial and Mining Company. The mining sector employs most workers outside the agricultural sector. In 1987 there were 55,050 employees registered in the mining industry. Its output in 1987 was 470,000 tons of copper, 22,000 tons of zinc, 6,000 tons of lead, and 4,100 tons of cobalt.

Zambia's mineral production, with the exception of cobalt, has declined since 1974, as shown in table 35. Declining production, due to the exhaustion of deposits, and depressed mineral prices have led to a dramatic drop in copper earnings. Almost exclusively minerals (copper, cobalt) are produced in Zambia by the Zambia Consolidated Copper Mines, which is 60.3 per cent government-owned through its holding company, the Zambian Industrial and Mining Corporation (ZIMCO). In 1986, 96 per cent of refined copper; 99 per cent of cobalt; 92 per cent of refined lead and 95 per cent of slab zinc produced in Zambia were exported. Domestic consumption as a proportion of production has been estimated at less than 1 per cent for copper. Local consumption of cobalt is thought to be below 10 tons/year.

Table 35: Mineral production in Zambia, 1974-1987
(Thousand tons)

Year	Copper	Cobalt	Lead	Zinc
1974	709	2.0	25	58
1975	648	1.9	19	47
1976	712	2.2	14	36
1977	659	1.7	13	40
1978	654	2.1	13	42
1979	583	3.2	13	38
1980	612	3.3	10	33
1981	589	3.2	14	34
1982	584	2.4	15	39
1983	575	2.4	15	38
1984	551	2.9	11	33
1985	525	3.6	10	29
1986	463	4.5	7	21
1987	470	4.1	6	22

Source: Government of Zambia, National Commission for Development Planning, Economic Report 1987, Lusaka, January 1988

In its north-central part, Zambia has some of the richest metal dep sits in the world. The copper-cobalt mines are linked geologically to those in the Shaba province of Zaire, both being part of the same copper belt which is 500 km long and 300 km wide and extends from Kolwezi in Zaire to Luanshya in Zambia. The two country's copper resources rank third in the world, after the USA and Chile. Zambia itself has an estimated 58 million tons, or 5 per cent of the world's known deposits. In addition, the Zambian/Zairean Copperbelt contains by far the greatest known resources of cobalt: of an estimated 9.9 million tons of cobalt resources in deposits on land, Zaire has a share of some 3.1 million tons, or 31 per cent, followed by Zambia with 1.7 million tons, or 17 per cent of the world total. Table 36 shows the recognized ore reserves of about 466 million tons, corresponding to about 330,000 tons of copper. There are also important lead zinc deposits at Kabwe.

Problems and prospects of the mining sector are basically the same as for the copper sector, because copper represents 90 per cent of the value of all minerals produced in Zambia, and second, because the production of other minerals such as cobalt and coal are closely associated with the production and refining of copper.

Table 37 shows copper production, import-export statistics, consumption and stocks between 1980 and 1987. This table also shows that the basic metals industry in Zambia is extensively integrated with industrialized countries. The establishment of domestic downstream industries have not been strongly pursued. This is also have for other non-ferrous metals.

Table 36: ZCCM ore reserves

	'000 t	Cu %			
NCHANGA			NKANA		
FD*	3198	6.51	FD	2133	1.84
PD	15428	6.20	PD	16597	2.14
U	95993	3.18	U	81913	2.43
Total	114619	3.68	Total	100643	2.37
KONKOLA			CHIBULUMA		
FD	620	4.02	FD	882	3.88
PD	3683	3.96	PD	1192	2.73
U	43845	3.86	U	6888	3.25
Total	48148	3.87	Total	8902	3.24
CHAMBISHI			LUANSHYA		
FD	542	3.02	FD	1576	2.22
PD	505	3.20	PD	5499	2.27
U	28000	2.68	U	31058	2.51
Total	29047	2.70	Total	38133	2.46
MUFULIRA			BALUBA		
FD	7236	3.08	FD	844	2.35
PD	8775	3.0	PD	2650	2.37
U	64780	3.18	U	43186	2.51
Total	80791	3.13	Total	46680	2.50

Source: Mining Journal, Mining Annual Review, London, June 1987

Notes: *FD = Fully developed
PD = Partly developed
U = Underdeveloped

Table 37: Statistical summary of copper production

	1980	1982	1983	1984	1985	1986	1987 Jan-Sep
UNWROUGHT							
Production							
Ores and concentrates(Cu content)	595,759	529,641	591,300	576,000	512,858	512,858	388,460
Blister and anode copper[a/]	601,348	580,700	562,722	531,945	544,176	514,090	398,407
Refined copper	607,100	587,000	573,500	521,900	509,968[b/]	487,300[b/]	385,606[b/]
Imports							
Ores and concentrates (Cu content)	-	-	-	-	30,521	29,417	16,402[c/]
Exports							
Refined copper Total	614,208	602,583	570,453	530,093	504,986	466,346	385,661
of which to:							
Austria	3,006	-	-	-	-	-	-
Belgium	11,882	13,513	25,771	32,086	20,706	43,632	31,822
Brazil	5,899	7,859	2,090	5,427	1,200	755	-
Canada	- 1,956	-	-	-	-	-	-
China	15,389	21,298	48,067	52,477	43,437	1,950	3,001
Denmark	3,876	-	-	-	-	-	-
Egypt	3,001	3,169	3,497	5,628	3,496	1,000	-
Finland	1,829	3,890	4,378	2,176	2,000	7,521	801
France	86,574	80,586	70,367	33,422	41,785	50,343	15,119
Germany, D.R.	1,197	2,250	2,000	2,505	500	-	-
Germany, F.R.	62,447	51,689	28,007	8,595	16,810	7,295	5,908
Greece	11,751	15,270	13,453	17,061	11,889	19,283	14,552
India	39,723	47,293	48,736	30,017	40,899	34,221	40,693
Indonesia	4,505	8,562	8,419	9,086	11,982	8,1999,50	
Italy	14,293	77,618	53,528	52,040	54,586	48,847	39,757
Japan	131,638	156,449	96,126	143,052	134,761	93,758	117,480
Malaysia	-	-	16,061	15,400	12,930	11,587	3,813
Netherlands	2,581	4,000	603	1,001	3,103	7,281	3,854
Romania	1,002	- 1,979	-	-	-	-	-
Korea, Rep. of	-	1,001	500	9,383	499	497	4,300
Sweden	13,585	18,339	21,691	4,687	6,000	6,981	-
Switzerland	1,895	2,380	1,932	875	200	-	-
Thailand	100	5,022	7,780	9,687	12,850	10,814	15,234
United Kingdom	54,869	43,800	55,026	23,195	41,673	50,300	7,860
USA	64,526	13,569	40,567	55,297	140	15,170	28,595
Yugoslavia	15,912	23,408	16,102	14,970	4,525	8,863	4,907
Other countries	2,764	779	3,773	2,026	39,015[b/]	38,049[b/]	38,263[b/]
Consumption							
Refined copper	2,209	2,793	1,136	-	-	8,300	-
Stocks (at end of period)							
at producers							
Ores and concentrates (Cu content)	51,229	55,652	32,491	28,015	25,863	31,761	25,134
Blister and anode copper	30,662	39,674	35,512	39,036	42,413	38,314	35,024
Refined copper	7,519	12,10	11,672	14,263	13,191	9,056	12,231

Source: World Metal Statistic 1988

a/ Includes Leach cathodes i.e. refined copper produced direct from concentrates withouth being treated in the smelter.

b/ Includes toll refined material.

c/ January to August.

