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The Non-Ferrous Metals Industry of the Federal Republic of Germany

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I. Introduction

The Federal Republic of Germany has a centuries old tradition in the extraction and processing of non-ferrous metals. This section of heavy industry consists of mines, metallurgical concerns, plants for semi-finished metal products and foundries. Besides primary production based on ores and concentrates there is also considerable recycling of scrap metals and non-ferrous wastes.

The non-ferrous metal industry is not a "main" sector within the the framework of the German economy: in 1982 its share in the GNP was merely 0,29%, with 92,141 employees in 1983 (0,4% of total German workforce).

Nevertheless these figures do not reflect the real importance of the industry. Without the metals and alloys supplied by the non-ferrous metals industry it would not be possible to cope with the demands of modern industrial society. The structure of this sector of industry is complicated and diffuse and because of the dissimilar importance of some metals over others. The integration with other sectors of industry is very intensive. Among other activities the non-ferrous metals industry supplies important sectors such as the automobile, electrical and mechanical engineering industries; in cooperation with these important costumers it is also developing new products on the basis of new technologies.

This paper is based mainly on two studies (Stodieck, Pommerening, Ziervogel 1985 and Harms, Stodieck 1983), undertaken by the German "Institut zur Erforschung technologischer Entwicklungslinien e.V.". If not otherwise stated, the data published here is from the above mentioned studies. I am indebted to Dr. Thomas Baack from Metallgesellschaft AG/Frankfurt, who helped me by providing material on this specialised field.

II. Mining and supply with raw materials

Because of the fact that the FRG has only has considerable home deposits of lead and zinc, the non-ferrous metals industry has without doubt a consumer-oriented location.

If metal content serves as a basis of production figures one has to state that the production has been declining continously over the last few years (see Table 1).

In 1983 the following lead-zinc pits were still in operation:

- Rammelsburg (Goslar)
- Hilfe Gottes (Bad Grund)
- Meggen (Lennestadt).

In 1983 over 1,8 million of crude minerals were produced, which resulted in 256,000 tons of concentrates (23,500 ton of lead and 92,600 tons of zinc). Table 2 shows the distribution between the two major companies in this field:

Table 2

Mining production of lead and zinc 1983
in %

company	lead	zinc	lead and zinc
Preussag AG	90	53	60
Metallgesellschaft AG	10	47	40
total	100	100	100

source: Fachvereinigung Metallerzbau e.V., Jahresbericht and Statistik 1983, Düsseldorf 1984, p.3

Table 1

Development of the mining production of non-ferrous metals in the Federal Republic of Germany 1970 - 1981

year	number of pits	raw and dump ore (wet weight) 1000 t	ores ready for works (dry weight)	yield of metal-content lead	zinc	copper
				1000 t		
1970	5	2 293	320,0	38,6	113,8	1,3
1975	4	1 972	307,9	31,4	111,6	2,0
1978	4	1 733	260,1	23,2	97,4	0,8
1979	3	1 662	266,3	25,2	96,9	0,9
1980	3	1 688	271,2	23,1	99,7	1,3
1981	3	1 720	252,7	21,6	91,8	1,4

source: Bergbaubehörden der Länder, Der Bergbau in der Bundesrepublik Deutschland - Bergwirtschaft und Statistik, different years

Apart from the deposits of lead and zinc the FRG does not have a considerable amount of non-ferrous minerals. Due to this fact the country is highly dependent on imports of these materials. In 1981 it imported:

- 3,9 million tons of bauxite (Australia 40%, Republic of Guinea 35%, Sierra Leone 15%), 469,000 tons of aluminiumoxide (Australia 58%, Italy 31%), 476,000 tons of raw aluminium (Norway 43%, Great Britain 12%);
- 215,000 tons of lead concentrates (Sweden 30%, Canada 16%);
- 481,000 tons of copper concentrates (Papua-New Guinea 44%, Mexico 28%, Republic of South Africa 13%), 66,000 tons of unrefined copper (Chile 27%, Poland 19%, Belgium 19%);
- 3,229 tons of tin concentrates (about 66% from Great Britain), 17,396 tons of tin metal (Thailand 36%, Indonesia 26%);
- 38,000 tons of raw nickel (Soviet Union 17%, USA 16%), 65,000 tons of ferro-nickel (Greece 55%) and
- 506,000 tons of zinc concentrates (Canada 27%, Sweden 14%,), 22,000 tons of raw zinc (The Netherlands 52%, Norway 14%), 55,000 tons of resmelted zinc.

The scarcity of indigenous raw materials is reflected in the very strong efforts to recycle wastes, metals and scraps: The amount of resmelted aluminium increased from 258,500 tons in 1970 to 423,600 tons in 1979. In 1981 out of 348,000 tons of lead 158,800 tons originated from secondary material. 40 percent of lead refined in the FRG came from indigenous secondary material.

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1) The - incomplete - figures for 1984 are:

4,1 million tons of bauxite (Australia 36%, Guinea 36%, Sierra Leone 15), 698,377 tons of raw aluminium (Norway 35%, Britain 8%);

206,723 tons of lead concentrates (Canada 20%, Morocco 13%, Sweden 12%);

85,500 tons of unrefined copper (Chile 26%, South Africa 28%), 458,700 tons of refined copper (Chile 23%, Poland 17%, Zaire 15%);

48,284 tons of raw nickel (Soviet Union 35%,USA 10%);

594,352 tons of zinc concentrates (Canada 40%, Greenland 10%, Sweden 9%). (source: Metal Bulletin 1985)

In the case of zinc the secondary production contributed with 31 percent to the supply of zinc.

Uninterrupted supply for the German non-ferrous metals industry is not so much dependent on the amount of available reserves as on the fact wheter the necessary investments for prospection, exploration and mining are undertaken in time. The non-ferrous metals industry is dependent on the activities of foreign companies. German investment in the mining of non-ferrous minerals is still the exception.

III. Production

Due to the ability to improve production and thus capacity the metallurgical concerns increased considerably during the seventies: The Norddeutsche Affinerie erected a new raw copper works at Hamburg; the German aluminium industry as a whole increased its capacities between 1968 and 1973 by 50,000 tons. The new zinc electrolysis works in Nordenhamm und Datteln replaced mainly old plants so that their supply did not increase to any significant degree.

In 1981 in the field of metallurgical works and recasting works
12 light metal plants,
13 heavy metal plants and
50 non-ferrous recastings plants
were in operation.

In 1981 the sales figures of these works accounted for 11,5 milliards German Marks; 4,6 Mrd. DM alloted to recasting works and 3,4 Mrd. DM to light metals works. The production of semi-finished products is the main activity of the sector. In contrast to the iron and steel industry the non-ferrous metals industry is producing semi-finished products with a higher degree of processing. Non-ferrous semi-finished products are turned into finished products if they are punched, turned, molded, cut to size,... for specific tasks.

Table 3 gives a survey of the development and the composition of semi-finished products in the German non-ferrous metals sector. It shows that the production of semi-finished aluminium products and aluminium alloys is by far the most important. If one takes into account the low specific weight of this metal the difference is much more important.
The expansion of the aluminium semi-finished production industry was by far of the most significance. In 1981 this sector produced about 77% more than in 1970; while the growth of the copper production increased by only 26%.

