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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

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METALLURGICAL INDUSTRIES IN ANGOLA*

Studies on the rehabilitation of African industry

No. 11

Prepared by

Regional and Country Studies Branch

Industrial Policy and Perspectives Division

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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 Angola 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.

This report focuses on the main problems affecting metallurgical industries in general. It is beyond the scope of this report to cover all the salient factors, especially at the micro level, which affect metallurgical industries in Angola. This report, however, provides a solid basis for a more complete survey.

This survey of metallurgical industries in Angola addresses three essential factors: a substantial local survey of metallurgical and other natural resources; areas currently developed and potentially exploitable for metal-related industries; and an assessment of the nature of existing metallurgical industries at the plant level.

This report, together with a companion report on metallurgical industries in Zambia, 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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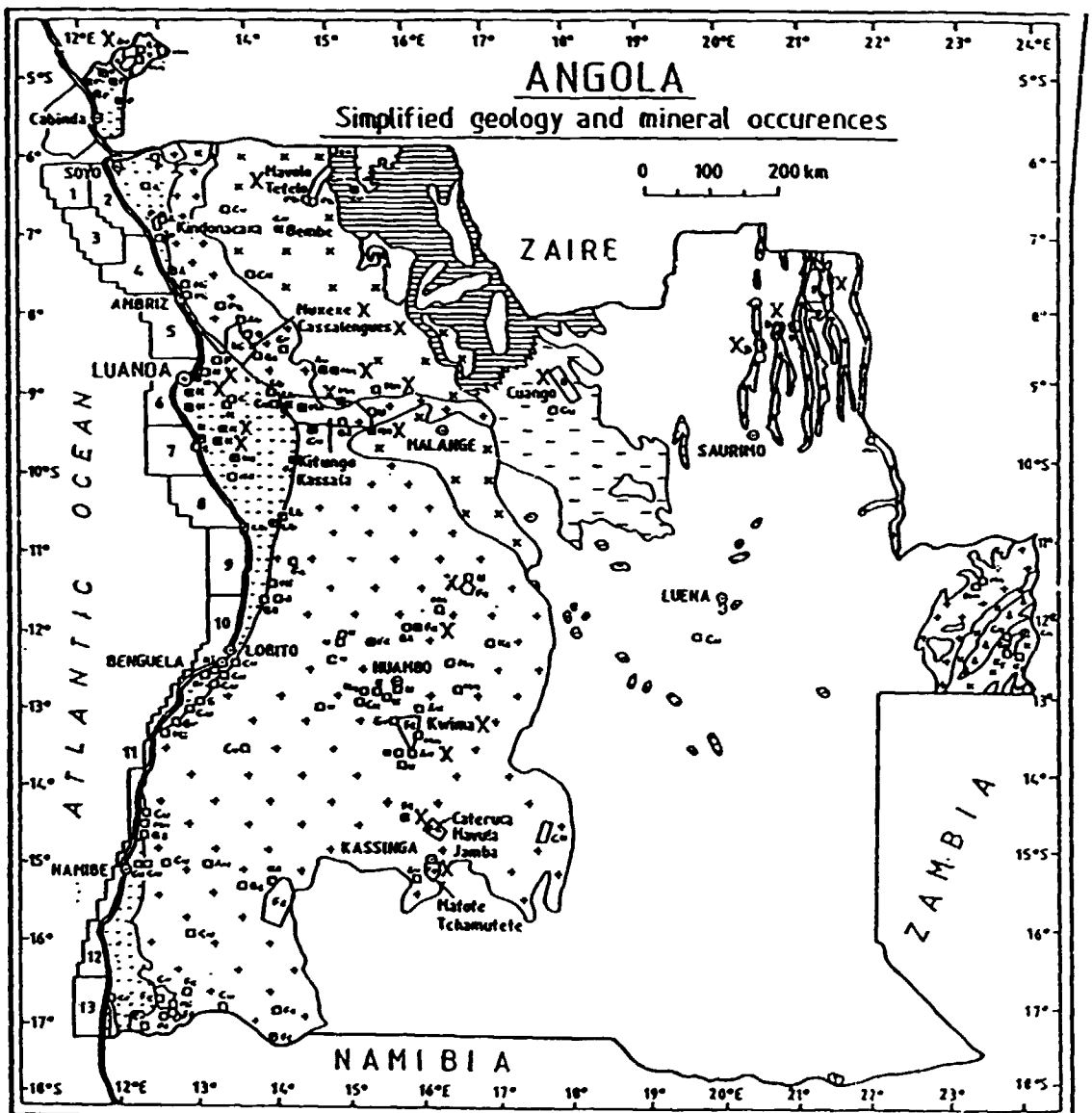

Geology

- Cretaceous - Quaternary
- Tertiary (Kalahari)
- Cretaceous (Kwango)
- Pre Permian (?)
- Carbonaceous - Jurassic (Karroo)
- Pre Cambrian (West Congo)
- Undifferentiated Pre Cambrian
- Major towns
- International boundary
- Geological contact
- Oil concession blocks (see table 7 of text)

Minerals

A	Asphalt	Gr	Graphite	Pb	Lead
Ag	Silver	H	Oil	Pt	Platinum
Au	Gold	Ka	Kaolin	Q	Quartz
Ba	Barite	Ki	Diatomite	S	Sulphur
Be	Beryl	Ky	Kyanite	Sn	Tin
C	Coal	Lb	"Libolite"	T	Talc
Cn	Corundum	Mi	Mica	Ti	Titanium
Cr	Chromite	Mn	Manganese	U	Uranium
Cu	Copper	Na	Rock salt	V	Vanadium
D	Diamonds	Ni	Nickel	W	Tungsten
Fe	Iron ore	P	Phosphates	Zn	Zinc

X Exploited deposit
■ Deposit of importance
▫ Deposit of secondary importance
○ Deposit of unknown importance
Area with dispersed deposits

Source : Ocurrences Minerais, OPSCM, 1965

LIST OF ABREVIATIONS

AGR	Agriculture
b/d	barrels per day
BOF	Basic oxygen furnace
CELB	Companhia Eléctrica do Lobito e Benguela
CONST	Construction
DANIDA	Danish International Development Agency
DR	Direct reduction
DRI	Direct reduced iron
EDEL	Empresa de Distribuicao de Electricidade
EAF	Electric-arc furnace
EIU	Economist Intelligence Unit
ENE	Empresa National de Electricidade
FAO	United Nations Food and Agricultural Organization
FERRANGOL	Empresa Nacional de Ferro
GDP	Gross domestic product
GFC	Gross fixed capital formation
Kz	Kwanza (Angolan currency)
LNG	Liquified natural gas
LPG	Liquified petroleum gas
MFG	Manufacturing
OHF	Open-hearth furnace
SADCC	Southern African Development Co-ordination Conference
SEF	Programa de Saneamento Economico e Financeiro
SKM	Siège Kolwezi Minas
SONANGOL	Sociedade Nacional de Combustiveis de Angola
TDR	TATA direct reduction
UNIDO	United Nations Industrial Development Organization
ZCCM	Zambia Consolidated Copper Mines Ltd.

0929s

CHAPTER 1
ECONOMIC BACKGROUND

1.1 Overview of the Angolan economy

Angola is potentially one of Africa's most prosperous countries. It has large reserves of oil, very great hydroelectric potential, numerous valuable minerals, including diamonds and iron ore, and plentiful agricultural land, of which only a small part (3 per cent) is at present cultivated. Angola has an area of 1.25 million sq km and a population of about 9.0 million (1988 estimate), which is growing at about 2.5 per cent per year.

In agriculture, coffee production reached an all-time record of 4.03 million bags (almost 242,000 tons) in 1972/73. A wide range of other cash crops, including sisal, sugar, tobacco and cotton contributed further to export earnings or supplied local industries. Manufacturing grew at an impressively high rate of 11 per cent per year between 1960 and 1973, and accounted for 16 per cent of gross domestic product (GDP) by the end of this decade.

Angola's economy is, however, still based on the production of primary commodities for export. The extractive sector took a new leap forward with the rise of the oil industry, which began production in 1956, and expanded rapidly after the first wells in Cabinda came on stream in 1968. Oil exports almost quadrupled in volume between 1969 and 1973, when it reached 7.3 million tons and became the top export earner, overtaking coffee. Other extractive industries also did well before 1975-1976. In the early 1970s Angola was the world's fourth biggest producer of diamonds, with an output of well over 2 million carats a year, 90 per cent of which are gem or near gem quality. Production of iron ore had risen from 106,000 tons in 1958 to 6.1 million tons by 1973 and had become the fourth main export after oil, coffee and diamonds, as shown in table 1 below.

Table 1: Major exports of Angola

	1973	1977	1980	1981	1982	1983	1984	1985	1986
Coffee ('000 bags)	3,500 (4,135)	951 (963)	721 (661)	344 (850)	290 (620)	217 (440)	254 (370)	214 (333)	270 (313)
Crude oil ('000 barrels/day)			134.2 (111.2)	129.4 (103.5)	129.6 (107.6)	178.0 (150.3)	204.0 (175.3)	231.9 (201.1)	280.7 (262.7)
Diamonds (Carats)	2,121 (1,940)	333 (337)	1,479 (1,460)	1,397 (1,409)	1,221 (1,260)	1,030 (1,002)	920 (954)	714 (741)	( )
Iron ore ('000 tons)	5,200 (1,438)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

Source: Economist Intelligence Unit, World Oil Trade 1987, 1988.

Note: ( ) indicates the quantity exported.

When Angola plunged into war in mid-1975, the disruption to the economy was devastating. Serious damage was done to basic infrastructure. Every sector of the economy, except for subsistence farming (on which 75 per cent of Angolans still depend for their livelihood) in some parts of the country, was hit by this upheaval. Ever since the economic dislocations of 1975-1976, the Government has striven to restore production to the levels achieved on the eve of independence (1973 being taken as the last "normal year" and hence as the standard point of reference). However, with the striking exception of oil, this has been an elusive goal, and in some key sectors, notably agriculture, the decline has become even more pronounced since 1975-1976. The war was the principal obstacle to agricultural recovery, although additional constraints arose from the ineffectiveness of the rural trading system and the shortage of goods for exchange with rural producers. Once a large net exporter of agricultural products, Angola now exports very little farm produce and depends almost entirely on imports to feed its urban population. Angola has become one of the countries which suffer from food shortages. According to the United Nations Food and Agricultural Organization (FAO) Angola required about 1 million tons of food aid in 1988, and still needs exceptional emergency relief.[1/]

Table 2 below shows the distribution of GDP by industrial origin in recent years.