8.2 Products of primary industry

Each of the segments of industry gives rise to its own range of products. Here we are concerned with the primary industry covering mining, mineral dressing, smelting and refining, each giving rise to products which form the basis of international trade.

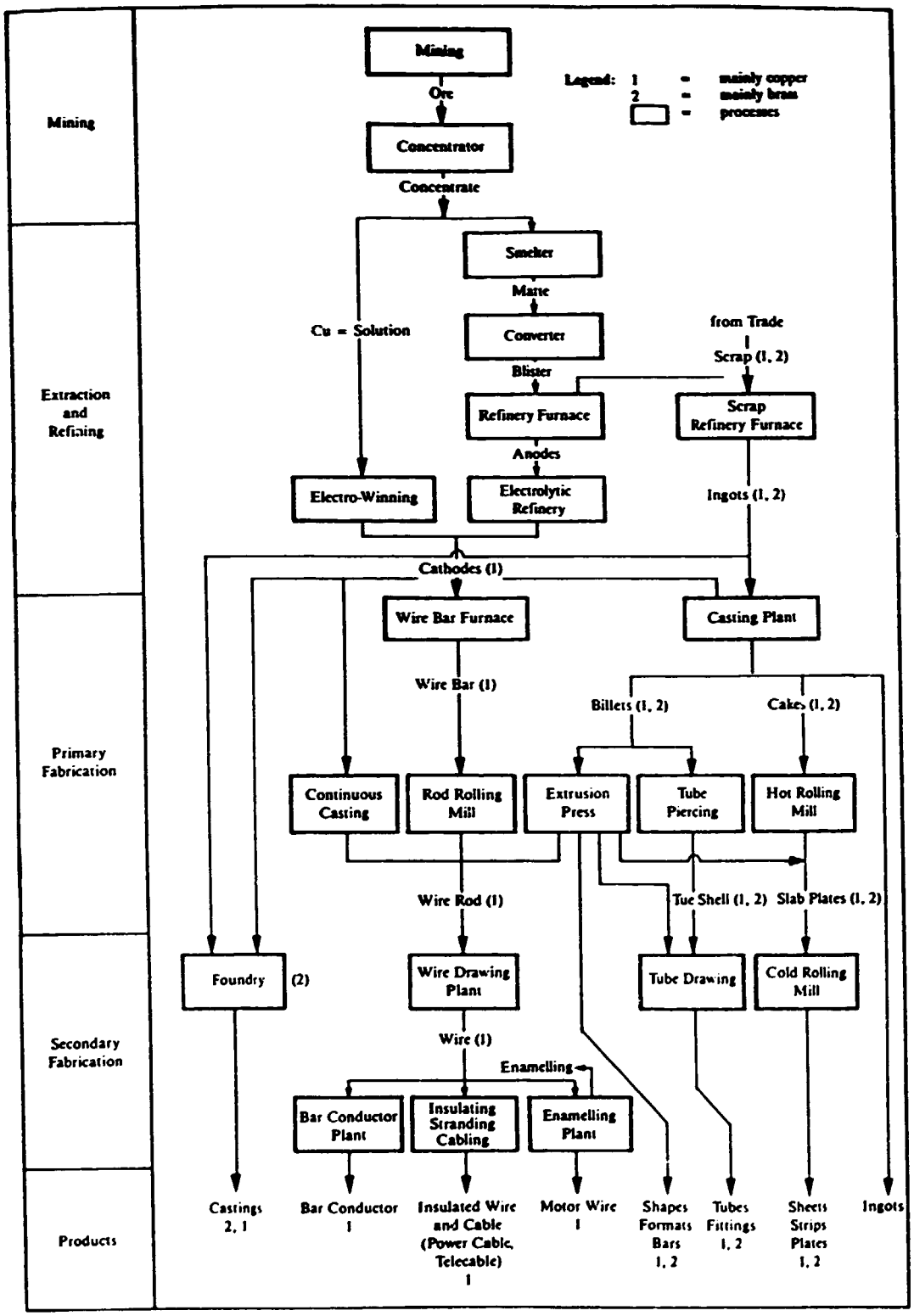
Because of its bulk, copper ore is usually not transported over long distances. Figure 3 shows the processes used in copper treatment and the subsequent fabrication sector, and interrelationship of the various processing stages. Although the diagram given is for copper, processing and fabrication of the other base metals produced in Zambia, i.e. lead, zinc and cobalt, would follow similar steps.

Copper is mined mainly as sulphide ore although oxide ore is also mined. The treatment stages commence with the concentration of ore through a variety of techniques, the main one being flotation, to produce a concentrate containing about 30 per cent copper. The concentrate is then melted down in a smelter to produce an intermediate copper matte containing about 60 per cent copper. The matte is further refined at high temperatures by air injection to provide blister copper with a copper content of 98 per cent copper. The blister copper is cast into anodes which form the material input for electrolytic refining during which they are dissolved in acidic solutions and re-precipitated by use of an electric current. The redeposited copper sheets are referred to as cathodes and contain more than 99.98 per cent copper. The cathodes are further refined by remelting in a reverberatory furnace and recast in the shape of wire bars whose shape is really a matter of convenience for subsequent fabrication processes. ZCCM's total smelting/refining capacity is estimated at 630,000 tons per year of refined copper, and its leaching plants have a combined capacity of about 263,000 tons per year.

During the processing of copper, a considerable amount of scrap is generated. Current estimates indicate that within the ZCCM operations at least 55,000 tons per year are generated. This scrap is recycled to either the smelting stage or wire-bar melting and casting facilities. Owing to the absence of a fabrication sector in Zambia, there is no significant copper-scrap based industry in Zambia outside ZCCM, apart from ZAMEFA (see 8.3) which uses about 50 tons per year.