Aluminium

The production of aluminium semi-finished products is mainly undertaken in integrated works. Blooms and press casts have qualities and dimensions in accordance with the needs of the next stage of processing.

In 1981 the production fo the foundries reached with 450,000 tons approximatly the level of 1970. In 1984 the total production of semi-finished products reached 1.145,300 tons, of castings 330,900 tons (Metal Bulletin 1985).
A shift of production from heavy casting to light-metal casting took place. Table 4 shows this development and the importance of aluminium casting for the period 1970 to 1981.

During the seventies growth in productivity was the decisive factor in the development of production. The real gross value added of the branch was increasing by about 25%. In the same period the number of employees declined by 15%.
The real reasons for the upsurge in productivity have to be identified as increased capital investment and technical progress.
In the aluminium and copper industry technological innovation was pursued to such a degree that one can state that the non-ferrous metals industry in the Federal Republic of Germany is one of the most efficient in the world.

Table 3

Production of semi-finished non-ferrous metals in the Federal Republic of Germany 1970 - 1980

Semi-finished production	dimension	1970	1975	1978	1979	1980	1981
aluminium a. - alloys	1 000 t	554,3	665,1	940,3	1 045,1	1 018,1	983,6
of it:							
- rolled products	"	317,9	374,3	564,6	638,2	615,0	645,7
- press a. cast mat.	"	190,8	235,4	305,1	345,8	338,1	280,3
- bearing material	"	45,6	55,4	70,6	61,1	65,0	57,5
lead a. -alloys	1 000 t	44,1	37,0	41,4	38,1	44,2	41,3
of it:							
- wire, rods	"	4,1	3,5	5,7	5,4	5,2	6,3
- sheets, strips	"	24,2	25,4	28,0	26,7	31,3	28,7
- tubes	"	8,0	3,3	2,8	1,5	3,0	2,2
copper	1 000 t	520,3	489,4	617,2	658,6	659,2	657,1
of it:							
- wire	"	398,8	357,5	453,9	481,5	484,3	481,5
- rods, profiles	"	25,6	26,6	27,2	29,2	30,0	30,9
- sheets, strips	"	40,7	44,5	62,6	68,6	70,0	74,1
- tubes	"	53,6	59,7	72,5	78,5	74,4	70,2
nickel a. -alloys	1 000 t	21,9	25,0	31,4	36,0	14,6[c]	12,4
of it:							
- rods, profiles,wire	"	5,1	5,2	6,8	8,3	5,7[c]	4,9
- sheets, strips	"	14,9	17,7	22,1	25,3	7,0[c]	6,4
- tubes	"	1,9	2,1	2,5	2,5	2,0[c]	1,1
zinc a. alloys	1 000 t	72,7	48,3	57,7	60,8	63,9	66,1
tin a. alloys	t	834	904	815	702	576	493

source: Fachvereinigung Metallhalbzeug e.V., Statistische Zusammenstellungen, Metallhalbzeug, different years, Düsseldorf

Table 4

Non-ferrous metal cast production in the Federal Republic of Germany 1970 - 1981

metal	dimension	1970	1975	1978	1979	1980	1981
aluminium a. alloys	1 000 t	241,6	211,3	293,7	318,8	318,0	307,3
lead a. alloys	1 000 t	7,3	5,8	7,2	6,8	7,1	7,7
copper a. alloys	1 000 t	98,9	77,3	79,8	84,3	87,0	78,2
zinc a. alloys	1 000 t	65,0	45,4	51,4	52,9	48,4	44,1
tin a. alloys	t	546	1 053	684	609	586	554
light-metal cast	1 000 t	281,8	227,4	310,1	334,8	333,2	320,1
heavy-metal cast	1 000 t	172,2	129,7	139,3	144,9	143,3	130,8

source: Gesamtverband deutscher Metallgießereien, Geschäftsberichte, verschiedene Jahrgänge, Düsseldorf

The very intensive cooperation between the aluminium plants and the semi-finished manufacturing industry, as well as the newly introduced casting methods for wires and plates have to be mentioned in this context. Market structures and competition conditions differ at the various levels of the non-ferrous metals industry. The few primary plants are producing raw and refined metals which have to be sold in competition against other Western European suppliers. Their position depends on the supply-side, the continous availability of cheap raw materials and the production costs.

The secondary plants produce alloys in accordance with the needs of home consumption (mainly foundries and semi-finished product plants). Because they are using production wastes of semi-finished works and foundries and scrap on the in-put-side they are quite dependent on the home market.
Costs of production and demand in important branches such as the automobile industry, are factors which determine the development of the secondary plants.

Between 1970 and 1981 the supply aluminium to the German economy (production+import-export) increased by 400,000 tons or by 3,2% per year.
The growth-rate in the aluminium industry was 2% higher than in other sectors of the non-ferrous-metals industry. In the first half of the seventies the home manufactures were able to raise their share in the supply of the home market from 50 to 75%. Since then the recasting plants have increased their production considerably, but nevertheless the market share of the German plants declined to 75%. Besides increased internal exports to Germany by concerns in Great Britain and Norway (Alcan) and Iceland (ALusuisse), "cheap-imports" from countries such as Egypt, Spain, Surinam - and in some years - Ghana also led to a deterioriation in the position of the German plants on their home market. Due to the high quality standard and technological variety their products, German producer were nonetheless able to compensate

for the losses the incurred on the home market by raising their export sales.

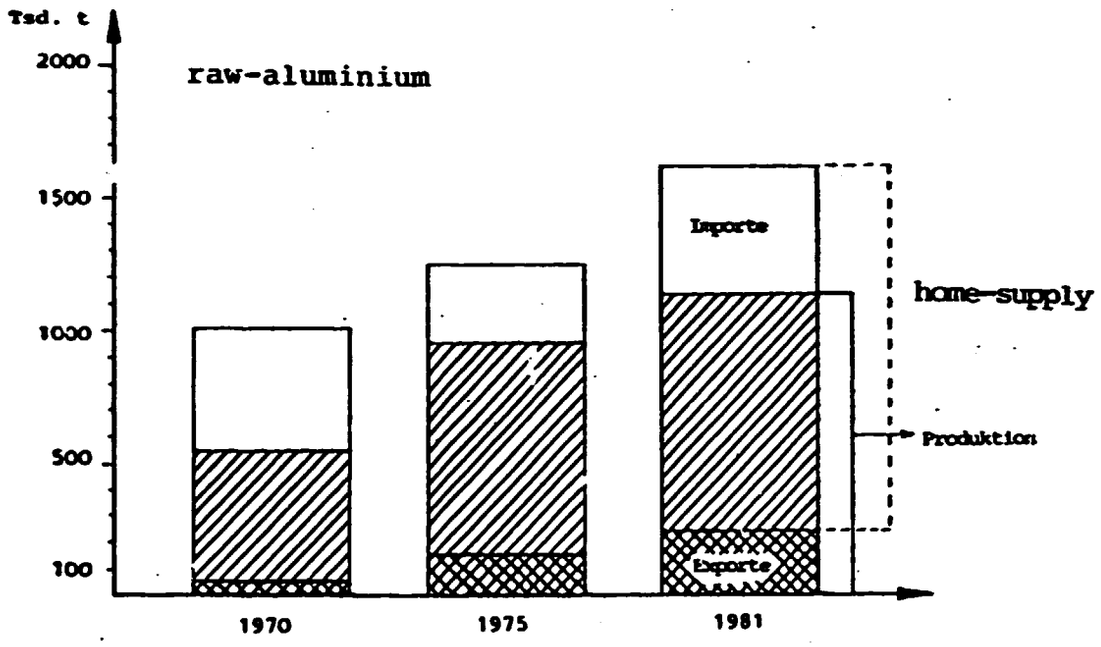
A similar development can be seen in the semi-manufacturing aluminium industry, where the "export drive" is much stronger: The production of these German plants, which are integrated almost 100% with pressrooms and to 60% with drawing mills, increased from 1970 to 1981 by about 430,000 tons or an average 5,4% per year. This growth has to be put down to the enlargement of the rolling capacities in the second half of the seventies, which had to be undertaken because of the technological needs of huge units. As shown in Table 5 exports were steadly increasing over the years. In 1981 310,000 tons of semi-finished aluminium were exported. But the increased import of standard sheets and simple press casted products decreased the market share of German producers from 85% in 1970 to 77% in 1981.