Table 2: GDP by industrial origin, 1983-1985
(Millions of kwanza)

	1983	1984	1985	Percentage of total
Agriculture and livestock	14,641.5	13,470.2	11,264.2	7.8
Fisheries	2,235.4	2,604.1	2,783.7	1.9
Petroleum	32,979.8	41,417.5	44,601.1	30.9
Manufacturing and mining	9,494.5	11,576.0	18,841.4	13.1
Construction	3,135.3	3,377.6	4,502.5	3.1
Electricity	751.2	725.5	854.5	0.6
Transport and communications	4,764.7	7,489.3	7,914.4	5.5
Trade	15,636.0	14,000.0	14,154.5	9.8
Services	34,007.5	34,554.0	39,399.0	27.3
GDP at factor cost	117,646.9	129,214.3	144,315.3	100.0
Indirect taxes	14,742.1	21,502.1	15,297.4	

Source: Angola to the 1990s, Economist Intelligence Unit, 1987.

1/ FAO, Monthly report, February 1988.

The petroleum sector has the largest share in GDP, and may be considered the only area of success. Oil production has been rising very rapidly in volume, and tends to ease the balance of payments pressure that forced the Government to run up arrears and cut sharply into its import budget after the crash in the oil market in early 1986. Major oil-field development projects have been coming on stream in rapid succession, raising Angola's oil production to about 375,000 barrels per day (b/d) by the end of 1987, almost three times the level of 1982, when the sustained rise in production began. The state oil concern Sociedade Nacional de Combustiveis de Angola (SONANGOL) has estimated the 1988 production at around 430,000 b/d. Export earnings for 1988 are projected to reach $2.0 billion.

According to a recent SONANGOL report[1], recoverable reserves now stand at more than 20 billion barrels. At production levels of around 400,000 b/d, this is equivalent to a 20 years' supply. However, the dramatic weakening of the world oil market since the end of 1985 has exposed the precariousness of Angola's almost total dependence on this one commodity. Oil has been the country's principal export since 1973 and, along with a small volume of gas and refined petroleum products, accounted for 96 per cent of total exports by 1986.

A return to peace is the indispensable condition for a broad-based economic recovery, which could be expected to bring large inflows of capital. The Government is now proceeding with its package of economic reforms, the Programa de Saneamento Economico e Financeiro (SEF), which provides for a shift in the agricultural policy towards farmers, an increased role for private traders, greater financial autonomy for state enterprises, economic decentralization, reduced control over foreign exchange earnings of export industries, liberalization of price controls, tighter control over money supply growth and devaluation of the kwanza. These measures are expected to help raise domestic production, improve supplies for the population, stabilize the purchasing power of the kwanza and promote non-oil exports.[2]

Success also depends on Angola's ability to muster external financial support. Here priority is being accorded to allieviating the country's foreign debt burden of around $4.0 billion, which president Dos Santos has described as the main obstacle to economic recovery.[3] Apart from debt relief, the Government aims at encouraging foreign investment under the SEF. To this end, the foreign investment law is being reviewed and a foreign investment office will be set up to promote and co-ordinate investment. It is expected that joint venture partnerships will be allowed with state enterprises as well as with firms in the local private sector.

One other principal barrier to economic recovery is the disruption of the internal transport system. Rural-urban trade will remain hazardous and supply bottlenecks will persist for hinterland industries, such as the diamond mines

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1/ SONANGOL, Annual Report 1988.

2/ See, among others, The regeneration of Angolan manufacturing industry with emphasis on agro-based industries, UNIDO, PPD.R21, 1988.

3/ See Metallurgical Industries in Zambia, September 1989, p.7.

in Lunda Norte and the manufacturing plants in Huambo. In addition, like many other sectors of the economy, transport and communication services suffer from acute shortages of qualified managerial and technical personnel.[1]

The Government is seeking $87 million to finance the first phase of an emergency transport rehabilitation programme. The cost of the whole scheme is $340 million. The programme, which was put together by the Transport Ministry and the Maputo-based Southern African Transport and Communications Commission, has already been endorsed as a special assistance programme by the Southern African Development Co-ordination Conference (SADCC) at its Council of Ministers Meeting held in Arusha (Tanzania) in January 1988. At this meeting, rehabilitation and expansion programmes for the railway, power and telecommunication networks were decided upon with the help of donor countries such as the United Kingdom, Federal Republic of Germany, Finland, Sweden, Canada and Portugal.

Medium-term economic prospects essentially hinge on two factors, the security situation and the level of oil-export earnings. Neither is likely to improve much in the foreseeable future, and economic activity is therefore likely to remain far below pre-independence levels, perhaps for many years. Manufacturing output in 1985 reached 54 per cent of the 1973 output, mainly due to the rapid recovery of the light industries, since other manufacturing subsectors are still at less than half the 1973 level. Food processing industries suffered seriously from the agricultural crisis and the collapse in rural/urban trade, and are now almost entirely dependent on imports of raw materials. Reviving heavy industry has proved even more difficult, because of the greater complexity of the industrial units involved and the magnitude of the investments required to restore them to their previous capacity.[2]

Shortages of goods, whether inputs for industry and agriculture or food and consumer goods, have been a chronic feature of Angolan life since independence and have assumed serious proportions in recent years. Above all, they are a consequence of the very low levels of production in most sectors of the economy and limited foreign exchange available for imports.

The key to the transformation of the economy will clearly be the expansion of the agricultural sector, which has been adversely affected by past war and policies and which has significant unexploited potential for both crop and livestock production. The industrial sector also has an important role to play in Angola's future economic development. If the economy is to become more independent both of imported goods and of crude oil 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.

1/ A recent UNIDO survey of agro-based industries in Angola ("The regeneration of Angolan manufacturing industry, with emphasis on agro-based industries", PPD/R.21, 1 December 1988) provides an in-depth diagnosis of physical, institutional and policy constraints as they apply to agro-industry in particular.

2/ African Research Bulletin 1988.

The following specific objectives for manufacturing industry have been formulated for the period 1986-1990:

- improved integration between diverse economic activities, in particular between industry, agriculture and trade, in order to stimulate national agricultural production and decrease external dependence.

- reduced need for new investment by endeavouring to make existing installations profitable;

- decentralized industrial production through the establishment of small, local industries capable of making a first transformation of agricultural products and meeting various local needs.

1.2 Review of the manufacturing sector

Manufacturing industry suffered greatly from the upheaval during and immediately after independence, and to date only partial progress has been made in restoring production to its level at the end of the colonial period, as table 3 indicates, with industrial production in 1985 still only 54 per cent of its real value in 1973. At present, some 80,000 workers are employed in this sector.

Table 3: Index of manufacturing
(Base year 1973 = 100)

Industry	1977	1978	1979	1980	1981	1982	1983	1984	1985
Food industries	30	31	31	30	32	29	46	41	37
Light industries	32	47	54	69	76	76	83	95	91
Heavy industries	20	30	32	36	32	34	40	29	35
Metallurgical industries	..	..	..	..	..	9	16	17	21
All manufacturing	28	36	39	44	47	46	57	56	54
Share of heavy industry in manufacturing industries (per cent)	14	..	..	..	..	..	15	11	14

Source: Economist Intelligence Unit, Angola to the 1990s, 1987.

The manufacturing sector, which accounted for 16 per cent of GDP in 1973 and roughly 10 per cent in 1986, is dominated by light industries producing consumer goods such as textiles, wood, hides and leather, tobacco and light chemicals. The food industry alone accounted for 46 per cent of the value of manufactured output in 1973, and other light industries a further 33 per cent, while industries classified as "heavy" accounted for the remaining 22 per cent. Manufacturers were heavily reliant on imports of, for example, intermediate goods, which accounted for 24.6 per cent of total imports in 1973 (mineral products, 5.4 per cent; chemical products, 11.1 per cent; plastics, rubber, resins and their products, 4.1 per cent; others, 4 per cent). The capital goods subsector (12.4 per cent of manufacturing in 1973) was also heavily dependent upon imports, with vehicle assembly from imported kits as one of the main activities. As a percentage of total imports in 1973, imports related to this subsector were: basic metals and their products, 11.6 per cent; machinery, tools and consumer durables, 22.9 per cent; transport equipment, 13.6 per cent; and professional equipment, 1.6 per cent.[1] In 1986, intermediate and capital goods accounted for more than 70 per cent of total imports.[2]

As table 4 shows, light industries account for an increasingly large share of industrial output; in 1985, light industries were leading with a 55 per cent share among the manufacturing sectors, followed by food industries, with a 31 per cent share. Heavy industries accounted for only a 14 per cent share.

Table 4: Composition of industrial production, 1973-1985
(Percentage)

Sector	1973	1977	1983	1984	1985
Food industries	46	53	37	33	31
Light industries	33	33	48	56	55
Heavy industries	22	14	15	11	14
Manufacturing industries	100	100	100	100	100

Source: Ministry of Industry, Angola, 1987.

Within heavy industries, the metallurgical industry's share was 30 per cent in 1985, following heavy mechanical industry at 31 per cent. The main branches of the heavy industry subsector are vehicle assembly, the production of steel bars and tubes, zinc sheets and other metal products, the assembly of

1/ Scandinavian Institute of African Studies, Research Report no. 57, 1980

2/ Economist Intelligence Unit, Angola, Sao Tome e Principe, no. 1, 1988.

radio and television sets, and manufacture of tyres, batteries, paper and chemical products. As for agricultural machinery, there is production capacity for ploughs and simple agricultural implements, but firms are mainly engaged in the assembly of agricultural machinery using fully finished imported components.

As table 5 indicates, production in heavy industries remains far below the pre-independence level in virtually all branches, with the notable exception of radio and television set assembly, although there have been large

Table 5: Heavy industry production, 1973-1986

	1973	1982	1983	1984	1985	1986	1985 as % of 1973
Vehicle assembly and components							
Tyres (thousands)	191	55	55	35	48	31	25
Inner tubes (thousands)	212	13	2	5	4	9	2
Buses (units)	150	220	77	63	18	101	12
Cars (units)	627	455	437	358	167	300[a/]	27
Motorcycles (thousands)	6.1	2.7	1.3	1.7	1.4	5.9	23
Bicycles (thousands)	36.5	4.0	4.6	1.5	1.8	8.3	5
Electrical goods							
Batteries (thousands)	62.3	38.3	15.8	19.8	21.3	19	34
batteries (thousands)	4,329	2,098	155	1,214	1,076	657	25
Radio sets (thousands)	25.8	86.6	38.8	37.0	33.8	21.0	131
Television sets (thousands)	..	10.7	5.6	2.1	8.3	4.9	..
Refrigerators (thousands)	..	..	..	3.1	2.8	4.5	..
Chemicals							
Acetylene (thousand m^3)	238	117	127	121	125	158[a/]	53
Oxygen (thousand m^3)	852	381	414	389	555	482[a/]	65
Metallurgical goods							
Steel bars (thousand tons)	26.6	1.7	2.3	1.8	4.1	6.5	15
Steel tubes (thousand tons)	14.3	1.0	3.6	3.7	3.0	4.0	21
Zinc sheets (thousand tons)	12.0	3.1	2.6	3.6	3.9	3.7	32
Electrodes (tons)	1,579	210	283	246	298	700	19
Machetes (thousands)	457	344	..	309	285	300	62
Metal furniture (tons)	..	..	..	720	720	815	..