What Zambia now needs is an increased and diversified fabrication of semis and an integration of its copper industry with downstream processing. Increased downstream processing would result in internal multiplier effects and also in increased value added and employment gains can be created. The question of fabrication of products to increasing local processing of Zambian metals haves been addressed by successive development plans, but few projects have been realized so far.

Figure 3: Flow sheet: copper processing



Source: Raw Materials Report, vol. 5, no. 4.

8.3 Primary and secondary fabrication

In the past the traditional method of fabricating wire rod for use in wire and cable manufacturing consisted of rod-rolling. The wire bar was heated to about 830°C and rolled in several phases to wire rods. In recent years, however, the trend in wire-rod manufacture has been towards continuously cast rod (CCR). This has resulted in greatly decreased production costs due to a reduction of process steps and improved quality, particularly by eliminating the need for welding a number of wire rod pieces together to produce a coil. Additional shapes and wire-rod in this primary fabrication sector include bars, sections and many other profiles. These are produced mainly by an extrusion process in which a hot billet is pressed through a die assembly at high pressure. Where a flat product such as a strip is required for subsequent sheet manufacture, slabs of hot metal are pressed between two adjacent rolls to reduce their thickness, a process which is generally referred to as hot rolling.

The products of the above fabrication processes (primary fabrication) are popularly refered to as copper (alloy) semi-manufactured. Copper is alloyed with other metals such as zinc, tin and nickel to form a product which meets the structural strength requirements of engineering articles.

Secondary fabrication is aimed at yielding the final end-user product. The manufacture of copper wire is done in the wire drawing plant. Tubes are obtained in thick, extruded, pieced or continuously cast shapes. The actual drawing is performed by pulling the tube over a die, the assembly being such that simultaneous reduction in outside and inside diameters take place. For the manufacture of sheets and foils, cold rolling is usually performed on hot rolled strips or sheets to reduce the thickness. These are the same as those of the iron and steel industry.

The last secondary fabrication method to be mentioned is applied in foundries. These are essentially workshops in which copper and copper alloys are melted and then cast into a wider range of intricate shapes. Most foundry products consist of copper alloys; brass alloy production accounts for 80-90 per cent. The alloys are commonly melted in an induction furnace of 3-5 tons capacity and cast into moulds, usually made of sand.

8.4 Local fabrication capacity in Zambia

The only notable producer is Zambia Metal Fabricators (ZAMEFA), whose factory is located in Luanshya, falls under the Industrial Development Corporation (INDECO) group, which owns 51 per cent of the company.

The products manufactured by ZAMEFA fall into several categories:

1. Continuous cast rod

   This commenced in 1983, and in 1985 7,000 tons of copper rods were produced, mainly for export, while the budgeted production figure for 1986 was 9,000 tons.

2. Wire and cable

A wide range of wires and cables, ranging from power cables of up to 3.3 m to domestic or construction wire in stranded, insulated and uninsulated forms as well as telephone cable. Total production of this category has been estimated at about 1,800 tons in 1987. Main users are the Post and Telecommunications Corporation (about 300 tons of telecommunication cable), ZCCM and ZESCO (about 600 tons of power cable).

3. Fabricated products

This category comprises the extruded products which consist of rods, bars and sections etc. About 100 tons/year of extrusion products are made on a jobbing basis.

Most of this production is done on behalf of ZCCM for its bus bars, anode lugs, bars for starting sheets, etc. Apparently, ZCCM supplies its own billets and pays for the production costs. The extrusion press was originally installed for the production of wire rod and has an installed capacity of 6,000 tons. Surprisingly, no tubes and pipes are extruded; at present they are imported into the country.[1/]

Other than ZAMEFA, there is another copper fabrication plant in which the Zambian Government has equity participation. This is the Société de Coulé Continué de Cuivre (SCCC), a subsidiary of a French company in which the Government owns 50 per cent at the shares. The plant produced CCR and in 1984/85 sold 164,140 tons of copper rod, out of which ZCCM's share of retained profits was ZK 1.2 million.

Besides the above-mentioned two companies, copper and copper-alloys are produced in several small foundries. Details are available on two non-ferrous foundries in the Copperbelt; the Foundry and Engineering Ltd. in Luansyha; and the Non-ferrous Metal Works in Ndola (see table 22 above). Although both produce primarily copper alloy castings, the former specializes in phosphor bronze, manganese and alminium bronzes, while the latter produces some tin bronze and brass. The foundries operate more or less on a jobbing basis. In October 1985, Non-ferrous Metal Works completed the construction of a new foundry which has an installed capacity of 1,000 tons.

Besides the traditional copper fabricators, Zambia Almunium Ltd., whose production was in the past concentrated on aluminium-corrugated sheets and kitchen utensils, has installed a horizontal continuous caster to diversify into the production of brass-semis manufacture. Its production commenced in March 1987, initially with an output of 1,000 tons/year of continously cast products.

1/ W.C. Lombe, Common Fabrication Facilities and the Mining Resource Base in Zambia, 1987.

The 1986 production capacities of copper and copper alloy products in tons are given below:

Company	Wire Rod	Rods, bars and sections	Strip, sheets and plates	Cables	Casting
ZAMEFA	9,000	6,000	-	1,800	-
Castings	-	-	-	-	400[a/]
TOTAL	9,000	6,000	-	1,800	400

Source: W.C. Lombe, Common Fabrication Facilities and the Mining Resource Base in Zambia, 1987.

Note: a/ Includes four small non-ferrous foundries in the Copperbelt.

The available capacity can well meet the demand for extruded products in copper (alloy) semis. The main problem would appear to be that rods, bars and sections are usually made from copper alloys (about 90 per cent) which are at present not manufactured in Zambia.

The Kabwe Division of ZCCM produces lead sheets and piping for domestic consumption. Lead sheets are mainly sold to ZCCM refineries and Kafironda who use it as acid resistant material. Smaller quantities are sold to Chloride Zambia Ltd. and SIMMS Electrical and Diesel Services Ltd. who both use it for the manufacture of automotive batteries. Sheet sales in 1985 amounted to 1,200 tons. The total local consumption of sheets and pipes in 1984/1985 was estimated at 25 per cent of total lead sales of 10,400 tons.

During the same year sales of domestically produced zinc accounted for 3.3 per cent of total zinc sales of 30,300 tons. The main consumers are GALCO (Zambia) Ltd. and PIPECO, both of the CHANDARIA Group of Companies, and Monarch (INDECO). All of those use zinc for galvanizing. Other consumers are MANSA Batteries (INDECO battery manufacture) and Metoxide (CHANDARIA zinc oxide manufacturing for paints and tyres). Sales of domestic zinc were projected at 1,124 tons for 1986.