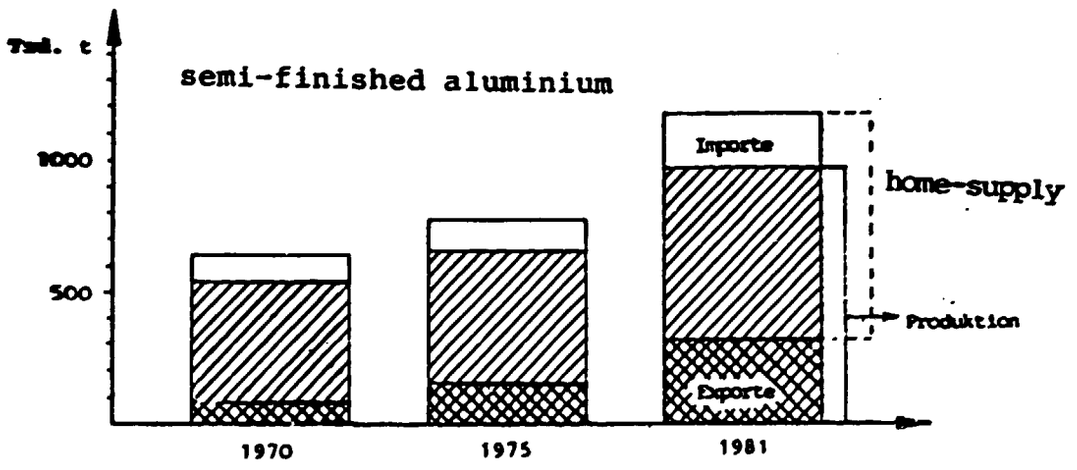
In the field of foundry products production increased between 1970 and 1981 by 65,000 tons or 2,2% on average yearly to 307,000 tons in 1981. (In 1979 there eas a record production of 318,000 tons). In this stage of processing aluminium is also the dominating growth-metal. Its expansion is closely linked to the developments of the automobile industry, which is gradually replacing iron and steel parts by aluminium. More than 2/3 of the cast-production is used by car manufactures. In the last few years French and Italien producers of ready-to-fit-in aluminium parts emerged as competitors to German producers.

If one investigates which companies are engaged in the German production of aluminium one finds besides the Vereinigte Aluminium Werke AG (VAW), the leading company in the Federal Repbulic of Germany, the same integrated works, active in countries all over the world: Alcan, Alusuisse, Kaiser and Reynolds. Moreover, Alcoa owns aluminiumoxide works at Ludwigshafen, while the Austria Metall AG together with Reynolds and VAW own the shares of the Hamburger Aluminium Werk GmbH (see Table 6).

Table 5

Aluminium: Home supply and foreign demand 1970, 1975 and 1981

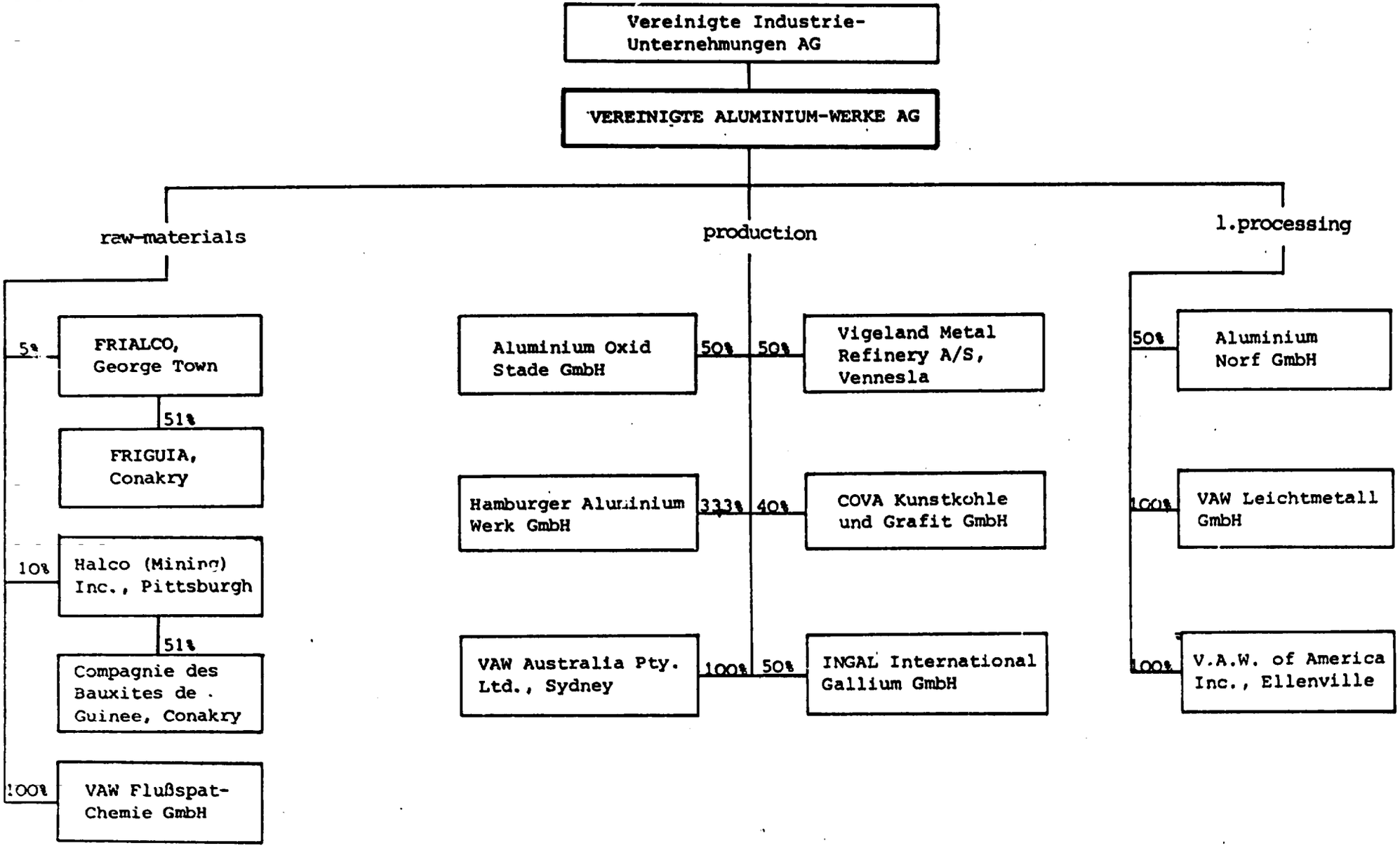




Source: Metallgesellschaft AG, Metallstatistik, different years, Frankfurt/Main

Table 6

German non-ferrous metal companies: Vereinigte Aluminium Werke, selected capital linkages



source: Harms/Stodieck 1983

The capacities of the oxide and aluminium production in the Federal Republic of Germany are shown in Table 7.