Source: Ministry of Industry.

a/ Estimated amount for 1986

investment projects for the rehabilitation or expansion of productive capacity, notably in the steel industry. UNIDO, since 1981, has provided assistance and advised on the rehabilitation of the SIDERURGICA National Steelworks.[1/]

The construction materials industry provides another example of the steep fall in output throughout the manufacturing sector after independence. In view of the country's enormous construction needs, a special effort has been made to reverse this decline. In 1985 the situation began to improve as a consequence of a rehabilitation programme started in 1982. With aid from the Danish International Development Agency (DANIDA), about $35 million was invested to rehabilitate, among others, the CIMANGOLA cement plant.

1.3 Plant-level information

In Luanda, there are dozens of metal-working companies, but little information is available regarding company names and nature of business. One company (460 workers) produces steel bars, another company (304 workers) produces steel pipes and a third company (80 workers) produces corrugated iron. In Huambo there is a company (106 workers) producing cast iron and animal ploughs.

Detailed information is available on the five metal-working companies located in the provinces of Huilaano Namibe.[2/] TUBO-FRIO (Lubango, Huila) is a small private company that started in 1980 as a service unit for domestic refrigerators, and has managed to develop its own designing and manufacturing capacity for household, institutional and commercial refrigerators. In terms of production of new goods, the company manufactures domestic refrigerators with a maximum capacity of 100 units per year, subject to availability of imported refrigerating units (compressors, evaporators and electronic controls). Due to difficulties in importing refrigerating units, the company has been limited to 10-15 domestic refrigerators and 3-5 industrial units per year. The company employs 15 workers, of whom 6 are skilled and the rest are assistants and trainees.

METAFUS (Lubango, Huila) was established in 1974 and has expanded to become the largest private industry in the region, with a yearly turnover of Kz 50-60 million and reported profits of Kz 8-16 million in the last three years. The main line of production is foundry production for aluminium, bronze casting and iron casting.

1/ The final reports have been submitted to the Angolan Government as of July 1984.

2/ Information on these five metal-working companies is provided in "Reconstruction Programme for the Proviinces of Huila, Namibe and Cunene Angola". Interim report, Ministry of Planning, Angola, March 1986.

Alvaro Vicente (Lubango, Huila) is a private company established in 1971 for the production of steel furniture. It suffers from low production due to poor management and lack of raw materials. The following figures indicate production of furniture in 1985.

Desks and shelves	(set)	55
Steel structures	(sq m)	1,256
Beds and berths	(unit)	436
Chairs	(unit)	272
Tables	(unit)	101

The Empresa de Recauchutagem (tyre retreading), with units in Namibe, is in many ways similar to the Empresa de Manutencao in Huila and Lubango. It is publicly owned and equipped for the production of castings, although it is presently out of operation. Its labour force at the time consisted of 17 workers, of whom 4 were administrators. Since the Namibe unit of the Empresa de Recauchutagem has only 3 moulding machines, as compared to the 6 moulding machines of the Empresa de Manutencao in its Lubango unit, its potential retreading capacity per year might be estimated at half the Lubango figure, i.e. some 2,500 units per year, with a potential saving in hard currency in the order of $125 per unit per year in 1985 and 1986.

ERMANAL (Namibe, Namibe) has shipyards and a marine workshop. The company employs 218 workers (35 in the mechanical workshop of Namibe, 50 in the port shipyard, and the balance in Tombua). The company, unlike FOREFAM in Lobito, does not yet have the facilities for steel boat production. Investment in berth and dry dock facilities for the production of wooden and steel boats up to twin seiners (250-300 tons) seems an advisable way to lead the firm out of its present crisis.

CHAPTER 2
THE RAW MATERIAL BASE

2.1 Mining

In addition to its petroleum resources, Angola has deposits of more than 30 minerals. Among the most important of these are iron ore, coal, copper and manganese, which are discussed further below. Other commercially valuable deposits are diamonds, phosphates, uranium, titanium, gold, bauxite, mica, nickel, limestone and asphalt rock. The mineral map of Angola (annex 1) indicates the major locations of known mineral deposits.

The mining sector of Angola is, in terms of value, the largest in SADCC, but this is almost entirely due to crude oil output. Table 6 indicates Angola's relative position among the SADCC member states in 1983.

Table 6: Basic economic and mining data, 1983

SADCC states	GDP (Thousands of US$)	Exports (Millions of US$)	Production (Millions of US$)	Mining (Per cent of GDP)	Exports (Per cent of total)	Employment (Per cent of total)
Angola	4.18	1,572	1,646	26	96	9
Botswana	0.89	611	590	28	75	27
Lesotho	0.35	47	19	1	41	9
Malawi	1.33	220	7	0	0	1
Mozambique	1.70	132	5	1	2	1
Swaziland	0.50	271	23	3	5	3
Tanzania	4.55	566	45	2	8	2
Zambia	3.35	869	1,040	15	96	16
Zimbabwe	4.73	1,133	470	11	61	6
Total	21.58	5,421	3,845	11	61	
Per cent Angola[1/]		19	29	43	263	157

Sources: SADCC Mining Sector, Analysis of Mineral Resources Development and Opportunities in the SADCC Region, Lusaka, 1985; and SADCC Government Data.

Note: 1/ Per cent Angola of SADCC total or SADCC weighted average.

Angola accounted for 43 per cent of the total value of minerals produced in the SADCC region in 1983. The mineral industry contributed 26 per cent of

the country's GDP, which was 163 per cent higher than the SADCC average, and second only to Botswana (28 per cent). Mineral exports were 96 per cent of total national exports or 57 per cent above the regional average, representing, together with the Zambian figures, the highest in the region.

However, forward linkages between the mining sector and the rest of the economy have been almost non-existent. Virtually all mineral production is exported to the developed market economies. By comparison, about 10 per cent of oil production is refined locally before export, and the small building materials sector, which includes the processing of sand, clay, limestone, gypsum, stone and marble, has very significant forward linkages.

There are also few backward linkages. There have never been industries other than the fuel industry supplying inputs to the mining subsector; all machinery, explosives, chemicals, etc. have had to be imported. In this case as well, the mineral sector is linked backwards (upstream) to the developed countries; in 1986, 79 per cent of imports and 90 per cent of exports went to or came from western Europe and North America.

2.2 Iron ore

The basic raw materials for iron and steel production are deposits of iron ore, coal, fuel oil, natural gas, fluxing materials such as limestone or fluorspar, steel scrap and an ample water supply.

Iron ore is the source of primary iron. It is therefore essential for the production of steel, which in turn is essential for maintaining a strong industrial base. Owing to the relative abundance, on a global scale, of iron ore and iron-making raw materials such as limestone and coal, and the strength of iron alloys such as steel, iron is the cheapest and most widely used metal.

Iron ore deposits exist in several parts of the country, and several hundred thousand tons per year have been mined since the mid-1950s in Malanje, Bié and Huambo. A decade later the Companhia Mineira do Lobito began exploiting the iron ore at Cassinga, about 500 km east of the southern Angolan port of Mocâmedes (renamed Namibe in 1982). In 1967 the Cassinga region had assured reserves of 130 million tons of relatively high grade ore (yielding a concentrate with a 60-63 per cent iron content) in a field of at least 2 billion tons of medium-grade ore. Two main types of high grade ore are available here. At Cassinga North (Jamba) there are an estimated 50 million tons of hematite; at Cassinga South (Tchamutete) there are proven reserves of 100 million tons of high grade alluvial ore (pebble ore); and at Cassala/Quitungo, several hundred million tons of unproven reserves. The iron content varies between 40 up to 60 per cent, and ore must be concentrated before shipping.

The following table shows iron ore reserves and chemical composition. Angola has iron ore deposits consisting of hematite, which may need washing and gravity separation and possibly heavy media separation to produce high grade concentrate. It is quite different from magnetite, which has been discussed in the study on metallurgical industries in Zambia.1/

1/ Metallurgical Industries in Zambia, September 1989.

Table 7: Iron ore reserves and chemical composition in Angola

Resources (Million tons)		Reserves (Million tons)	Type	Mineral	Iron content (Percentage)
Developed	1,000	320	Lake Superior	Hematite	32.0
Unprocessed	2,000	200	Lake Superior	Hematite	40.0

Source: ECA 1987.

The reserves currently recorded at 1,270 million tons are mainly of the Lake Superior primary type, enriched superior hematite and alluvial ore, with an iron content ranging from 40 to 60 per cent.

Prior to the emergence of oil as the main export, from 1973 onwards, iron ore was Angola's third most important export, after coffee and diamonds. Since independence, however, the industry has contracted dramatically. The iron ore mines halted production a few weeks before independence, because of technical and financial set-backs as well as political upheavals.

In 1981 the Government set up a state company, the Empresa Nacional de Ferro (FERRANGOL), for the exploration, mining, processing and marketing of iron ore. The rehabilitation proposals for Cassinga North were approved, and in June 1981 AUSTROMINERAL was contracted to undertake the work. At the end of 1981 about 150,000 tons of ore from various pre-independence stockpiles at both Jamba and the SACOMAR terminal were exported to Austria. Regular production of 1.1 million tons a year of sinter feed and lump ore was scheduled to start in mid-1983, but security problems held up completion of the $14 million rehabilitation project until early 1986.

Cassinga North is now ready to resume production, and the Government's revised 1986 Plan included an iron ore production target of 350,000 tons. However, mining is unlikely to start up again in the foreseeable future for two reasons: the railway to Namibe needs extensive rehabilitation and world market prospects are much worse than had been forecast since 1981. The security in the area, which was another major problem, has improved somewhat recently. Nevertheless iron ore prices were much the same in 1985 as they had been in the late 1970s. World steel production is likely to grow only very slowly over the rest of the decade. With production costs being low for the most efficient larger iron ore producers, such as Australia and Brazil, prices in international markets are also likely to be low, and there will continue to be stiff competition for markets, casting a shadow over the commercial viability of restarting production at Cassinga.

2.3 Coal

The coal deposits of eastern and southern Africa occur in the Karoo Basins. In general, Karoo coal is bituminous, with a high ash content. The Karoo Basins also contain important reserves of anthracite, which, in economic terms, are clearly the most important in the whole of Africa. The reserves of the Customs Union of Southern Africa, including Botswana, Lesotho, Namibia and Swaziland are estimated at 80 billion tons. Angola has known recoverable reserves of 8 million tons, but its deposits are not yet under exploitation.

In iron and steel production, coal and coking coal is used mainly in the blast furnace process, the gasification process and the direct reduction process. It can also be used to generate electrical energy. Iron oxides are reduced to metallic iron by means of carbon. The carbon required for smelting iron is obtained from the destructive distillation of selected coking coal. The physical properties of metallurgical coke as well as its composition depend mainly upon the coal used and the temperature at which it is carbonized. Not all coal will form coke and not all coking coals will give the same firm cellular mass that is characteristic of coke suitable for iron and steel production.