With regard to cobalt, local consumption is virtually non-existent, as mentioned before. Unified Chemicals of Lusaka manufactures a range of metal salts for exports and local consumption. This includes the manufacture of small quantities of cobalt nitrate. Consumption, however, is unlikely to exceed 1 ton/year.

CHAPTER 9
CONCLUSION

Zambia's economy has been on a declining path since the collapse of copper prices in the mid-1970s. Zambia's dependence on the copper industry for virtually all its export earnings seems to be one of the causes of the country's current financial and economic difficulties. Most observers agree that Zambia's inability to reduce its dependence upon copper will soon bring about the depletion of economically recoverable ore reserves.

Despite extensive mineral surveys, there are no known ore bodies in the Copperbelt large enough to offset the natural depletion of existing mines in the 1990s. In spite of this, Zambia has to rely to some extent on copper revenues to finance its investment programmes to support other sectors of the national economy and to diversify the country's economic base.

If Zambia aims at achieving food self-sufficiency and at boosting agricultural exports and inputs to industry as part of the process of restructuring the economy away from copper dependence, the agricultural sector - which has perhaps the greatest unfullfilled potential - is worth attention. The industrial sector also has an important role to play in Zambia's future economic development.

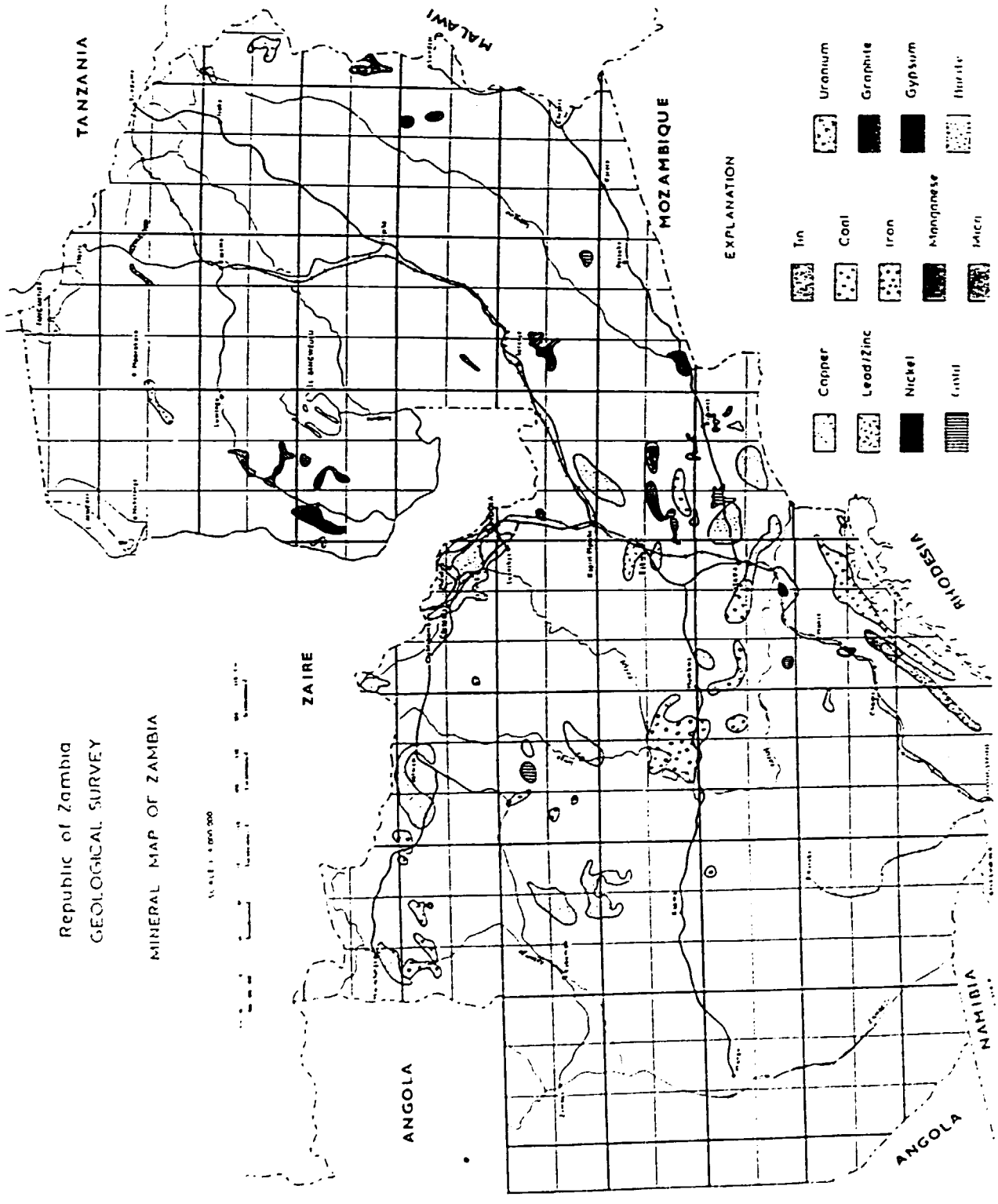
In order to make the economy more independent both of imported goods and of copper exports, industrial and agricultural production must expand in a balanced, integrated way so as to meet a large share of demand from domestic sources and to generate new export revenues. This leads to more production of high value-added products and a sound development of the national economy.

In this respect, the development of metallurgical industries such as foundries and forges, and the iron and steel industry has an important role to play in Zambia's future economic development. As a matter of fact, foundries and forges constitute an industrial base for the current manufacture of a wide range of agricultural implements and machinery, irrigation equipment, and a variety of water supply machinery and equipment. The iron and steel industry can produce intermediate goods as well as raw materials for the manufacturing and agro-based industries. Foundries and forges can also provide these industries with spare parts, metal coating and fabrications to maintain their continuous operation.