Table 7

Capacities of aluminium-oxid- and aluminium production in the Federal Republic of Germany in 1983

companies/works	capacities 1000 t/year
Vereinigte Aluminium Werke AG (VAW) Bonn, Berlin	
Oxide	
- Lippewerk, Lünen - Nabwerk, Schwandorf - Aluminium Oxid Stade GmbH, Stade (50 % VAW; 50 % Reynolds)	885[b]
Aluminium	
- Elbewerk, Stade - Innwerk, Töging - Lippewerk, Lünen - Rheinwerk, Norf - Hamburger Aluminium-Werkes GmbH Hamburg (1/3 VAW, 1/3 Reynolds, 1/3 Austria Metall AG)	418[b]
Alusuisse Deutschland GmbH, Konstanz	
Oxide	
- Martinswerk GmbH, Bergheim/Erft	340
Aluminium	
- Aluminium Hütte Rheinfelden GmbH, Rheinfelden	64
- LMG-Leichtmetall-GmbH, Essen	133
Kaiser Aluminium Europe Inc. Deutschland Düsseldorf	
Aluminium	
- Kaiser Aluminium Europe Inc. Deutschland Hüttenwerk Voerde, Voerde	72
Alcan Aluminiumwerke GmbH, Frankfurt	
Aluminium	
- Werk Ludwigshafen	44

Alcoa Deutschland GmbH	
Oxide	
- Werk Ludwigshafen	120
Reynolds	
Oxide	
- Aluminium Oxid Stade GmbH (50% Reynolds; 50% VAW)	315[c]
Aluminium	
- Hamburger Aluminiumwerk GmbH, Hamburg (1/3 Reynolds, 1/3 VAW, 1/3 Austria Metall AG)	33[c]

a Normal utilization of capacities and usual use of raw materials

b Without the shares of productions of Reynolds or Austria Metall AG

c Without the production shares of VAW or Austria Metall AG

source: Stodieck et al. 1985, p. 15 f.

All of the important aluminium producer are also engaged in the processing:

Vereinigte Aluminiumwerke AG

locations: Neuss, Norf, Lünen, Teningen, Roth, Bedburg, Hannover, Neumünster, Bonn, Weilheim, Köngen

products:
- sheets, strips, foils, plates, sections
- improving of foils, manufacturing of foils
- die forms
- cast products
- extruded shapes
- bullions
- free formed pieces

Alusuisse Deutschland GmbH

locations: Singen, Essen, Rheinfelden, Bergheim

products:
- sheets, ribbons, circular blanks
- profiles, bars, wires, compound castings
- thin sheets
- etched foils

Alcan Aluminiumwerke GmbH

locations: Göttingen, Uphusen, Nürnberg, Berlin, Plettenberg-Ohle, Lüdenscheid, Neuss, Lorf, Lünen

products:
- rolled flat products: sheets and ribbons, polished and blank
- sheets with surface modification
- coloured aluminium
- packaging systems
- flow moulded pieces
- aluminium postons
- wires and ropes

Kaiser Aluminium Europe Inc. Deutschland, Düsseldorf

locations: Koblenz, Berlin

products:
- sections, sheets, extruded shapes
- bars, rods, gutters, cables, sheatings

Reynolds Metals Company, Richmond, (USA)

location: Hamburg

products:
- semifinished cast products
- rods, profiles, tubes
- tin-container, strips

Copper

Over a period of more than 10 years the supply of refinded copper showed fluctuations between 700,000 and 800,000 tons. In 1981 the supply had risen only insignificantly above the 1970 level. Since the mid-seventies the German copper works had to reduce their production by 60,000 tons due to the scarcity of suitable raw materials. The primary works of the Norddeutsche Affinerie were affected by this development to the greatest extent.

Foreign copper producers such as Chile, Poland and South Africa penetrated the German market which they now supply with 60% of the consumed refinded copper.

The market volume for conductive material, which is used mainly for cables and wires, expanded between 1970 and 1981 by 60,000 tons or 1% per year. The German producers increased their production capacities with the result that production rose twice as fast as did the home market volume. For this reason they pressed into foreign markets, especially into those of the European Community and the European Free Trade Zone. Since 1975 their exports increased by over 120,000 tons, i.e. an average of 16% per year.
Because of the fact that on the other hand imports rose considerably, the share of the German suppliers dropped from 90% to 75%. Between 1970 and 1981 the market share for semi-finished alloys, especially semi-finished brass, which is mainly used in the machine building industry, declined by 65,000 tons to 290,000 tons. Nevertheless, the German producers did not reduce their capacities but produced 400,000 tons, the total for 1970.

As in the case of non-alloyed copper, German producers also found new sales areas in the European Community, the European Free Trade Zone and in the USA.

Unlike the German aluminium industry, integrated copper works are the exception. As a by-product of lead/zinc mining copper ores

with a copper content of 1,000 tons per year are being extracted by Preussag AG, whereby the processing is carried out by Norddeutsche Affinerie AG.
On the stage of metal producing Norddeutsche Affinerie AG is a complex copper concern with processing capacities for concentrates and scrap- and waste-material. In the secondary range one finds the Kayser AG which is working mainly as a secondary plant but also uses extra blister copper and other intermediate products.

These two companies hold shares in the Berliner Kupfer Raffinerie GmbH., which is producing raw copper in the form of anodes for refining in the two mother companies in Hamburg and Lünen.
Table 8 gives a survey of the capacities, table 9 demonstrates the capital-linkages.