2.4 Manganese

Manganese ore was produced at the Kiaponte and Kitota mines in Malanje Province until 1973 by the Companhia do Manganese de Angola. Over a period of thirty years, from 1943 to 1973, 604 kilotons of ore were extracted. Production in 1972 was 37.7 kilotons and fell to 4.7 kilotons in 1973, while exports for the same years were 51.0 kilotons and 8.0 kilotons, respectively. Production has been stopped since the 1970s.

The main deposits are located in the Maiombe region (Cabinda), the Lucala region (Kiaponte and Kotota mines, Cuanza Norte and Malanje), Quicama (Bengo) and Capuia (Nuambo). Reserves in the most important region (Lucala) are estimated at 5 million tons of high grade (55 - 60 per cent), but large areas have not been explored. FERRANGOL is also responsible for manganese exploitation, but has no plans for the reactivation of the mines. About 95 per cent of all the manganese ore produced world-wide is used in iron and steel production, either in its raw form or as an alloy, and there are no existing satisfactory substitutes for its use in these applications. It fulfills a variety of functions; it improves strength, toughness and workability of the steel and acts as deoxidizer and desulphurizer.

2.5 Copper

Copper is extracted from sulphide or oxide ores. Although about 80 per cent of world copper ores is obtained from open-pit mines, Angola's sulphide deposits are located at depth. This treatment consists crushing, fine grinding and concentration by flotation. Oxide ores which are to be found on the surface are leached with acid, and the dissolved copper is then recovered by precipitation on scrap iron. Copper concentrate is smelted to an impure blister copper and then upgraded to refined copper by fire or electrolytic refining.

The copper deposits in Uige Province in the north were mined until 1963 by the Empresa do Cobre de Angola, which was linked to a Portuguese monopoly (CUF, which later became SIMEIRA). The three main deposits are at Mavoio, Tetelo (1 km apart and about 120 km north of Uige) and Bembe. These are deposits of the metasomatic type occuring in the West Congo formation, and the copper is found in limestone and calcareous shales or sandstone of the schisto-calcareous type, generally associated with the Luango Fault Zone.

(a) Mavoio

This deposit has two types of ores, primary sulphide ore in dolomites and secondary oxide ore in ferruginous "black earths". The mines are situated on a major fracture called "the Hematite Fault" and were closed in the early 1960s when the high grade ores (10 per cent copper) were exhausted. However, there remain large sulphide ore reserves grading 2 to 3 per cent copper, with an unknown cobalt content.

(b) Tetelo

The sulphide ores of this deposit occur in faulted and brecciated zones, immediately to the north-east of the Mavoio deposit. In the early 1970s, the Simeira Consortium assessed this deposit and estimated reserves to be 8.2 million tons at 2.6 per cent copper (cut-off 0.5 per cent copper) and 1.2 million tons at 7.99 per cent copper (cut-off 3 per cent copper) with associated cobalt (0.04 - 0.10 per cent) and silver (15 grams per ton). The stratiform ore body is between 150 and 300 m below the surface adjacent to the Hematite Fault.

(c) Bembe

This deposit is about 100 km north-west of Uige and was exploited in pre-colonial times. The Empresa de Cobre de Angola mined the high grade oxide (malachite) pockets without much success. There is also an unknown quantity of disseminated sulphide ore reserves in argillaceous sandstone.

Geological (i.e., inferred) ore reserves of the Tetelo-Bembe "zone" are estimated at 10 million tons at 2 per cent copper. Although copper is the main metal, there are also associated elements such as vanadium, cobalt, barium, lead, zinc, gold and silver.

The other major copper "zone" is the extension of the Zambian Copperbelt in Alto Zambeze in the extreme east of the country. Here, inferred reserves are put at 10 million tons grading 1 per cent copper. Due to the extremely isolated location of these deposits, there are no plans for their development at present.

2.6 Some notes on the copper industry in Zambia and Zaire

A proper assessment of the potential development of Angola's copper industry should take into account related developments in the copper industry of Angola's neighbours, particularly Zambia and Zaire. Zamiba and Zaire have relatively developed copper industries, such that their production of copper has become essential to the normal operation of their national economy. Export of copper has become the principal source of foreign exchange for both countries.

In Zambia, copper ore used to be extracted from 15 mines by two companies - Nchanga Consolidated and Roan Consolidated, but the Zambian Government reorganized copper mining in 1982. Zambia Consolidated Copper Mines Ltd. (ZCCM) was formed from the merger of the above two companies, in an attempt to streamline management and rationalize their operations. As a result, ZCCM became the second largest copper mining company in the world after CODELCO-Chile, a wholly Government-run operation.

Copper output in Zaire comes from 10 properties operated by two companies, GECAMINES, the National Mining Company and SODEMIZA. Mine production of copper was 502,000 tons in 1987, most of which was shipped overseas to be refined. Production of refined copper amounted to about 265,000 tons. More than 60 per cent of total output comes from open-pit works located in the Shaba region, which provides the bulk of GECAMINES' production. GECAMINES' production complex is an intricate matrix of operations spread over 300 kilometres in the Zairean Copperbelt, and grouped in three separate geographic areas in the Kolwezi (west), Likasi (centre) and Lumumbashi (south).

The transportation difficulties, which adversely affect exports of minerals and imports of supplies to Shaba's industries, are reflected in a significant reduction in tonnage dispatched in recent years. GECAMINES currently has an annual concentrating capacity of 530,000 tons per year of copper and a smelting and leaching capacity of 470,000 tons per year; the mining capacity, however, has in recent years been only about 450,000 tons per year because of a lag in overburden removal resulting from weak management in the open-pit mines and low equipment availability. GECAMINES' copper refining capacity is limited to 250,000 tons per year; it also has a production capacity of 15,000 tons per year of cobalt and 70,000 tons per year of zinc. Table 8 shows the production statistics of GECAMINES' mines, concentrators and metallurgical plants.

Apart from GECAMINES, there is another mining company producing copper, albeit on a modest scale. SODEMIZA was 80 per cent owned by CODEMIZA, which in turn was held by Nippon Mining (47.48 per cent) and other Japanese companies, notably SUMITOMO Metal Mining and MITSUI Mining and Smelting. It has an annual production capacity of about 35,000 tons. In 1983, the Japanese shares were sold to the Government. Since late 1984 SODEMIZA concentrates have been processed at facilities of ZCCM, a short distance across the Zambia-Zaire border. SODEMIZA is currently managed by a Canadian team contracted by the Government.

Presently, both Zambia and Zaire have experienced minor increases in already high stripping ratios, while average copper grades decreased by approximately 8 per cent. The average grades in 1986 were 4.05 per cent copper in Zaire and 2.11 per cent copper in Zambia, down from 4.40 in Zaire and 2.30 in Zambia in 1981. In Zaire, problems such as high stripping ratios for surface mining and the need to employ higher cost underground mining methods, complicated by high water inflow and high ore dilution, led to an increase in average mining and milling costs. The situation in Zaire and Zambia is further complicated by a chronic shortage of foreign exchange for importation of new capital equipment as well as spare parts, which results in increased downtime for equipment under repair.

Table 8: GECAMINES - Production, 1982-1984

	1982	1983	1984
Mines			
Open-pit			
- Volume excavated (thousand m^3)	22,430	27,411	28,708
of which SKM[a/]	21,387	25,190	26,369
- Ore (thousand tons)	8,506	10,205	9,931
of which SKM[a/]	7,924	9,095	9,437
Underground			
- Ore (thousand tons)	5,755	6,036	6,121
Total ore (thousand tons)	14,261	16,241	16,052
Average grade (per cent copper)	4.2	4.0	4.1
Concentrators			
Ore feed (thousand tons)	16,014	17,482	17,536
Concentrates (thousand tons)	1,576	1,701	1,818
Average grade (per cent copper)	30.6	29.4	29.0
Metallurgical plants			
Lubumbashi Smelter			
- Blister copper (thousand tons)	153.9	160.3	156.8
- Black copper (thousand tons)	3.7	0.0	0.0
Shituru Hydrometallurgical Plant			
- Copper deposited (thousand tons)	132.7	137.5	136.4
Luilu Hydrometallurgical Plant			
- Copper deposited (thousand tons)	169.7	166.6	172.7
Shituru Refinery			
- Electro copper (thousand tons)	175.1	227.2	224.5
Kolwezi Hydrometallurgical Plant			
- Zinc deposited (thousand tons)	72.6	70.5	74.8
- Cadmium deposited (tons)	304.8	338.5	355.0
Production			
Copper (thousand tons)			
Wirebars	175.0	226.9	225.2
Electrowon cathodes	132.9	80.5	82.6
Blister	153.4	158.4	157.7
Others	-	-	-
Cobalt (tons)			
Chips	5,087	3,363	5,266
Granules	-	1,897	2,827
Others	486	90	982
Zinc (tons)	64,425	62,500	66,100
Cadmium (tons)	281	308	318

Source: GECAMINES, Annual Report, 1986.

a/ Siège Kolwezi Mines (SKM): Kolwezi open-pit mines.

As shown in table 9, stripping ratios in Zambia and Zaire are very high, although average copper production costs in Zambia and Zaire are among the lowest in the world.

Table 9: Production parameters for selected copper properties and average copper production cost in selected countries in 1986

Country	Production (10^3mt ore)	Grade (% copper)	Open-pit (percentage)	Stripping ratio	Average pf 113 operation mines (US$ per lb Cu.)
U.S.A.	185,000	0.65	88	1.33	0.55
Canada	105,600	0.53	92	1.22	0.56
Chile	110,600	1.40	50	2.54	0.30
Mexico	27,700	0.69	100	2.34	0.45
Peru	42,100	0.91	93	1.09	0.37
Philippines	51,100	0.43	60	1.00	0.70
Zaire	15,300	4.05	61	7.80	0.39
Zambia	24,000	2.11	39	13.60	0.41

Source: U.S. Bureau of Mines and Engineering and Mining Journal 1988.

Copper deposits in Angola are located along Zamiba's rich Copperbelt. Developing a copper industry would be a major part of a diversification strategy aimed at reducing the country's dependence on oil exports. Zambia and Zaire can transfer know-how to operate a copper mining and smelting industry. They could also develop an inwardly oriented copper industry which facilitates the work of downstream industries and promotes industrial linkages in co-operation with Angola. This can give Zamiba and Zaire an opportunity to change their outward-oriented copper industry, which specializes in upstream industry which contributes relatively little value added. UNIDO has conducted the feasibility study for production of semi-fabricated and finished products in Zambia on the basis of co-operation between Zambia and Angola.[1/]

1/ UNIDO DP/RAF/79/006.1981.