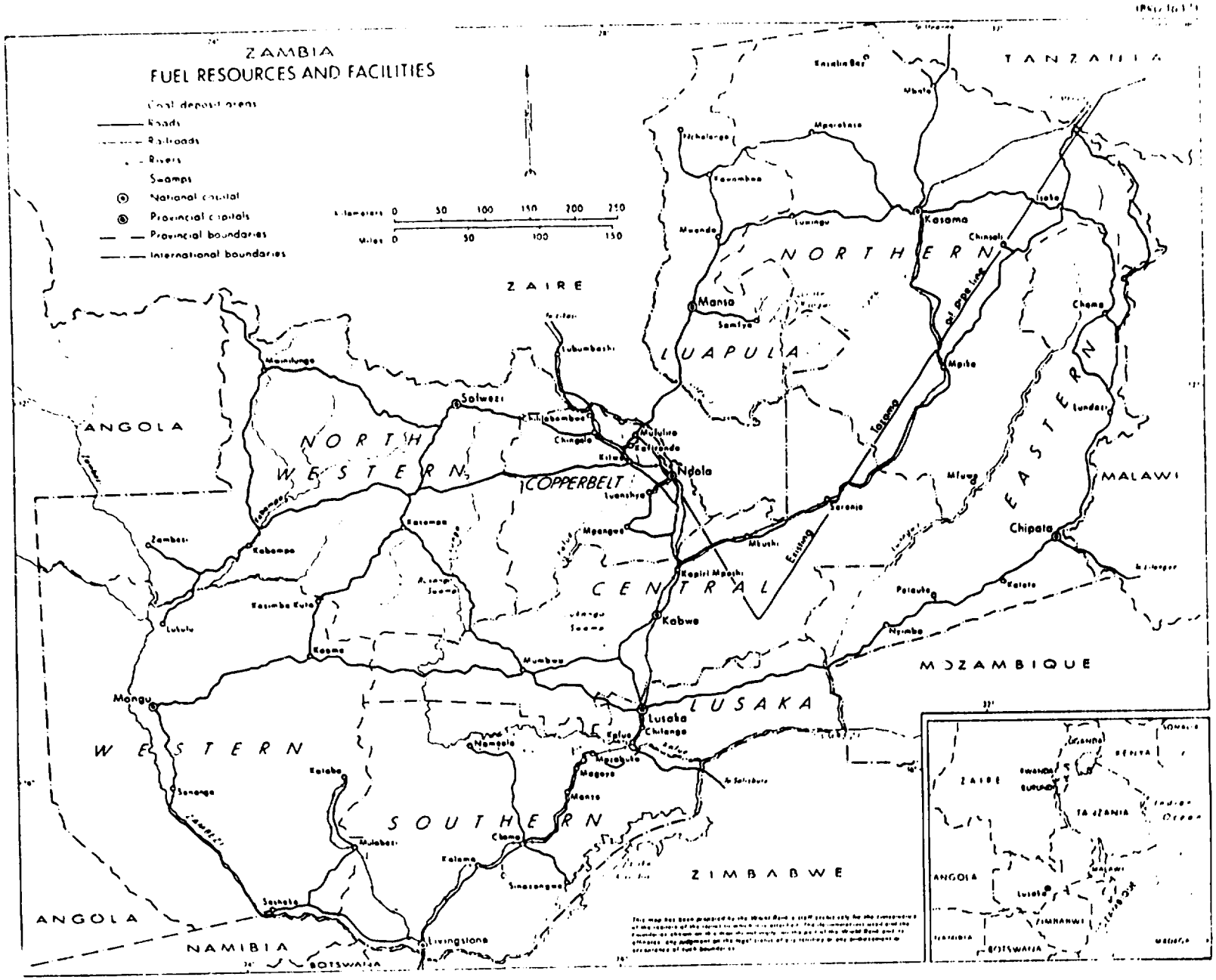
An integrated approach to industrialization can be promoted through further development of the iron and steel industry. However, existing foundries and forges in Zambia require upgrading in order to support the integrated development of the industrial sector.

The development and the rehabilitation of core metal working facilities such as foundries, forges, tool rooms, metal firming, fabrication and coating facilities promote the engineering industries subsector, which includes manufacture of machine tools, tractors, transport vehicles, low cost transport equipment and spare parts. Thus, the development of these core metal-working industries is a must, not only for the development of original equipment for manufacturing industries, but also for its expected galvanizing effects other sectors of the economy.

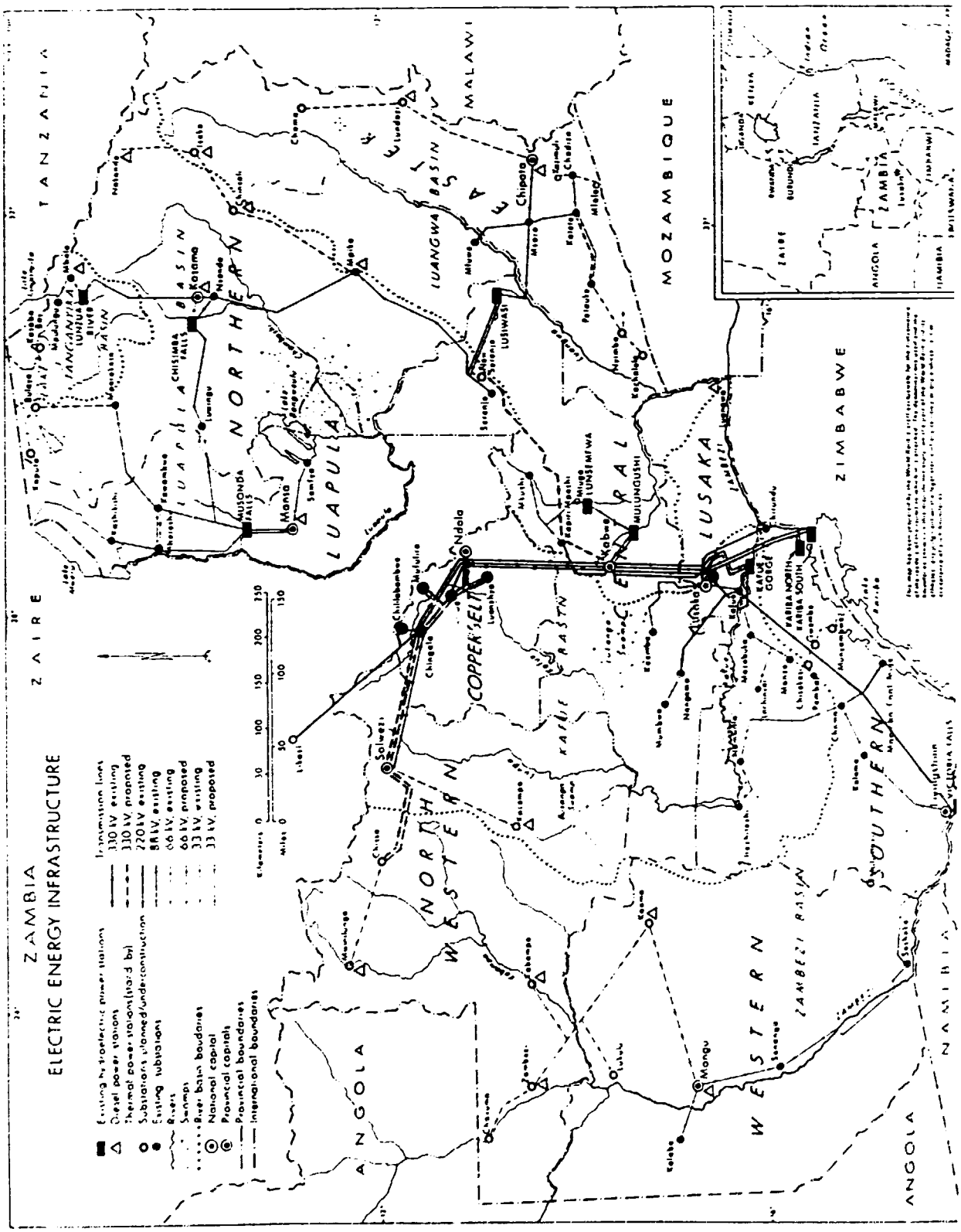
Annex 1.1: Zambia: Geological Survey and Mineral Map