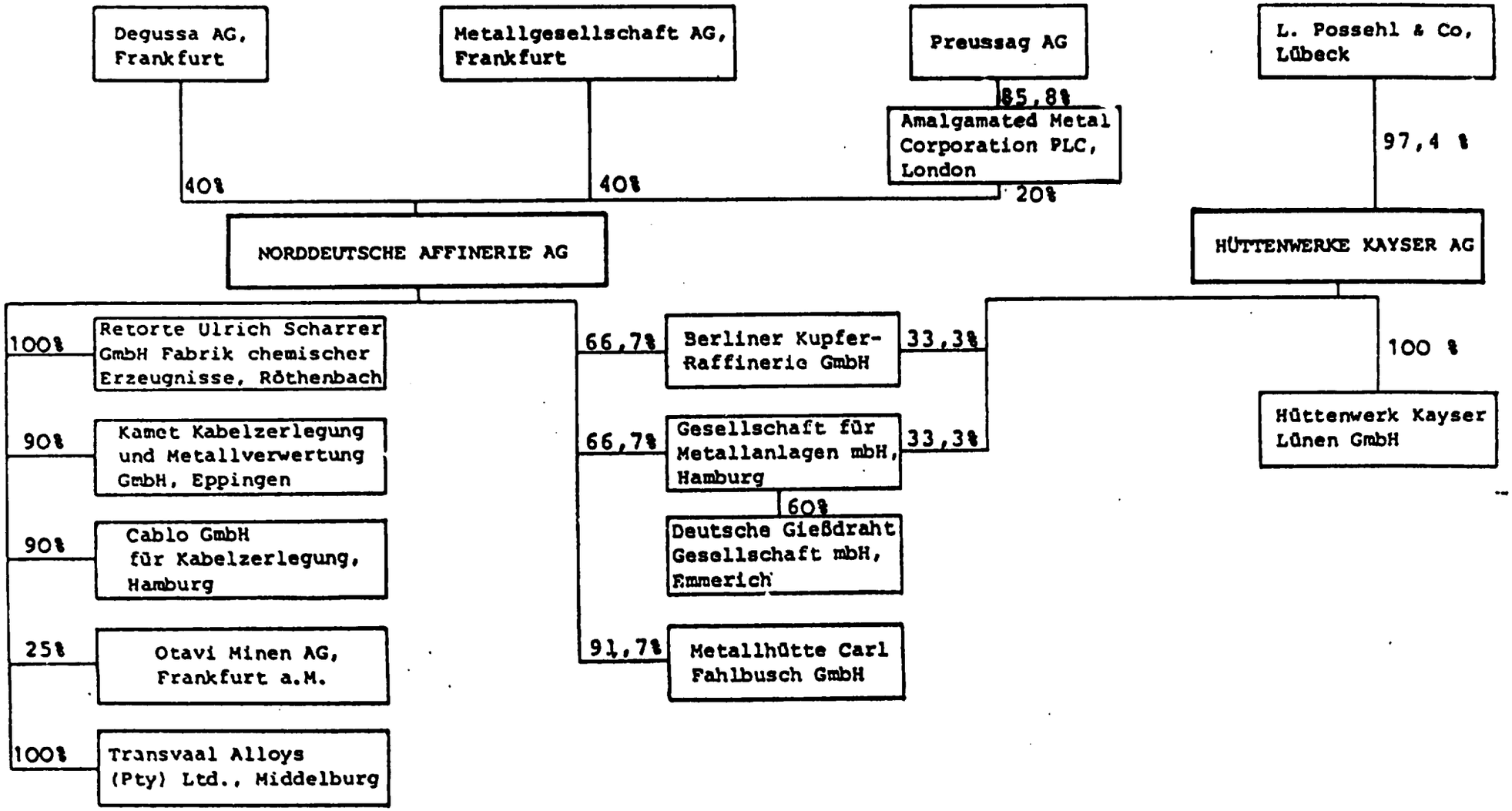
Table 8
Capacities of German Copper Plants

companies	capacities tons p. year
Norddeutsche Affinerie AG	
- Flash Smelting Process	550 000 t concentrates (150 000 t raw copper)
- shaft furnace	80 000 t raw copper
- copper cathodes	240 000 t
Hüttenwerke Kayser AG	
- copper cathodes	150 000 t
Berliner Kupfer-Raffinerie GmbH	
- copper anodes	15 000 t
Metallhütte Carl Fahlbusch GmbH	
- copper cathodes	10 000 t

source: Stodieck et.al. 1985

Table 9

Capital linkages of the German copperworks



source: Uwe Harms, Helmut Stodieck, Branchenstrukturuntersuchung NE-Metallindustrie, Hamburg 1983

These companies are not active in the field of copper manufacturing. Apart from small companies with a very specialized production programme or a regional market one finds about 15 large companies such as Felten & Guilleaume Energietechnik GmbH, or Kabel- und Gutehoffnungshütte AG, with a wide range of products and large production units.
Foundries which manufacture copper and copper alloys are of regional importance and they work in close contact with their clients. Different companies are engaged during various stages of production. Links between concerns, such as those between Felten & Guilleaume Energietechnik GmbH and the Philips group or between the Kabel- und Metallwerke Gutehoffnungshütte and the Gutehoffnungshütte Group provide connections to other sectors of industry.

Lead and zinc

In contrast to aluminium and copper the home deposits of lead and zinc play an important role for German manufactures. Primary and secondary works have a "natural" location in the Federal Republic of Germany. For reasons of environmental protection and security of supply the FRG has to raise the amount of recycled materials.

Two important companies, the PREUSSAG AG and the METALLGESELLSCHAFT AG, are active in the manufacturing of lead and zinc. The Preussag AG is only active on plant-level and supplies trade-lead, fine-lead, especially hard lead alloys and lead-oxide for use in the chemical industry. The Metallgesellschaft AG is also active in manufacturing. For instance, the Metalon GmbH supplies lead-alloys and semi-finished alloys, casted articles, products for radiation protection and sound absorption. Lead tin solder of every type is produced by Berzelius and Küppers Metallwerk GmbH. But only a small amount of the production of lead is integrated in this form. Alongside its main product copper, the Norddeutsche Affinerie produces lead which is supplied as raw and fine lead and also in form of different alloys.

In the case of zinc, Metallgesellschaft AG and Preussag AG are much more active on the first stage of manufacture. Preussag is mainly engaged in the field of galvanization, while the activities of Metallgesellschaft concentrate on the production of semi-finished products. The most important engagements of these two companies are shown in Table 10 and the structure of capital-linkages is illustrated in Table 11.