CHAPTER 3
ENERGY

3.1 Energy in iron and steel production

The iron and steel industry is relatively energy-intensive; the availability of energy is a prerequisite to the operation of steel plants. The overall conversion or dissociation of iron ore (hematite) has an energy requirement of about 7 million BTU per ton. Expressed in another way, the conversion of hematite to metallic ore represents the formation of a new "fuel" by a matching consumption of another fuel or energy source. The required fuel may be coal, oil, natural gas, combustible biomass, another metal (e.g. aluminium in the thermite process), or combinations and derivatives of these. Potential energy sources include electrical energy obtained from a variety of energy sources (fossil fuels, hydro-systems, solar, nuclear, etc.) and introduced through a variety of techniques.

The steel industry uses a number of different technologies, which can be classified as open-hearth furnace (OHF), basic oxygen furnace (BOF) and electric-arc furnace (EAF). By the end of World War II, the open-hearth furnace had assumed a dominant role, accounting for 88-90 per cent of production. After the war, however, the basic oxygen process began to replace open hearths in the United States and Thomas converters in Europe. This basic furnace offered much shorter heating times and therefore required much less labour and capital per ton of output. The basic oxygen furnace can accommmodate less scrap than open hearths unless the scrap is pre-heated at a substantial cost penalty. Electric furnaces, however, use virtually 100 per cent scrap (or directly reduced iron where natural gas is abundant).

Energy inputs among the three systems differ widely, in terms of both the quantity and the quality of the energy used. The BOF system is by far the most efficient in terms of the quantity of energy used per ton of steel produced. A comparative survey of 16 steel-producing countries for 1980 gave the following range of energy consumption by different furnace systems, in terms of gigajoules per ton of steel:

Basic oxygen	0.8 - 1.2
Open-hearth	4.0 - 7.1
Electric-arc	5.1 - 8.6

The high energy intensity of the open-hearth furnace, compared with the oxygen furnace, largely explains why it has been phased out over the past 27 years in most developed countries. The relatively high amount of energy required by the electric furnace generally translates into higher energy costs relative to the basic oxygen system .[1/]

1/ See "Energy and ferrous inputs to iron and steel production" in Metallurgical Industries in Zambia, May 1988.

About one fifth of the total cost of producing liquid steel is accounted for by energy use in the electric furnace. Table 10 shows the structure of direct energy input in electric-arc steel production by type of energy in ten selected countries in 1980.

Table 10: Direct energy input in electric-arc steel production by type of energy in selected countries in 1980
(Percentage)

	Belgium	Czechoslovakia	Finland	France	Germany, Federal Republic of	Hungary	Italy	Sweden	USSR	Japan
Solid fuel - total	-	-	2.72	-	0.48	-	1.06	...	-	1.18
Liquid fuel - total	-	-	3.08	1.11	0.47	-	2.46	...	1.06	2.96
of which: Fuel oil	-	-	1.64	1.11	0.47	-	2.30	...	1.06	1.18
Other	-	-	1.44	-	-	-	0.18	...	-	1.78
Gaseous fuel - total	13.98	2.40	3.62	5.93	9.90	-	3.25	...	11.70	-
of which: Natural gas	13.98	-	3.62	5.93	8.68	-	-	...	10.64	-
Blast furnace gas	-	-	-	-	0.14	-	3.25	...	0.53	-
Coke oven gas	-	2.40	-	-	1.08	-	-	...	0.53	-
Converter gas	-	-	-	-	-	-	-	...	-	-
Other	-	-	-	-	-	-	-	...	-	-
Electric energy	86.02	94.50	90.58	90.36	87.45	90.43	92.24	100	87.24	92.90
Oxygen	-	3.10	-	2.60	1.69	-	0.97	...	-	2.96
Other types of energy	-	-	-	-	-	9.57	-	...	-	-
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	...	100.0	100.0

Source: ECE Steel Committee 1987.

Electricity thus accounted for about 90 per cent of direct energy inputs in electric-arc steel production in each of the ten countries, and in no country amounted for less than 85 per cent of the total.

Angola's steel plant presently has a 20-ton Tagliaferri electric-arc furnace and, if Angola wants to build a direct reduction (DR) plant, the demand for electricity will be great. The energy input in direct reduction processes occurs mainly in two forms - reductant and electric power. The energy requirements of different processes vary and primarily depend on the type of reduction unit utilized and the nature of the reductant used.

The total cost of energy constitutes a major portion of the operation cost of direct reduced iron (DRI), and sometimes may be as high as 25 per cent. The energy consumption rates, as indicated by the various rotary kiln process suppliers, are indicated in table 11.

Table 11: Typical energy consumption in rotary kiln processes
(Consumption per ton DRI)

Plant location	Process	Average metallization (Percentage)	Reductant (Gigacalories)	Fuel oil (kg)	Power (kWh)
Charqueadas, Brazil	SL/RN	92	6.93	2.78	127.9
		92	5.28	11.16	107.3
Glenbrook, New Zealand	SL/RN	89	4.58	7.0	120
SIIL, India	SL/RN	90	6.12	2.0[a/]	120
Dunswart	Codir[b/]	92	3.51[c/]	NA	118

Source: ECE Steel Committee 1985.

Notes: a/ Used for initial start-up only.
b/ Dunswart unit used both gas and coal until 1981.
c/ Thermal energy consumption in 1981 was 4.54 gigacalories (about 19 GJ) and in 1980 was 4.96 gigacalories (about 20.5 GJ) per ton DRI.

The general level of energy consumption in the rotary kiln processes is higher than in the gas-based processes. A major reason for this is that between 0.4 to 0.44 tons of fixed carbon most be introduced into the kiln for each ton of DRI. Since most rotary kiln installations use low quality coal, which has high ash and volatile matter content, the energy consumption level is high.

The energy consumption of different types of processes is compared in table 12. It will be noted that at the present stage of development, the shaft furnace processes require the least amount of energy, due to the thermodynamic advantage inherent in this process.

Table 12: Comparison of total energy requirements of different types of processes

Process	Average metallization (Percentage)	Natural gas/coal (Gigacalories)	Power (Gigacalorie equivalents)[a/]	Total (Gigacalories)
Gaseous reductant				
Retort	85 - 87	3.3 - 4.0	0.0 - 0.06	3.3 - 4.06
Shaft	90 - 92	2.5 - 3.3	0.1 - 0.12	2.6 - 3.42
Fluidized bed[b/]	92	3.7	0.04	3.74
Solid reductant				
Rotary kiln	89 - 92	4.5 - 5.3	0.1	4.6 - 5.4
Retort	90 - 94	4.10	0.08	4.18

Source: ECE Steel Committee 1985.

Notes: a/ On the basis of 860 kilocalories of equivalent thermal energy for each kWh.
b/ Only Fior considered.

3.2 Electricity - general aspects

Metallurgical industries require tremendous amounts of energy, and generally the type of energy required is electrical. Angola is especially well endowed with potential hydroelectric resources from scores of rivers. Power stations on four major rivers traditionally supply most of the electricity consumed in the main urban areas: Cambambe on the Kwanza River and Mabubas on the Dande River provide electricity to the capital and much of the north; Biópio and Lomaúm (a hydro/thermal plant) on the Catumbela River supply cities in the central provinces; and Matala on the Cunene River is the main source of power in the south. These potential hydroelectric resources totalled 7,710 mW, compared with the installed generating capacity in 1985 totalling 429 mW, of which 289 mW was hydroelectric.[1/]

There are, in effect, three distinct electricity grids, in the north, center and south of the country, which, like the country's three main railways, remain unconnected. There are separate local grids in Cabinda and in the diamond mining area of Lunda Norte. Several state companies are responsible for power supply in different parts of the country - SONEFE in the north, the Empresa Nacional de Electricidade (ENE) and the Companhia Eléctrica do Lobito e Benguela (CELB) in the centre, and the Empresa de Distribuicao de Electricidade (EDEL) in the south. An investment priority in the next few years will be to connect the three main grids, so that power can be transferred from one system to another.

1/ Installed capacity in Angola is thus rather small in comparison with Zambia. See Metallurgical Industries in Zambia, September 1989.

Table 13 shows the main electricity generating plants, and indicates their installed capacities.

Table 13: Main electricity-generating plants - installed capacity
(Megawatts)

Hydroelectric plants		Thermal plants	
Cambambe	180.0	Luanda	24.4
Lomaúm	35.0	Biópio	22.6
Matala	27.2	Namibe	11.5
Mabubas	17.8	Cabinda	15.0
Biópio	14.4	Huambo	10.0
Luquixa	1.1	Uíge	4.1
Kunge	1.1	Lubango	3.6

Source: SADCC Energy.

The difficulties facing the electricity supply companies and the decline in economic activity since independence are reflected in statistics on energy production. Excluding electricity generated for their own consumption by businesses and municipalities (estimated at about 20 per cent of total electricity output at present), production totalled 705 million KwH in 1985, 28 per cent less than in 1973, as table 14 indicates.

Table 14: Electricity production and consumption
(Millions of kilowatt hours)

	1973	1980	1981	1982	1983	1984	1985
Production	984	693	720	780	770	758	705
Consumption	914	626	651	691	686	...	...

Source: Ministry of Planning, Angola, 1987.

The Angolan Government has launched an ambitious project to build a new 520 mW hydroelectric station on the Kwanza River, at Kapanda, 400 km south-east of Luanda, to boost generating capacity in the northern system. A tripartite agreement on this US $900 million project signed in November 1984 ($600 million for Brazilian civil engineering work and $300 million for Soviet electrical equipment) will almost double Angola's generating capacity and is due for completion in the early 1990s.

3.3 Natural gas

Natural gas is an ideal fuel for direct reduction of iron from a technical point of view. The technology for the catalytic reforming of natural gas and other light hydrocarbons to produce mixtures of carbon monoxide and hydrogen was developed and refined by the chemical process industry to provide synthetic feedstocks. This technology was readily adopted by developers of the direct reduction process, since it gave a clean, highly reducing gas requiring little or no conditioning prior to use for reduction, and required a relatively simple and therefore cheap processing unit.

Developing countries have played an important role in the commercialization of DR processes. In fact, some of the processes actually originated in developing countries, while in other cases, the first commercial units were installed in the developing countries, as shown in table 15.

Table 15: Role of developing countries in the development of direct reduction processes

Process originated in developing countries		First commercial plants installed in developing countries	
HYL - Mexico:	sponge iron retort	HYL - Mexico:	sponge iron retort
TDR - India:	sponge iron rotary kiln	HIB - Venezuela:	sponge iron fluidized bed
		Purofer - Iran and Brazil:	sponge iron shaft furnace
		FIOR - Venezuela:	sponge iron fluidized bed
		NSC-DR - Malaysia:	sponge iron shaft furnace
		SL/RN - New Zealand:	sponge iron rotary kiln
		ACCAR - India:	sponge iron rotary kiln
		KINGLOR - Burma:	sponge iron retort

Source: ECE, Steel Committee.