Annex 1.1: Zambia: Electric energy infrastructure



Annex 1.3: Zambia: Fuel resources and facilities



Annex 2: Major engineering firms in Zambia

Company	Produce	Nominal capacity
Copper Crafts Ltd.	Silver trays and vessels copper lamps	
Claus Rygaard	Silverware	
Baba Auto Engineering	Skinning rotor Relining of brake shoes	
J.D. Corbishley Box 8097, Kitwe	Welding machine coils accessories	 200 units
E.B. Steel Box 1250, Kitwe	Steel structures agricultural implements coach/body builders	30 74 66
Associated Industries Box 35270, Lusaka	Pots, curry dishes billy can rings buckets, teapots saucepans frying pans tea sets, tray spoons allied	35,000 kg 9,000 kg - 10,200 kg - 10,000 kg
Diecab Division of Boart Zambia, Ndola	Rock drilling machines and spares	
Atlas Copco	Rock drills and pushers	
Perway Industries Box 21189, Kitwe	Rail turnouts and fittings	720
Vulcan Foundry & Iron Works, Box 954, Lusaka	Aluminium castings grey iron castings	- -
Mine Safety Appliances (CA) Ltd., Box 27, Ndola	Ventilation ducting hard hats assembly miners belt, miners cap lamps, protective safety clothing	 -

Modern Industries Box 658, Mufulira	Steel beds furniture burglar bars cycle carriers	12,000 - - -
Bologrini Foundries (Z) Ltd., Box 520, Chingala	Water pumps/impellors slush pumps, bushes gate valves, tapes, socket lines, crushes and spanners	
Central African Engineering Corporation, Box 20974 Kitwe	Steel fabrication and erection plant and crane hire	--
Best Weld engineering Box 32234, Lusaka	Wire screen and spares sheet metal) general fabrication)	42 tons 175 tons
Don Enterprises Box 31707, Lusaka	Agricultural implements	
Turning & Metals Box 31608, Lusaka	Agricultural implements	
Lusafrica Industries Ltd., Box 31425, Lusaka	Agricultural storage containers	
Fabro Metal Ltd., Box 301, Lusaka	Picks hoes, shovels, axes, spades	
Brake & Clutch Co	Brakes, clutches	80,000units
United Machining Works Box 520, Chingala	Shafts, gears bushes, nuts	
Shifal Engineering Works Box 1870, Ndola	Steel wool bed accessories fire extinguishers	180 tons 50 tons 120 units
Kitwe Processing Box 1382, Kitwe	Metal products	700 tons

Foundry & Engineering	Non-ferrous casting concentrates spare parts	50 sets
	bronze brushes and bars	75 tons
	tin lights	30 tons
Zambia Containers Box 7, Mufulira	General hire cans	1,450,000
Steel Mater Engineering Box 2276, Kitwe	Rail wagons tanks erective/fabrication	
All metal Engineeering Box 1273, Lusaka	Structural steel work	-
	tanks	1000
	maize mills	125
	fodder mills	20
	maize shellers	25
Musendo Turning Box 71404, Ndola	Building structures tanks door frames window frames burglar bars	
Zamcapital Enterprises	Paultry drinker valves	
Auto Radiator Ltd.	Radiator cores	
Bwalya R.D. & Co	Pipes	
Compestan Services	Pneumatic drilling equipment	
Allen West (Z) Ltd. Box 20736, Lusaka	Motor control centres electrical motor starters	
Muchinga Engineering Box 90659, Luanshya	Light engineeering products	
International Bolts & Nuts, Box 1830, Kitwe	Bolts studs studding	
Girder Engineering	Liners frames	
	pulley	600 tons

Premji Industries Box 301115, Lusaka	Spray pumps paraffin stores	
Fibreglass Enterprises Box 22298, Kitwe	Bakery trays engine bonnets bar stools switchgear and metering equipment tanks	
Hume (Z) Ltd. Box 32099, Lusaka	Prestressed lighting brackets and columns cable covers and markers	
Moonlite Industries Box 31168, Lusaka	Paper clips	
EML Ltd. (or BML?) Box 31189, Lusaka	Stay 'D' iron rods conduit boxes couplings, locknuts copper brackets male bushes	
Gem Industries Box 72391, Ndola	Copperware	
All Metal Engineering Box 31273, Lusaka	Hammer mills	
Extrusion Process (Z) Ltd., Box 30843, Lusaka	Aluminium collapsible tubes	
Monarch (Z) Ltd. Box 20976, Kitwe	2.5-litre cans 5-litre cans steel windows) doors/door frames) wheelbarrows water heaters galvanized hollow-ware welded wire products	4,800,000 4,800,000 2,600 tons 15,000 tons 5,000 tons 133,000 tons 1,500 tons
Andrea Machinists Box 23226, Kitwe	Moulds water valves propellor shafts	

Cool Aluminium Ltd. Box 1784, Ndola	Aluminium suspended) celings) venetian blinds) exterior sun awning) curtain track)	1,200 tons
Fabro Metal Ltd.	Picks, hoes, shovels axes, spades	
Non Ferrous Metal Works Box 874, Ndola	Solder white metal printers metal aluminium ingot brass billet copper ingot rope capping	30 tons 5 tons 4 tons 2 tons 15 tons 20 tons 15 tons
Anros Industries Box 30327, Lusaka	Nails diamond mesh (galvanized) fencing wire	
Roan Engineering Box 37, Luanshya	Pipe logs couplings cylinders and valves general engineering and mining equipment fabrication	
A.W. Construction Box 608, Kitwe	Chairs	
Copperbelt Steel Mfg. Box 653, Kabwe	Steel arch supporters) diamond mesh wire) barbed wire) cranby cars) transformer tanks)	9,000 tons
E. Walker Welding & Repairs, Box 214, Choma	Drug harrows draw bars cultivators ridgers ploughs hoes, trailers) water carts) farm gates)	10,000 7,000 500 2,000 2,000 -