Table 10

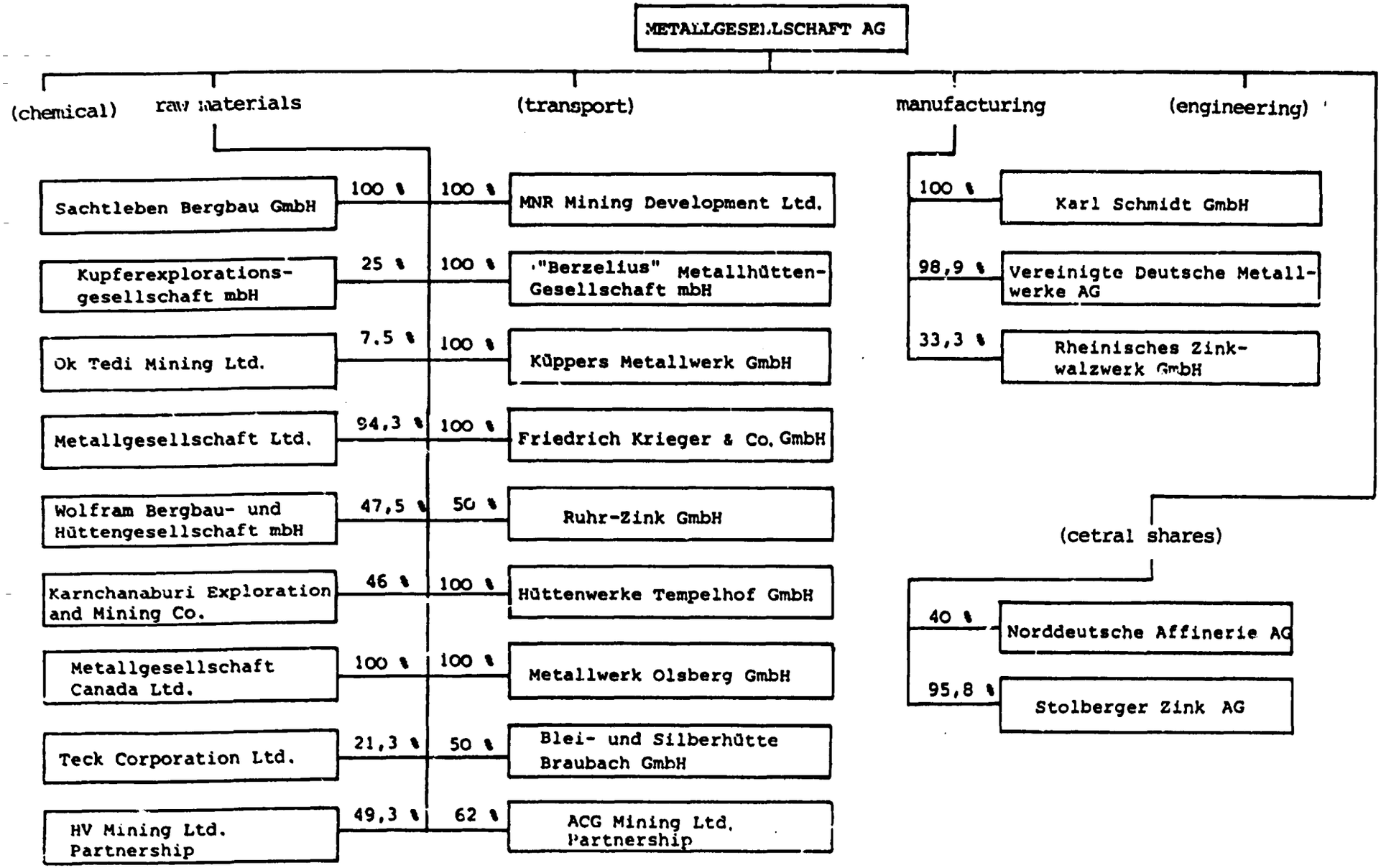
Lead- and zinc-manufacturing companies of Metallgesellschaft AG and Preussag AG in the Federal Republic of Germany, 1983

group/company	location	main products
Metallgesellschaft AG		
- Rheinzink GmbH	Datteln	semifinished products, gutters, raining tubes, structural parts out of high-purity zinc
- Metalon GmbH	Stolberg	fine-zinc die casting alloys,semi-finished products lead and zinc or alloys
- Friedrich Krieger & Co. GmbH	Hilden	hot galvanizing
- Berzelius und Küppers Metall-werk GmbH.	Duisburg	filler wire, special solders
- Hüttenwerke Tempelhof	Berlin	zinc die casting
Preussag AG		
- Druckgußwerk Ortmann GmbH	Velbert	zinc die casting
- Fusor Druckguß-werk GmbH	Berlin	zinc- and aluminium die casting
- Preussag Berliner Großverzinkerei	Berlin	hot galvanizing, spray coat galvanizing
- Feuerverzinkung u.Metallveredelung (works of Preussag Metall)	Neumünster	hot galvanizing, gal-
- Metallveredelungs-betrieb Heinbach GmbH	Heinebach	hot galvanizing
- Großverzinkerei Schörg GmbH	Fürstenfeld-bruck, Lahr, Dogern	hot galvanizing
- Josef Siepe Verzinkerei GmbH	Köln	hot galvanizing

source: Stodieck, Pommerening, Ziervogel 1985

Table 11

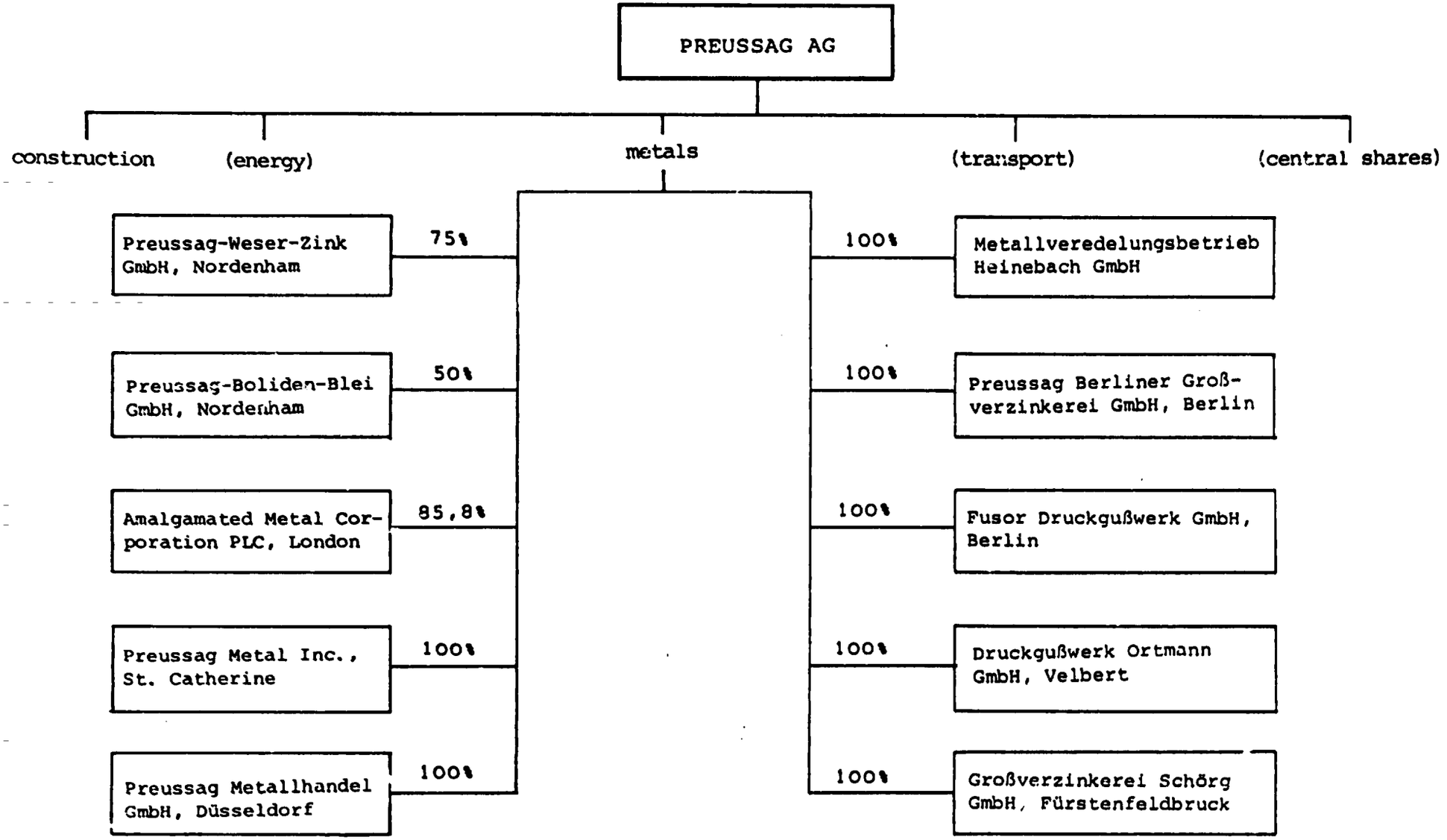
German non-ferrous metal companies: Metallgesellschaft AG, selected capital linkages



source: Harms/Sodieck 1983

Table 11a

German non-ferrous metal companies: Preussag AG, selected capital linkages



source: Harms/Stodieck 1983

IV. Development of Demand

Development of consumption

Between 1970 and 1981 German for non-ferrous metals increased by 660,000 tons 2% or with an average of 2% per year (see Table 12). As far as quantity is concerned, aluminium is the most important metal. With the exception of the crisis ridden period in the mid-seventies, the total demand increased from 881,000 tons in 1970 to 1,4 million tons in 1981. This corresponds to a yearly average growth rate of 4,4%. As regards of consumption aluminium led the field in the total consumption of non-ferrous metals; its growth-rate laid above the growth-rate of overall industrial production which accounted for an average increase of 2% per year.