Note: Purofer (Thyssen), Kinglor-Meteor (Danieli), SL/RN (Lurgi), DRC (Davy Kekee), FIOR (Davy McKee), HYL (HYL), Miolex (Miolex), ACCAR (Boliden Allis).

Natural gas is the simplest reductant for making DRI. Since Angola is rich in oil and natural gas, gaseous DR processes have been the obvious choice for the production of sponge iron. Liquified petroleum gas (LPG), also known as liquified natural gas (LNG), is used in these processes. Angola's proven reserves of LPG total 37 billion cu m. There are reserves of both associated and non-associated gas. Important reserves have been discovered in block two (in the Etele field) and block three (Punja), as well as in several fields in Cabinda, including Livuite, Takula, Numbi and Banzala. Since 1982 Livuite and some associated gas have been exploited for both gas lift and injection to boost crude production in the nearby Malongo fields and to extract about 6,000 b/d of propane/butane mix for export. These LPG exports began in June 1983, and by 1980 reached 2.0 million barrels, with a value of $17 million.

Direct reduction refers to a number of processes that are alternatives to the blast furnace and coke oven for the production of iron. These processes typically operate at lower temperatures than blast furnaces and convert iron ore to iron without melting. DR is compatible with other new technological developments, and direct reduced iron can alsc be used as a substitute for scrap. This is especially of importance to Angola, which will face scrap shortages in the near future. Angola will have to provide its own sponge iron or DRI, if scrap is not available.

The HYL process was the first to produce sponge iron on an industrial scale. HYLSA of Mexico has developed this process and plants in Mexico, Brazil, Iran, Venezuela and Indonesia. The original HYL I process, offered up to the end of 1980 was discontinued. In 1980 the HYL III process was developed. With respect to the TDR process, it was developed in India and the first commercial plant has been set up in India. This TATA direct reduction (TDR) process uses sub-bituminous coal as a reductant, feeding it into both ends of a rotary kiln. IPITATA is the first commercial sponge iron plant based on the indigenously developed TDR technology, which went into commercial production in April 1986.

There are five types of processes:

1. Gas-based retort processes. HYL retort process utilizes reformed natural gas as the reductant.

2. Gas-based shaft furnace process. It involves the purofer (Thyssen), Miolex, Armed, HYL-III and NCR-DR processes (Nippon steel).

3. Gas-based fluidized bed process. Both FIOR and HIB processes processes have one commercial unit each. The FIOR unit belonging to FIOR de Venezuela SA in Matanbas was put into operation in 1976. The HIB plant located at Puerto Ordaz, Venezuela, primarily produces low metallized briquettes for smelting and occasionally this has been used for steel-making.

4. Solid reductant based rotary kiln process (Danieli). There are five rotary kiln processes based on the use of non-coking coals, namely SL/RN (Lurgi), Codir, Accar (Bolioen Allis), DRC (Davy McKee) and TDR.

5. Solid reductant based retort process. At present there is only one plant based on the use of non-coking coal in a retort furnace. This plant, located in Burma, has adopted the Kinglor-Meteor process.

Electric-arc furnace steelmaking using only processes based on scrap cannot make certain steel grades such as deep drawing sheet steels and cold drawing tubes or wires. Consequently, EAF producers who are interested in broadening their product ranges where control of tramp elements is essential can improve feedstocks primarily through addition of DRI. As the industrial sector in Angola takes off, gradually more steel products will be required. More flat products rather than round products are in demand for further industrialization of the country. Then SIDERURGIA Nacional will have to change its inventory to DRI and examine the possibility of either importing DRI from overseas or establishing a plant to produce its own DRI.

There is a variety of energy sources for the iron and steel industry, including coal, natural gas, petroleum, liquid petroleum gas, and purchased electricity. Angola has an EAF mini-mill which requires a considerable amount of electric power. Natural gas (or coal) is needed if Angola is to build a DRI-making plant for an integrated mini-steel mill. For this purpose, Angola has oil, natural gas, coal and electricity. The energy situation in the developing iron and steel industry in relation to other industrial sectors is very good. The prospects for the iron and steel industry is therefore promising, to the extent that there is a continuing increase in demand for steel products.

CHAPTER 4
THE IRON AND STEEL INDUSTRY

4.1 General aspects

A steel plant with a capacity of 30,000 tons a year and 50,000 tons of reinforcing bars was built in Luanda in 1972-73. Rolling mills are composed of two open mills (450 mm and 300 mm) and two continuous mills (280 mm and 260 mm) with a total 50,000 tons of rolling capacity. This plant was largely inoperative after independence, but was rehabilitated and reopened in 1984. Production of steel bars amounted to 4,099 tons in 1985, compared with 26,572 tons in 1973. There are plants for steel tubes (with a production level of 2,997 tons in 1985, compared with 14,309 tons in 1973) and zinc sheets (down from 12,009 tons in 1973 to 3,882 tons in 1985). Mitsubishi, Japan, has a 50 per cent stake in the latter plant.

The existing steel plant (SIDERURGIA Nacional) is a mini-steel mill (i.e. with an electric-arc furnace) based on scrap which is collected by a national system of scrap preparation in Angola. SIDERURGIA Nacional disposes of one Tagliaferri electric arc furnace (30,000 tons per year).

4.2 Steel production, consumption and imports

Table 16 shows Angola's GDP per capita; GDP shares of gross fixed capital (GFC), manufacturing (MFG) construction (CONST) and agriculture (AGR); population; steel consumption; steel production; steel intensity; and steel imports.

GDP per capita has tended to decrease since 1970, and the value of GDP at 1980 constant prices has become less than half the 1970 level. This fall of GDP per capita caused declines of steel intensity and steel consumption per person.

Steel intensity is the volume of steel consumed per value unit of total economic output. It is assumed that changes in steel intensity are directly related to the level of income.

The shares of GFC, MFC and CONST to GDP have generally decreased, as has crude steel production. Steel production amounted to 41,000 tons in 1975, but decreased to 10,000 by 1986. Steel consumption per capita was 31.22 kg in 1968, but had declined to 8.57 kg by 1985. Steel consumption was at a peak of 172,000 tons in 1974 and went down to 52,000 tons in 1975, which is also the average figure for steel consumption for the decade 1975-1985, the lowest level being reached in 1983 with 15,000 tons.

Table 17 indicates total imports of semi-finished and finished steel products in Angola from 1981 to 1986. With the exception of a low of 7,450 tons in 1983, steel imports averaged 35,000 to 55,000 tons. Steel imports were 35,7000 tons in 1986, less than half the 1970 level. Tubes and fittings were the products most in demand.

Table 16: Composition of GDP and data on steel, 1965-1986

Year	AGR/GDP (per cent)	Steel intensity (kg in 1980)	Steel consumption (per cent)	Steel consumption ('000 tons)	Crude steel production ('000 tons)	Imports ('000 tons)	GFC/GDP (per cent)	MFG/GDP (per cent)	CONST/GDP (per cent)	Population ('000)	GDP/POP (in 1980 US$)
1965	-	-	11.78	61	-	45.6	8	4	3	5,180	423
1966	-	-	17.73	93	-	-	12	4	3	5,245	516
1967	-	-	25.05	133	-	-	12	4	4	5,310	576
1968	-	-	31.22	169	-	-	11	4	4	5,382	863
1969	-	-	22.30	122	-	-	11	5	4	5,472	917
1970	58	0.020888	19.51	109	-	85.0	9	3	3	5,588	934
1971	57	0.024625	22.48	130	-	-	10	3	3	5,732	921
1972	56	0.017731	16.10	95	-	-	10	4	4	5,900	908
1973	52	0.021501	20.19	123	-	-	9	5	4	6,092	939
1974	47	0.031633	27.30	172	35	-	8	4	5	6,300	863
1975	60	0.015525	7.98	52	41	37.4	6	3	1	6,520	514
1976	46	0.014314	6.37	43	38	-	7	3	2	6,753	445
1977	47	0.019159	8.43	59	40	-	8	3	2	6,998	440
1978	45	0.012144	5.38	39	40	28.7	9	3	2	7,247	443
1979	44	0.015844	6.96	52	40	39.1	9	3	2	7,491	438
1980	43	0.023363	10.49	81	30	58.6	9	3	2	7,723	449
1981	44	0.020607	8.82	70	30	61.0	8	3	2	7,939	428
1982	47	0.014795	6.51	53	30	38.0	8	3	2	8,142	440
1983	49	0.004128	1.80	15	20	7.5	8	3	2	8,339	445
1984	50	0.020866	8.43	72	20	51.2	8	3	2	8,540	404
1985	45	0.018793	8.57	57	10	39.3	8	3	2	8,754	456
1986	44	0.012008	5.56	50	10	35.7	6	2	1	8,891	463

Source: UNIDO Data Base; UNIDO Sectoral Studies Data Base; UNCTAD 9, 1987; IISI 1987.

Table 17: Total imports of semi-finished and finished steel products, Angola, 1981-1986

(Thousands of tons)

Year	Ingots and semis	Heavy sections	Light sections	Plates	Sheets less than 3mm	Hoop and strip	Tinplate	Railway track material	Wire rods	Wire	Tubes and fittings	Wheels, tyres & axles	Total
1981	1.99	0.34	1.67	4.53	17.33	0.08	0.02	0.11	3.17	0.35	31.43	-	61.02
1982	2.62	0.26	2.95	1.05	3.64	1.77	-	1.68	2.04	0.59	21.42	-	39.02
1983	0.02	1.06	0.83	2.81	0.55	0.15	0.19	-	0.10	0.07	1.67	-	7.45
1984	0.06	2.03	2.11	1.96	7.79	0.09	-	0.00	4.36	0.49	32.02	-	51.16
1985	-	0.30	2.67	1.61	8.89	0.76	0.19	0.03	0.02	1.20	23.63	0.00	39.30
1986	0.54	0.57	1.32	4.77	9.76	0.01	0.15	0.00	0.01	0.08	18.46	0.06	35.73
Total	5.23	4.56	11.55	16.73	47.96	2.86	0.55	1.82	9.70	2.78	128.88	0.06	232.68

Source: ECE, Statistics of World Trade in Steel, 1987

In 1984 UNIDO provided assistance to the rehabilitation of SIDERURGICA Nacional Steelworks. This project was designed to assess the present status of the SIDERURGICA Nacional Steelworks, to improve the operating and maintenance procedures in the steel-making and rolling shop, to prepare a plan to upgrade capacity and quality of products and to improve the management of the iron and steel sector.

In another project, UNIDO studied the conditions for co-operation in the development of the iron and steel industry. Possible techno-economic co-operation between Angola and Mozambique was investigated, aiming at the eventual development of an iron and steel industry (e.g. a sponge iron plant) based on Angolan iron ore and Mozambican coal. The project also foresaw laboratory and bench-scale tests of ore and coal samples with a subsequent techno-economic appraisal. Angola has plans to rehabilitate its steel capacity of 50,000 tons and to integrate its facilities in order to produce 150,000 tons of crude steel and 1.0 million tons of sponge iron.