Agricultural Irrigation Ltd.	Aluminium irrigation pipes	
Nortnland Agricultural Ldt.	Mould-board ploughs cultivators and allied spares	800
Mufulira Bronze Castings	Agro-industrial commercial machines and spares	
Tubes Limited Box 80680, Kabwe	Aluminium tubes	1,400,000 Ft.
Cool Aluminium Limited Box 1784, Ndola	Aluminium suspended ceilings, venetian blinds, exterior sun awning curtain track	1,200 tons
Alpha Rolling Mills Box 80413, Kabwe	Copper rolled sheets	1,920 tons
Kabwe Diecasting Works Box 80048, Kabwe	Taps, nuts and bolts, valves, window frame handles concealed door stoppers furniture handles zinc alloy sheets copper sheets	80,000 65 tons 45,000 200,000 35,000 500,000 15 tons 65 tons
Fabro Metal Limited Box 300301, Lusaka	Picks, hoes, shovels	-
Nonferrous Metal Works Box 874, Ndola	Solder white metal printers metal aluminium ingot brass billet copper ingot rope capping	30 tons 5 tons 4 tons 2 tons 15 tons 20 tons 15 tons
Anros Industries Box 30327, Lusaka	Nails diamond mesh (galvanized) fending wire	- - -

Roan Engineering Box 37, Luanshya	Pipe lengths couplings cylinders and valves general engineering and mining equipment fabrication	- - - -
A & W Construction Box 608, Kitwe	Chains	-
Copperbelt Steel Mfg. Co Box 653, Kabwe	Steel arch supporters) diamond mesh wire) barbed wire) cranby cars) transformers tanks)	9,000 tons
Galco (Z) Limited Box 75, Lusaka	Corrugated steel sheets) (galvanized) ridgings (galvanized)) flat and black sheets) (galvanized) steel sheeting and accessories (galvanized) aluminium coloured panelling	18,000 tons
Appollo Engineering Works Box 621, Ndola	Steel stuctures, water tanks, fabrication machine shop engineering cast iron valves agriculture implements	
Mathews Engineering Box 2, Luanshya	Mining equipment loader bricks industrial fibreglass roof sheeting	-
Bobkin Engineering Chelston, Lusaka	General engineering	-
Bayco Box 21164, Kitwe	Structural erection instrument tools	-
Navint Engineering Works Box 674, Ndola	Folding beds divan beds steel chairs steel collapsible gates	-

Karig Investments Box 178, Kitwe	Industrial and household fittings educational and other toys	10,000 70,000
Jung & Company Box 2418, Kitwe	Cement mixers block-making machines agricultural machinery	36 24 36
Trojan Security Devices Kapondo Street, L/Stone	Mortice rods ironmongery builders hardware	 108,000
Luanshya Engineering Co P.O. Box 3, Luanshya	Mining and industrial equipment fibreglass/resin products	2,000-2,500 tons 50 tons
Tesolin & Darioli Engineering P.O. Box 21217, Kitwe	Steel pipes steel structures steel gratings flanges, allied machinery parts	 -
Delta Enfield Engineering Box 543, Ndola	Carton brushes contacts current collectors	 100,000
J. Legge & Co (Z) Ltd. P.O. Box 403, Lusaka	Legge locks lock furniture	- -
Savannal Agric.Imp. mfrs P.O. Box 188, Petauke	Hoes axes, bolts, ox cart, cycle carriers, ploughs	 -
Ifestos Engineering P.O. Box 1941, Ndola	Steel structures water tanks fabrication machine shop engineering	 -
Metallic Crafts Ltd.	Furniture tubular can bats wrought work	 -
Hardware Manufacturers (Z) Ltd., Box 32166, Lusaka	Hardware and ironmongery electron planting and contract work	400,000 pieces 750,000 pieces

Shenga Steel Box 30977, Lusaka	Steel furniture, shelving, partitioning racking, steel scaffolding, ancillary equipment, agricultural implements, steel reinforcing	- -
Meem Engineering Box 33185, Lusaka	Hoes, picks, harrows, ploughs, cultivators, planters, slashers, axes, spades, water tanks, rakes, wheelbarrows, scotch carts, farm trailers, burglar bars, steel doors, folding and cutters, fencing gates, roof trusses, farming, bakery and security equipment	 -
Demar Engineering Box 8051, Kitwe	Hoes rakes	60,000 60,000
Lock-Pro Box 35582, Lusaka	Shovels, forks, badzas, rakes, slashers, hydraulic presses vices, solar heating heating pellets, treatment units swelling pumps	25,000 pieces 250 pieces 20 pieces 70,000 pieces 150 pieces
RAINE Engineering Co Box 188, Luanshya	Structural steel products	-
BOL Engineering Box 238, Ndola	Steel structures burglar bars metal steeling gutters and downpipes	 -
Trusteel Limited P.O. Box 90188, Luanshya	Structural steel products	-
Engineering Service Installations, Box 21866, Kitwe	Baking ovens mixers, pans and associated accessories	 -

UNIGLO Limited P.O. Box 35051, Lusaka	Aluminium ladders sliding doors shop fronts swing doors fronts	700 300 300 300 300
ZAMALU P.O. Box 32270, Lusaka	Aluminium ware enamel ware other hollow-ware sheet metal fabricated products	500 tons 540,000 dozens 120 tons 120 tons
Amalgamated Steel Engin. P.O. Box 30332, Lusaka	Water tanks refuse collectors poultry equipment wheelbarrows rainwater grain silos	400 7,500 6,000 3,000 3,600 100
Zambia Enamel Ware P.O. Box 32270, Lusaka	Enamel ware	300,000 dozens
E.G.S. Contractors Box 10012, Chingala	Steel structures, burglar bars, water tanks	-
Brake and Clutch Company	Brakes, clutches	80,000 units
Cutler Hammer (Z) Limited	Electrical switchgear motor control equipment distribution boards and components	
Schrevder & Co Box 1262, Ndola	Diamond mesh fencing wire posts gates small vehicle bodies steel roof structures bolts burglar bars	200 tons - - - - - -
Pipeco	Steel pipes steel tubings steel sections steel fittings	15,000 metric tons