Compared to aluminium, the consumption of copper was much more dependent on economic factors. Taking 1970 as a starting point the consumption of copper increased only by an average of 1,2% per year.

The demand of lead varied between 330,000 and 360,000 tons per year. If one examines the consumption development over a longer period one detects a fundamental stagnation.

For zinc and tin a similar development applies . While the boosted level of tin prices is supressing demand beyond 15 or 16 tons and stimulating substitution, zinc suffers from its dependence on sensitive branches of industry. Increase in demand in times of brisk economic development with a flourishing automobile and construction industry is regularly followed by a massive decrease of consumption in times of upward economic activities. As late as 1981 the consumption of zinc reached the 1970 level of 410,000 tons.

Aluminium nickel is the second material which enjoys an above average in the rate of demand. In 1981 total consumption was

Table 12

Consumption of aluminium, lead, copper, nickel, zinc and tin in the Federal Republic of Germany 1970 - 1981, in 1000 tons

	1970	1975	1976	1977	1978	1979	1980	1981
aluminium	881,0	957,4	1 263,7	1 251,6	1 336,4	1 487,2	1 455,0	1 418,5
lead	355,0	282,5	299,8	348,5	335,8	361,3	333,1	331,6
copper	854,7	741,3	889,8	853,8	924,9	996,7	1 023,7	978,6
nickel	40,9	42,8	56,4	53,6	66,4	76,5	67,6	62,0
of it: high purity	31,9	34,6	42,6	31,2	36,2	42,9	40,3	36,7
zinc	412,7	318,4	349,9	355,5	417,3	447,4	436,9	411,9
tin	15,1	13,0	15,7	14,9	15,1	15,2	15,9	14,5
total	2 559,4	2 355,4	2 875,3	2 877,9	3 095,9	3 384,0	3 332,2	3 217,4

source: Metallgesellschaft AG, Metallstatistik, different years, Frankfurt/M.

about 50% higher than in 1970; which meant an average growth rate of 3,9% per year.
But one has also to take the fact into consideration that the "young metal" nickel started its upswing from a very low level and gained from positive developments in the high-grade steel sector. The ongoing crisis in the iron and steel industry is reflected in the declining demand for nickel. The growth of demand is limited to ferro-nickel and nickel-sinteroxide which have replaced pure nickel in the production of high-grade steels.

Development of the structure of consumption

Aluminium

Together with the export production of semi-finished products the transport sector emerged as "the locomotive" of aluminium consumption, too, consuming about 90,000 tons mor in 1981 and thereby increasing its share to above one fifth of total aluminium consumption.
If one separates the consumption for the export of semi-finished products from the overall consumption, the share of the transport sector amounts to above 30%. The by far most important share is alloted to the automobile industry. The efforts to reduce the weight of automobiles are the main reasons for increased use of aluminium.
In a long perspective the constru business will be an important and increasing consumer of al. .um. The third growth-sector is the packaging industry (see Table 13).
In the field of electrical engineering the substitution of aluminium by other materials came to an end years ago. The sales figures are stagnating at a level between 60,000 and 700,000 tons per year.

Table 13

Consumption of aluminium in 1970, 1975 and 1981

	1970	1975	1981
total consumption of aluminium a. -alloys in t	829 900	910 300	1 325 600
of it (in %)			
transport	20,2	18,8	21,0
machine eng., precision mechanics, optics	7,6	6,1	5,6
electrical engineering	12,4[b]	7,4	4,7
construction industry	13,5	15,1	11,6
chemical ind., food prod., agriculture	2,7	1,5	0,7
packaging industry	8,3	8,8	7,6
household art.a.office suppl.	2,1[b]	7,4	5,0
powder consumption	0,9	0,3	0,4
iron and steel industry a. aluminiothermics	4,1	4,7	5,0
fabricated metal products a. miscellaneous	9,7	8,8	7,7
export of semi-finished prod.	15,6	21,1	30,7

source: Metallgesellschaft AG, Metallstatistik, different years, Frankfurt/M.

Lead

The demand of the accumulator industry is the main determinant for the whole consumption of lead. Even if one takes into account the stagnation in the automobile industry, the lead demand in this sector has increased continously to 43% (1981) of total consumption (see Table 14 and Table 15).

Table 14

Use of "classical" semi-finished lead and -alloys in the Federal Republic of Germany (home consumption) in 1983

	t	in %
SHEETS, STRIPS, PLATES, ETC.	26 064	74/100
- construction business: roofings, surfaces, chimney coating	16 900	65
soundproof installations	1 300	5
- chemical machine making: linings, sheet metals constr.	3 900	15
- steel- and container constr., medical eng., nuclear techn.	1 300	5
- packaging industry: bottle tops, tubes	1 200	5
PIPES	979	3/100
- construction business: sewage pipes		
- chemical apparatus constr.: pipelines	970	99
WIRE, BARS, SMALL SHOTS	4 186	12/100
- ammunition industry	4 000	95
MISCELLANEOUS	3 868	11/
TOTAL	35 097	100/
- construction business incl. soundproof installations	18 200	52/
- apparatus construction and radiation protection	6 170	18/
- ammunition industry	4 000	11/

source: Stodieck, Pommerening, Ziervogel 1985

Table 15

Consumption of lead in 1970, 1975 and 1981

	1970	1975	1981
total consumption, in t	358,900	285,600	322 800
of it (in %):			
cable industry	22,4	14,5	7,9
accumulator industry	33,1	41,1	43,1
colours and chemicals	18,9	23,3	27,0
semi-finished products	14,2	15,9	15,4
castings	1,6	1,7	2,2
typemetals	1,8	1,6	2,7
surface protection and powder	1,4	1,1	1,0
tubes and bottle tops	0,8	0,8	0,7

source: Metallgesellschaft AG, Metallstatistik, different years, Frankfurt/M.

Copper

Semi-finished copper is mainly used as conductive material in the electrical industry. Cables and wires constitute 75% of this sector. 20% are used for electrical distributing networks, switches, electricity, machines, etc.
Substitution in favour of aluminium in the high-voltage area and miniaturising in the field of electronics and telecommunications were compensated by an absolut growth in consumption.
Semi-finished brass in form of bars, rails, profils, plates and tubes is used in the building of machines and appliances.
Fittings, screws, locks ans structural parts for the electronics industry are important manufactured goods supplied by this sector.