4.3 Foundries and forges

For an industrial enterprise to function effectively, it is imperative that the various resources invested and utilized in the production activity be optimally utilized. To achieve this, development of ancillary industries and support facilities plays a vital role. The major support facilities required for the development of engineering goods and agricultural machinery are foundries and forges, along with heat treatment, metal-forming and fabrication facilities. The production of original equipment and spare parts by these facilities will play a vital role in promoting the rational and integrated development of the industrial sector.

Foundries and forges are spread over the country, as annex 4 shows. Details were only available on three foundries and forging shops in the provinces of Huila and Namibe. They are METAFUS (Metalurgi e Funricao do Sul Lda, in Lubango, Huila), the Empresa do Manutencao (Lubango, Huila) and the CFM Foundry. The following summary offers information on the labour requirements and sales volume of these foundries and forges:

Name of foundry	Labcur	Sales
METAFUS	103	Kz 500,000/head (1985)
Empresa de Recauchutagem	18	Kz 30,580,000 (1984)
Empresa de Manutencao	53	Kz 5,000,000 (1984)
CFM Foundry (railroad workshop)	25	-

METAFUS is the largest private foundry industry in the area. It has a large turnover and is profitable. It is using its installations to its full capacity and is in the process of building another workshop adjacent to the existing one. Aluminium, based on imported ingots and local scrap, is used mainly for the production of domestic hardware: cooking pans, frying pans, pressure cookers and a variety of institutional cooking pots of large size (up to 120 liters). The company even produces aluminium plates and cups, which might be considered wasteful, given the idle capacity for plastic products available at Saplas. Production is around 150 tons per year, which will be expanded substantially when a new furnace is installed.

Bronze casting at METAFUS is based exclusively on scrap and is directed mostly to the production of spare parts for other industries. Cast iron production is mostly orientated to plough points. About 30,000 units are produced per year, and the raw material is exclusively scrap.

There is also a machine tool workshop, devoted exclusively to the finishing of cast pieces, especially the alumirium tableware that needs rectifying of surfaces and polishing. The new foundry will also include an electric furnace for melting steel scrap. This will greatly expand the possibilities to use available raw materials and help to improve the quality of finished products. The existing sand moulding system will be replaced by Coquille Casting, which will lead to quality and cost improvement. There is also a meta furniture department, devoted mainly to office furniture and metal chairs and tables for domestic use. Sales per worker figure at over Kz 500,000 per head.

The Empresa de Manutencao (Lubango, Huila) is a public company equipped for the production of castings (iron, aluminium and bronze), metal carpentry and light machine tool work. This is complementary to the Alvaro Vicente company, with which it shares the same director. It also shares most operational problems. The current situation of the company, which has practically ceased production, is not encouraging.

The main section of the company used to be its foundry, with an electric furnace suitable to melt steel scrap, but this is now out of production due to lack of refractory bricks. The other electric furnace for iron production does not work for lack of coking coal, and the casting sand stock has not been filled up for a long time.

The aluminium and bronze furnace is limited to the production of ingots out of scrap material. The metal engineering workshop would be able to produce a variety of complicated steel products, if its machinery (three old forges and three manual forging presses) had not been totally neglected. This machine shop had to close down in 1984.

The machine tool section has some very old equipment, including a 100-ton hydraulic press, a huge lathe 6 metres in length, a milling machine plus three medium-sized and two small universal lathes, and other ancillary machine tools. The work force is composed of 45 workers, 5 administrative staff members and 3 technicians.

The CFM railroad workshop at Luango is a good foundry plant and has high quality installations. It is mainly used for railroad maintenance. It can produce ferrous and semi-ferrous castings.

Table 18 shows total imports of engineering products of Angola and two other countries for reference. In 1986, US$531 million of engineering products were imported. About 10 per cent of these products were agro-related products, tractors, machine tools, metal-working machinery and spare parts. Much of the latter could be locally produced upon rehabilitating existing foundries and forge shops.

Table 18: Total imports of engineering products by Angola, 1963-1986
(Millions of US dollars)

	1963	1965	1970	1975	1980	1985	1986
Angola	35.1	51.5	125.0	123.6	617.8	422.9	531.9
Zaire	53.1	83.3	185.9	467.2	474.8	373.4	502.1
Zambia	-	-	-	337.8	396.1	231.1	244.5
Total Africa	2,687.3	3,710.8	6,129.3	20,941.2	38,008.7	24,122.6	25,063.1

Source: Economic Commission for Europe, 1987

Existing foundries and forges in Angola require upgrading. For this purpose the Angolan Government launched a master plan in 1984, with UNIDO assistance, on the optimal planning, co-ordination and monitoring of the overall activities for the further development and modernization of the foundry industry. Furthermore, the Angolan Government would support the establishment of a foundry centre in Huambo on the basis of the existing foundry Marcao Nove. A draft proposal was submitted for the establishment of a demonstration foundry with a capacity of about 1,000 tons/year of iron and steel castings and of 100 tons/year of steel forgings.

4.4 Scrap collection and processing

One of the biggest problems facing the Angolan mini-steel mills is the availability, generation, collection and preparation of scrap. If not in the near future, then in the next 5 to 10 years a considerable shortage of steel scrap is likely to arise (over 50,000 tons approximately). The scrap needed until 1990 is estimated at 440,000 tons, while supply is estimated at 390,000 tons.

Reprocessed scrap makes an important contribution to a country's steel supply, since it can be used to produce agricultural machinery, capital goods and spare parts for all other metal-working industries.

There is a considerable amount of iron and steel scrap available in the country. At the same time the metallurgical/foundry shops in Luanda and in other major towns experience a serious shortage of scrap for their melting facilities, which directly causes considerable decrease in the metallurgical production rate. This has been a reason for UNIDO to assist the Angolan Government in the establishment of a national system of scrap collection and processing, to supply the SIDERURGIA Nacional.

According to a study conducted in 1983 by the Ministry of Industry of Angola, the total availability of usable metal scrap in 1980 was 133,793 tons. Based on this figure, the following calculations were made by UNIDO[1] regarding the production of steel based on metal scrap during the period 1986-1990. These figures could form the basis of a strategy of successive extension of Angola's scrap collection and processing potential.

Table 19: Production of steel based on metal scrap, 1986-1990
(Tons)

Year	Annual quantity	Cumulative total
1986	43,658	250,451
1987	45,404	295,855
1988	47,220	343,075
1989	49,109	392,184
1990	51,079	443,259

Angola is shown to have considerable demand for regenerated metal scrap which would justify investments for its processing, if a sufficient supply of scrap would be available. Forecasts of the availability of metal scrap during the period 1986-1990 are shown in the table below. It is clear that demand constantly outstrips supply.

Table 20: Estimated availability of metal scrap, 1986-1990
(Tons)

Year	Annual quantity	Cumulative total
1986	44,454	182,533
1987	47,741	229,974
1988	51,427	281,401
1989	55,414	336,816
1990	59,400	396,215.

In the post-independence period (1975-1982) no system existed in Angola for the collection and processing of metal scrap. A concept paper for the establishment of a national Angolan system for scrap collection and processing was prepared by the Ministry of Industry during the period 1979-1982, accompanied by a techno-economic feasibility study. This project included the establishment of two basic regional enterprises for scrap collection and processing - SUCANOR (Luanda) and SUCASUL (Lobito), as well as a detailed programme for the establishment of a national network of small enterprises (scrap centres) throughout the country. These centres have been planned to take account of geographical and infrastructural factors of allocation,

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1/ Assistance in Iron Ore and Iron Scrap Processing, People's Republic of Angola, UNIDO, December 1986.

generation and consumption/requirements of metal scrap. The establishment of a domestic scrap collection system was found to be cheaper than importing scrap.

The shortage of scrap has strongly affected the productivity of the biggest national metallurgical enterprise - SIDERURGIA Nacional Steelworks in Angola. This plant has single hot-rolling steel bar and wire facilities for civil engineering and building construction, namely concrete reinforcing bar and heavy gauze wire, into two kinds of steel, A-24 and A-40, from 6 to 32 mm diameters, with a projected production rate in the steel-making shop of up to 30,000 tons/year and in the rolling mill shop of up to 45,000 (50,000) tons/year. SIDERURGIA Nacional's production rate represented more than 85 per cent of the overall installed metallurgical capacity in Angola and its raw material supplies are based exclusively on metal scrap. In the post-independence period the steel production of the enterprise has been continually falling and came down from the maximum attained output in 1975 of 37,607 tons/year of final products, equivalent to 41,000 tons/year of raw steel to an annual output of 10,000 tons/year of raw steel in 1985. One of the main reasons for this has been the lack of a suitable national structure for metal scrap collection and processing. The problem has therefore been given high priority by the Government of Angola, taking also into consideration the high internal demand of the civil construction industry for metallurgical materials.

Based on the study's detailed techno-economic analysis and feasibility confirmation, the Government, by decree, decided to establish the pilot scrap enterprise of the Angolan scrap system, the SUCANOR centre in Luanda.

Mid-1982, UNDP/UNIDO technical assistance was requested by the Angolan Government for the preparation of a detailed design (blueprint) for the SUCANOR centre, as well as for assistance to the national counterpart in the construction phase. UNDP/UNIDO Technical Assistance was later extended to all activities related to the building of SUCANOR, in close collaboration with the National Directorate of Heavy Industry of the Ministry of Industry and the Directorate of SUCANOR.

In the light of joint plans of both the Governments of Angola and Zaire for an integrated development of the iron and steel industry in the region, a reflection on Zaire's iron and steel sector is useful.

The Government of Zaire, hoping to alter Zairean trading patterns and encourage the manufacture of finished goods in Zaire, founded SOSIDER in 1972 as the first stage towards establishing an iron and steel industry.

The Maluku steel mill is equipped with relatively up-to-date technology, including a good quality control unit and mechanical workshop which has the capacity to produce some spare parts necessary for the steady operation of the plant. At present there are 515 staff members, down almost 200 since the end of 1982.

SOSIDER's Maluku Steel Plant is located in Maluku, 85 km north-west of Kinshasa. This plant has good housing facilities for employees. It is located along the Zaire River which provides plenty of fresh water. There is a small harbour, but it is not equipped for product shipment and scrap collection. Imports and exports are hindered by a waterfall on the way to the

Atlantic Ocean. The well developed highway between Kinshasa and Maluku enables the collection of scrap and selling of steel products in the domestic market. Between Kinshasa and Kisangani, a distance of about 1,600 km, there is a regular passenger and freight service by river. Barges could be used for transport; however, the waterways are in urgent need of dredging beyond Kisangani and on many tributaries. The low river level between Ilebo and Kinshasa causes transport interruptions. The transport infrastructure as a whole has steadily deteriorated since independence due to lack of Government investment as well as external problems such as the closure of the Benguela railway to Lobito because of the Angolan civil war. As a result, transport has become the most frequently mentioned difficulty of industry and commerce.