Lutanda Limited Box 516, Kitwe	24" heavy duty mower 16" domestic mower agricultural mower mixers, grass cutting and concrete machines dumpers	300 300 100 - -
Conveyor Services Ltd. Box 191, Ndola	Conveyor belts	25,000 metres
Alor Engineering Box 2739, Lusaka	Water and fuel tanks ground-nut shellers stockfeed mixers cooking pots vehicle bodies fish fryers	40 - 20 30 40 -
Romana Mechanical Foundry & Transport Ltd. Box 838, Lusaka	Maize/ground-nut shellers maize loading machine seed grading machine ground-nut and maize mills	150 50 100 100
K.B. Davies & Company Box 10122, Chingala	Diesel engines marine outboard engines	50 50
Forgian Engineering Box 706, Kitwe	Mine implements and equipment	-
Scaw Limited Box 418, Kitwe	Grinding media) specialized castings)	50,000 tons
Valtas Engineering Box 1050, Ndola	Electrical distribution board meters meter boxes dustpans first-aid boxes trunks	 5,000 5,000 20,000 - 1,000
Bisinllah Engineering Co Box 30702, Lusaka	Water tanks gears mining industrial equipment hacksaw blades press metal products steel fabrication aluminium and iron castings foundry works	2,000 6,000

A.B.C. Brothers Box 30008, Lusaka	Farm gates sack barrows fencing and burglar bars	550 400 10,000
Thiter Engineering Services	Fish plates, plates and bolts dog spikes, eye bolts scrap bolts, wedges	340 tons
Amiran Limited P.O. Box 31744, Lusaka	Aluminium irrrigation pipes	700,000 meters
Agricultural Machinery & Equipment Supplies Ltd., Box 34628, Lusaka	Tractor components farm implements disc ploughs pistons gear pulleys tees and bands pipe fittings couplings, fittings bolts and nuts copper fittings gearboxes water pumps	60,000 7,200 2,400 24,000 1,200 48,000 2,400 36,000 72,000 units 1,200 1,200 2,400
Agricultural Implements Manufacturing Co Box 22694, Kitwe	Disc ploughs planter harrows cultivators	920 units 700 units 960 units 300 units
Reunited Engineering	Maize mills maize shellers planters	150 500 600
Tripe Jay Equipment Box 21534, Kitwe	Concrete mixers dumpers	30 30
Contractual holdings Box 2630, Kitwe	Diamond drilling crowns and shells rock drill, threaded rock drill, unthreaded dicarb spares and equipment	18,125 150,000 53,000 14,000
Industrial Equipment Box 22300, Kitwe	Valves	6,000 units
Cooeco Engineering	Cranby cars tray cars buckets chute boxes	240 tons

Metal Containers Ltd.	Tin containers barrels, small drums	301,000
Northland Engineering Box 7164', Ndola	Hammer mills tanks, vessels, framed structures, pontoons, vehicle bodies, bus assembly	300 -
Robert Hudson Box 150, Ndola	Steel pipes and general fabrication	1,000
Rotex Machine Engineering Box 1187, Chingala	Precision parts for mine machinery (shafts, bushes, pump spares)	
Steel Products Ltd. Box 32, Mufulira	Earthmoving equipment bucks, ventilation ducts	800 tons
Prestigio Manufacturing Box 1688, Ndola	Shafts, gears, bushes, pulleys, studs, bolts, nuts	
Steel Development Ltd. Box 4, Ndola	Trailers, tanks, galvanized sheeting, piping, steel components, sheet, metal work	
B.J. Engineering Box 662, Chingala	Precision parts for mines	
Grippe Engineering Box 238, Ndola	Gears, shafts, bushes, nuts, bolts, spares	
Globe Electric (1965) Ltd. Box 675, Chingala	Bolts, nuts, shafts, bushes, gears	600
C B. Beries Machinists Box 874, Kitwe	Machined metal parts, acid pumps, spare parts	120.000
Ndola Engineering Co Box 199, Ndola	Shafts, pulleys, bushes, spindles, gears	
Sand Cast Foundries Box 2004, Kitwe	Fabrication of casting in bronze, aluminium section	

Eastern Garage Box 2267, Ndola	Diamond mesh, fencing wire, burglar bars	
A.B. Hayward (1976) Ltd. Box 226, Luanshya	Dustbins, wheelbarrows, underground ventilation meter boxes	
ZNEL Box 34595	Drums cans and pans	600,000 511,205,000
B.M.S. Engineering Box 33241, Lusaka	Precision tools, press metal products, truck bodies filing cabinets, shelvings door/window trames	
Record Engineering Box 544, Ndola	Shafts, bushes, gears, bolts, nuts, pins, spares	
Kenny Engineering Box 529, Ndola	Stacking machines hexagon lamp mesh	30 300
Crusher Plant Manufacturing Box 1694, Kitwe	Screen mesh	4,000 units
Choma Auto Engineering Box 67, Choma	Iron gates scales trailers water carts	40 10 10 -
A.E. Derovan (Pvt) Ltd. Box 1041, Kitwe	Welding electrodes	45 tons
Ndola Metal Founders Box 2283, Ndola	Phosphor bronze brass aluminium, lead, cast iron rods, shafts, sections	
Setchells Ltd. Box 1300, Ndola	Barrel and running ripples	6,000
Zemsteel and Turning Box 32967, Lusaka	Abrasives brushes gears hacksaw blades shovels metal chairs	100,000 2,000 1,000 200,000 20,000 10,000

Thermex Engineering Box 2735, Lusaka	Water tanks rainwater and other galvanized goods	1,500 -
Prestige Engineering Box 3869, Lusaka	Hoes slashers ploughs harrows scotch carts roof trusses, burglar bars garden equipment	150 units 320 units 446 units 333 units 150 units
Brass Works Manufacturers Box 30444, Lusaka	Locks window handles door handles window winders	4,500 50,000 50,000 50,000
Petrox Group (Z) Ltd. Box 1833, Lusaka	Drums and barrels) collapsible containers) other containers) sheet metal items)	700,000
M.W. Wynberg Ltd. Box 825, Ndola	Water tanks, doors general sheet metal and joinery works	-
Nove Distributors Box 929, Ndola	electric converters, idler wheels, idlers	-
Canta Engineering	Roof bolts, steel ladders) chute boxes, bottle cells) carriers) sprays, bolts and nuts truck bodies	9,420 8,700,000
Crown Cork Co (Z) Ltd. Box 71564, Ndola	Crowns aerosol cans sanitary cans decorated plastic general cans	2,500,000 1,000,000 units 2,000,000 -