In the past the development of copper and brass consumption was determined by numerous, sometimes conflicting tendencies. There

was an increasing demand for these materials in the building industry, while in other fields, such as plastics, aluminium and high-grade steels were replacing copper.
The automobile industry is still an important consumer of semi-finished copper and brass. A car contains on average 8 kilos of these materials.

The development of copper consumption is shown in Table 16

Table 16

Consumption of copper in 1970, 1975 and 1981

	1970	1975	1981
total consumption of copper a. -alloys, in t (copper content)	887,000	751,200	988,900
of it (in %):			
copper semi-finished	60,4	65,5	66,5
brass semi-finished	26,8	22,1	22,2
semi-finished prod. out of alloys	2,4	2,1	4,0
bronze cast	1,4	1,1	0,7
brass cast	3,3	3,0	2,3
copper cast (incl. other alloys)	4,0	4,5	2,9
copper salts	1,3	1,3	1,0
miscellanous	0,4	0,4	0,4

source: Metallgesellschaft AG, Metallstatistik, different years, Frankfurt/M.

V. Locations factors and structural adjustments

The development of the German non-ferrous metals industry is clearly affected by strong demand in the German economy. With the USA and Japan the Federal Republic of Germany is the third most important consumer of non-ferrous metals in Western industrialized countries. If one considers France, Italy, Great Britain and Germany as an economic unity, the German non-ferrous metals industry is operating on a market which counts for 6 to 8 million tons per year.

Table 17

Production of non-ferrous metals in the Federal Republic of Germany compared with other regions in 1973 and 1983

	production in 1000t		%share (1983) in prod.		
	1973	1983	EC	IC	world
primary aluminium	533	743	38,6	6,7	5,2
refined copper	407	420	40,2	5,7	4,3
refined lead	316	353	30,1	9,0	6,7
zinc	395	356	27,4	7,7	5,7

EC - European Community

IC - Western Industrialized Countries

source: Stodieck et al. 1985, p. 220

Table 18

Exports and imports of non-ferrous metals in 1983

	exports		export ratio a)	imports		import ratio b)
	1 000t	EC in%		1 000t	EC in%	
primary aluminium	237,8	75,9	32,0	497,1	24,1	49,6
refined copper	70,0	51,3	16,7	397,5	15,4	53,2
refined lead	108,4	60,0	30,7	63,1	91,3	20,5
zinc	115,1	55,4	32,3	144,0	70,8	37,4

a) exports in % of production

b) imports in % of production (production+/-trade balance)

source: Stodieck et al. 1985, p. 218

The "young", dynamic metal, aluminium, but also the "classical" copper materials of great importance for the future development of technology, will guarantee a steady growth in this sector. But one should not oversee the fact that the German non-ferrous metals industry is confronted with a wide range of problems: The increasing costs of energy are a permanent problem for the aluminium industry. Even if the energy costs of the German aluminium works are still within the international average, they do have massive disadvantages if one compares the energy costs of works in Canada, the USA, Norway and the Gulf States. Industrialists argue that the building up of nuclear power stations in the Federal Republic of Germany is by far too slow and discriminations against cheap import coal which is driving up energy prices.

In the case of lead, environmental protection causes the most important problems: According to industrialists the new regulations cannot be carried out with the present technology. As the new processes are not mature enough, lead producers are holding back urgently needed substitute investment.

The copper industry suffers from a severe lack of raw materials at home. There is a total dependence on imports of blistercopper and newly erected works in Southeast Asia with extremly low fees for refining are attracting a large amount of raw materials available world-wide.

Industrialists complain about "distorted competition" emanating from producers in Spain, Brasilia and Southeast Asia.
Mines, which normally had to pay the freight costs to the plants in the past, now "prefer" plants situated closer to them.
A reduction in the capacity of the German plants would aggravate the situation of the semi-finishing industry which is also confronted with severe overcapacities.

Restructuring which would contain measures to consolidate the range of production, orientate to products with higher qualities and cooperate with other producers,... will have to take place in the next few years.

The zinc industry is also confronted with considerable overcapacities. In Western Europe there is a total zinc overcapacity of around 200,000 tons; plants are being run on a capacity of only 80% and the prices are on a very low level even in times of economic upturn. Moreover, the industry is confronted with temporary shortcomings in the supply of raw materials and concentrates.

VI. Perspectives for the development of the German non-ferrous metals industry

Forecasts about the future devlopment of the non-ferrous metals industry in the FRG are not available at present. Technological and economic circumstances which were determined by the relation between economic development and metal consumption in the past have changed drastically. The change from a long period of expansion of the national economy to stagnation and decline has hit

the different metal sectors in different ways. In the case of the German non-ferrous metals industry, the tendencies are not uniform:

- Because of poor profitability the German mining sector has been decling continously during the past years. The exhaustion of the mine works of Rammelsburg and its closure in 1987 will lead to a further decline in production. Even if further explorations are undertaken in the FRG, the prospects for opening new mine-projects are hardly probable. The future of the German metals industry as whole will lay in joint-ventures and the aquisition of shares in the mining industries of developing countries.

- Rising costs and new demands for environmental protection are speeding-up the rationalization efforts of the companies. The German primary plants which were confronted with a reduction in the supply of home ores, have now changed into pure wage-plants. The problems connected with this development are:

  * Developing countries are struggling to accumulate enough capital for their needs. For this reason they are engaged in erecting their own processing capacities for raw materials. Therefore, the supply of raw materials could become a complicated problem for German wage-plants in the future.

  * Rising transport costs indirectly support the efforts of developing countries to enter into the further processing stages of their raw materials. Also, countries such as Japan, South Korea and Taiwan are closer to the rich deposits of Australia and Southeast Asia than European plants.

  * The strong position of the German Mark vis-a-vis the US-Dollar caused a deterioration of the competive position of German producers struggling against foreign companies for a share of the world market.

- Because of the very close link between primary and semi-finished plants which is characteristic of the German non-ferrous metals industry, the latter is also affected by the problems of the pri-

mary works. In the past, semi-finished plants have profited of plants "in the neighbourhood", from the exchange of experience and a coordinated development of new products. The very low stock-piling policy of such concerns was also a positive result of the close cooperation beween primary and secondary works.

- The high consumption of non-ferrous metals by the German manufacturing industry is a strong positive determining factor in future developments in this sector. The further growth of demand, espescially of aluminium, the high yield of old and waste materials as basis for a secure supply of recasting works and the high standard of qualitiy and flexibility are other positive aspects of the German non-ferrous metals industry.

- At present the German non-ferrous metals industry is undergoing a remarkable process of internationalization. The aim of this process is a strong integration into the international field of mining and trading in raw materials.
  Preussag AG took over the majority of shares of Amalgated Metal Corporation PLC (AMC), London. In the opposite direction, the Australian MIM Holding aquired shares of the Ruhr Zink GmbH and of the Rheinisches Zinkwalzwerk GmbH. The aim of these transactions is security of supply for the German plants and access to the German market for the MIM. Preussag AG is cooperating in the field of lead with Boliden AB and in the field of zinc with Société Minière et Métallurgique de Peñarroya in Nordenham. The planned aquisition of shares from VÖEST-Alpine Intertrading by Metallgesellschaft AG are also part of these strategies These developments have without doubt, opened up a new round of intensified competition.

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