The economy of Zaire must become less dependent on non-ferrous metal exports and imports, and industrial and agricultural production must expand in a balanced, integrated way. The iron and steel industry has an important role to play in Zaire's future economic development. It can meet a larger share of demand through domestic production and generate new export revenues. The plant, with an investment of $120 million, was designed to produce 250,000 tons of liquid steel annually and started operation in 1974. The plant consists of a 50-ton electric-arc furnace (considering three shift operations) for scrap-melting in the production of carbon steel, a continuous billet strand casting (the output billet size is 100 x 100 m; the other output billet size of 140 x 140 m is never in use), a hot-roiling mill to produce bars, sections and wire rods with a capacity of 100,000 tons per year, a cold-rolling mill including a galvanizing line (which was never in operation), and facilities for the production of corrugated sheets with capacity of 150,000 tons per year and other facilities such as a maintenance workshop, energy supply facilities (which are not considered sufficient); and nearly residential facilities.

The capacity utilization of the Maluku Iron and Steel Plant of SOSIDER during 1974-1984 was as low as 2.5 per cent because the plant was working intermittently. In 1986 it was completely shut down due to insufficient power supply and shortage of inputs of raw materials and refractories.

CHAPTER 5
CONCLUSION

In terms of economic potential, Angola is one of Africa's richest nations, with generous reserves of land, water and mineral wealth. In order to make full use of this potential, however, Angola needs to transform a primarily mineral and agricultural economy into a modern industrial economy and to diversify primary commodity export-oriented industries into a more self-reliant industrial base.

If the Angolan economy is to become more independent of both oil exports and imported goods, industrial and agricultural production must expand in a balanced, integrated and efficient manner so as to meet a larger share of domestic demand and generate additional export revenues. Development of the iron and steel industry, such as the existing Siderurgia Nacional and auxiliary foundries and forges, has an important role to play in this and other aspects of Angola's future economic development. The iron and steel industry is one of the key industries in the economy because it has important backward and forward linkages to other industries, and supplies the basic materials for all major industrial activities.

For an industrial concern to function effectively, the various resources invested and utilized in production must be used in the most efficient way. To achieve this, it is necessary to have and develop ancillary industries and back-up facilities as needed for the production of machine tools, agricultural machinery, tractors, commercial vehicles, etc. These ancillary and support facilities include foundries, forging shops, tool rooms provided with heat treatment, metal forming and fabrication and metal coating. At present these are not well developed in Angola, and some existing ancillary facilities require substantial upgrading and rehabilitation. The manufacture of original equipment and spare parts by these facilities can play a vital role in promoting the rational and integrated development of the industrial sector as a whole in Angola. These ancillary and support facilities, together with Siderurgia Nacional, will lead to greater horizontal integration at the country level and is a prerequisite for the industrialization of Angola.

The development of metallurgical industries throughout the region will require co-operation between Angola and each of its neighbouring countries, Namibia, Zambia, Zaire and Congo. However, communications between Angola and its neighbors are relatively poor, although there have been in the past some joint ventures in the mining and metallurgical industries. Regional co-operation should be considered as the most appropriate mechanism for establishing and developing strong mining and metallurgical activities so as to facilitate industrial and economic development within the subregion.

There is also a need for the exchange of basic information on national plans for the development of the metallurgical industries. Regional co-operation is imperative, since the demand for metallurgical products in one country is too small for efficient plant operation. Dialogue among major actors at all steps of the production and distribution of metallurgical products should be encouraged, with a view to developing mutual strong points and complementarities in order to achieve the optimization of the whole cycle. For industrialization, complementary planning based on subregional

markets and resources would appear to be a means for bringing about concomitant development of the industrial sector in these countries.

The metallurgical infrastructure which already exists in the region, although in need of substantial rehabilitation at the level of the industrial plants, provides an excellent basis to support small-scale metallurgical industries which meet regional requirements for metal products. Regional co-operation with regard to the use of ore treatment, smelting, refining and other facilities will greatly enhance the viability of small-scale metallurgical industries. There is considerable scope for regional co-operation in joint training, the sharing of mining facilities, and in joint action to produce many of the essential inputs to metallurgical industries. For example, Angola has a steel mill while Zambia has a copper mill, and Zaire has both. There is a need to for these countries to co-operate in terms of material requirements and to develop a rational strategy and policy which would benefit these countries both individually and collectively.

UNIDO, UNDP and other United Nations member agencies have given valuable technical assistance to Angola and other developing countries for the development of their metallurgical industries based on local materials and processing with the following goals in mind:

- Promotion of the efficient utilization of existing resources of promising indigenous raw materials;

- Establishment or expansion of domestic production facilities for the required metallurgical products;

- Establishment of indigenous nuclei of metallurgical expertise.

Developing countries such as Angola are in need of independent advice concerning the evaluation of metallurgical industry studies and projects. This point has been stressed in past international conferences and UNIDO consultation meetings, and has led to requests for UNIDO assistance. It has also been suggested that the activities of UNIDO should be enlarged so that developing countries can obtain increased technical assistance in long- and medium-term planning, project evaluation, and management and labour training for their metallurgical industries.

Taking all these needs into consideration, UNIDO could play an invaluable role in bridging the technology gap in Angola. The role of UNIDO must be supportive of rather than alternative to national efforts, and must be geared to preventing unnecessary duplication and waste of resources, as well as promoting self-sufficiency and self-reliance in metallurgical industries in the region as well as in Angola itself. Recent revisions of Angola's mining laws to stimulate foreign investment and support for regional co-operation is a positive step in the direction of a more reliable and integrated approach to industrialization.

Annex 1: Metal-working industries in Namibe and Huila Provinces

Product	Company
Machine - Tool Work	Ermanal Shipyards - Namibe Emp. Metalo - Mecanica - Namibe Emp. Material de Construcao - Namibe
Ship Maintenance and repairs	Ermanal Shipyard - Namibe
Metal Carpentry and Metal (4) Furniture	Emp. Metalo - Mecanica - Namibe Emp. Material de Construcao - Namibe
Mining Extraction	Roremina - Namibe
Tyre Remouldings	Emp. de Recauchutagem - Namibe
Metal Casting	Railroad Workshop - Lubango Emp. de Manutencao - Lubango Metafus - Lubango
Machine - Tool work	Railroad Workshop - Lubango Emp. de Manutencao - Lubango Metafus - Lubango
Metal Carpentry and Metal Furniture	Alvaro Vicente - Lubango Emp. de Manutencao - Lubango Metafus - Lubango
Refrigeration	Tubo-Frio - Lubango
Mining Extraction	Ferrangol - Cassinga* Roremina - Lubango (2)
Tyre Remoulding	Emp. de Recauchutagem - Lubango (3)

(1) This company is the only one producing some cast iron parts for agriculture

(2) This company exploits granite quarries in the Chincuntite aria (Huila) and marble quarries in Namibe, but has headquarter offices in Lubango

(3) This public enterprise is made up of the merging of two old private workshops

* Not visited.

Source: Boletim Trimistral de Estatisticas
Delegacao Provincial de Estatistica Vol. II, No. 2

Annex 2: Basic metal industries and fabricated metal project identification in the Provinces of Huila, Namibe and Cunene

1 Agricultural implements and hand-tools. The GPR is already pushing such a project through some of the Lubango metal industries.

2 Agricultural machinery: ploughs, sprayers and cultivators. There is substantial production of plough blades but no serious study about appropriate designs of full ploughs and other cultivators.

3 Trailers and animal carts. The basic capacity for producing these elements is there, but they need to develop standard designs and some sort of production line.

4 Industrial and domestic hand-tools. There is a desperate need for the most elementary tools, from hammers and screwdrivers to spades and racks.

5 Sheet metal fabrication - silos, tanks, piping. Empresa de Manutencao used to have some equipment for this activity, including some curving rools - but that company is practically paralysed.

6 Irrigation systems - using cement, plastic and metal piping, and even sprinklers and sprayers.

7 Basic agricultural machinery for crop processing: crushers, hullers, decorticators, hammer mills, grain driers, etc.

8 Irrigation pumps, starting perhaps with licenced assembling and then partial manufacturing of components.

9 Light transport equipment like wheel barrows, ladders, etc.

10 Kerosene and gas stoves and lamps. This is also a very urgent need for rural and urban dwellers since the supply of electricity distribution is uneven, firewood is bcoming expensive and scarce, and so are paraffin candles. In fact, there is a new gas terminal in Namibe, and there should be a substantial expansion of its distribution.

11 Ferrous and non-ferrous foundry - beyond Metafus and CFM. Perhaps for standard products such as sanitary ware, piping and fittings, valves, machinery parts, etc.

12 General machine-tool and fitting workshops, similar to those of Ermanal and DFM.

13 Solar pannels for domestic and industrial use - these are very widespread in most countries in the Southern African sub-continent.

14 Rerolling mills that can use ferrous scrap for laminated products - a technology that is very common in the Indian sub-continent.

Source: Government of Angola, Ministry of Planning, 1986.

Annex 3: Foundries and forges in Angola

Product	Number of Factories	Potential Output	Actual Output(1985)	Comment
Ships Ship repair	1	3 units 250 units	3 units 250 units	Benguela - 586 employees
Cutlery	1	3.23 million units	3 million units	Luanda - 45 employees
Screws and rivets	1	1,100t	754t	Huambo - 67 employees
Aluminium tableware	1	1,155t	340t	Benguela - 103 employees
Crockery Steel utensils	1	471t 505t	140t 150t	Benguela - 50 employees
Buses Renault 4	1	500 units 1,000 units	250 units 800 units	Luanda - 600 employees
Tyres Air ducting	1	4,570t 323t	1,620t 40t	Luanda - 594 employees

Product	Number of Factories	Potential Output	Actual Output (1985)	Comment
Steel bars	1	30,000t	30,000t	Luanda - 460 employees
Lamps and stoves Metal tableware	1	110,000 pieces 150t	96,000 pieces 150t	Luanda - 147 employees
Animal ploughs Cast iron	1	5,304 units 160t	5,000 units 150t	Huambo - 106 employees
Animal ploughs Disc harrows Seed drills Cultivators Agricultural implements	1	5,000 units 400 units 600 units 300 units various	—	Lubango
Animal ploughs Disc harrows Seed drills Cultivators Agricultural implements	1	2,500 units 200 units 300 units 150 units various	300 units (tractor drawn)	Luanda - 62 employees
Pipes	1	24,000t	6,000t	Luanda - 304 employees
Corrugated iron	1	16,000t	6,000t	Luanda - 80 employees
Scrap iron recovery	1	24,000t	14,000t	Luanda

Source: Angola: A Survey of Industrial Potential. Economic and Export Analysis Ltd., United Kingdom, 1986