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07739

Distr.
LIMITED
ID/WG.250/17
8 November 1977
ENGLISH

United Nations Industrial Development Organization

Workshop on Case Studies of Aluminium Smelter
Construction in Developing Countries
Vienna, Austria, 27 - 29 June 1977

STATUS QUO AND TRENDS IN THE PRIMARY ALUMINIUM INDUSTRY* (1977)

Lecture given by

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id.77-7916

On the request of Mr. Szakal and our Conference Chairman I am giving you a few facts and figures on the status quo of the primary aluminium industry in 1976 plus extrapolation of trends.

This extrapolation of trends has been done by various institutions in North America, Europe and Japan as well. We tried to integrate these perspectives. It is easy to do so because you all know that after World War II aluminium was growing with 8 or 9 per cent p.a. and everybody is convinced that the growth of aluminium will go on because it is such an essential material for transport, packaging, architecture, electrical conductors, car industry. But in the foreseeable future the growth probably will not be 8 or 9 per cent any more when looking at the various circumstances which I will explain in some graphs.

The important fact is that 90 per cent of the smelters now are in highly developed countries. But in the future these countries, classically - the siting of aluminium smelters, have not enough energy and have other constraints, too, like very strict pollution control; further our shortest raw material is capital. There is not enough capital as Mr. Fischer indicated yesterday, like 5 billion dollars per year to build one million ton capacity per year. But when looking more closely at what Mr. Fischer said, I think he took 5000 dollars per metric ton as a total cost for a new smelter. But when you add the bauxite mine, the alumina plant, extrusion equipment, rolling mill and all the rest of it - energy supply alone could be $800 to $1000 per installed kilowatt - it is easily $ 8 billion per year to increase the use of primary aluminium by 1 million tons a year. To make the long story short, various studies more or less come to a projected growth rate of primary aluminium for the next decade in the order of four, perhaps five per cent. This is about half of the previous growth. Not only aluminium, but other metals like steel or copper are in the turn of an S-curve (Fig. 1).

We all have seen S-curves before. The primary aluminium industry was very happy for the 25 years 1950 to 1975 to be in the linear part III of the S-curve which means almost linear growth. When interpreting this in terms of mathematicians it is an exponential growth, certainly. There is no doubt that the S-curve approaches stage IV for the per capita consumption of primary aluminium in Highly Developed Countries (HDCs). But, emerging nations and developing countries are, in their pe capita consumption, in the lower part of the S-curve which means increased per capita consumption over the next decades. It is easy to prove that around the turn of the century the West European countries consumed about 0.5 kg of aluminium per capita; that is similar to what the developing countries consume now. That means there is a time-lag of 75 years between the per capita consumption in LDCs. The HDCs now consume an average of 12 kg/cap.; USA consumes 23 kg/cap.; Germany, France, Switzerland, this group of countries consume about 15 kg/cap. (Fig. 2). So these HDCs are in the upper part of the S-curve. In these countries aluminium consumption may grow three per cent, maybe four per cent. This depends how much the car industry picks up. The world-wide growth of aluminium consumption may be five per cent. But a country like Brazil, Iran or other emerging nations, rich in resources, may easily have growth rates of 10 or 20 per cent. This was just a short introduction.

I tend to have an optimistic outlook because we strongly believe the aluminium industry is alive and well. Let us take this home because some people may believe we are a sick industry. We are not. In Fig. 3 you see the primary aluminium consumption in the Western World versus time (1965 - 1976). Let me say why Western World; because our friends from most of the COMECON countries do not provide figures about production or consumption of aluminium. We therefore have to do a wild guess, e.g. about the USSR. Some people say the Russian aluminium production is 2 million tons per year, some say it is three. That is why we plot here the figures of the Western World. North America and Europe have a lion's share of consumption. This is a consumption plot. Africa represents a very thin slice and South America is already of some significance in use of aluminium. We all see this dramatic drop in 1975. There is no doubt that this will pick up. But with per capita consumption of basic materials nothing happens suddenly. There is no quantum jump to be expected, like the very thin slice of Africa in 5 or 10 years could be a big slice; it cannot be. So let us take this home.

The annual increase in primary aluminium consumption (1965 - 1976) is quite significant in these three continents: Africa 13.7 per cent p.a., Aeia 13.5 per cnet, Sou h America 12 per cent; while in Australia 9.3 per cent, Europe 6.6 per cent, North America 3.1 per cent p.a. In the USA, they are consuming already 23 kg/cap., it ie not easy to go from 24 kg to 30 kg. Stage IV of the S-curve indicates clearly its impact in North America and in Europe. Europe ie lagging behind becauee countries like Spain, Portugal and parts of Italy (southern part), Greece, Turkey, all belong to Europe, consume below 10 kgs/cap. That is why Europe is, in the S-curve, lower than North America. So, the conclusion is: aluminium has its highest growth ratee in developing countriee, whereas absolute tonnage consumption ie greater in industrialized countries. We have to remember always this when looking at growth rates of for instance Africa, South America. You see the growth rates of 12- 13 per cent but it is a very small amount in tons.

I would also strees at this point that eometimes the futurologists are in discredit, you know. That is because Herman Kahn and some othere, drive people crazy with all their prognoses. We stick to what we call simple common sense prognosis like I told you, there are no quantum jumps, for instance in the increaee of the aluminium consumption in Africa in ten years. What I show in Fig. 4 ie what we consider a useful prognosis-model by establishing three different scenarios.

Fig. 2 and many other statistical data indicate that growth of aluminium consumption increasee with GNP. That is true for concrete, for steel, for aluminium, for other basic commoditiee. This is the backbone of our prognosis model. We know the consumption pattern of basic materials with GNP. These curvee are available for many different countriee. If the structure of different countries is comparable, it is possible to predict about what steel, concrete or aluminium consumption could be anticipated in ten years by making reasonable assumptions regarding developments of GNP.

Further, we have picked four sectors which are mostly responsible for the growth of primary aluminium consumption: architecture (26 per cent), transportation (22 per cent), packaging (13 per cent) and electrical industry (12 per cent). They account for 75 per cent of total aluminium consumption in the USA and 67 per cent in Europe. Then we asked ourselves how are these four sectors using aluminium up to now. By the end of 1973 we have, in Table 1, presented data for Europe, the Western World, the USA and Japan. The USA being otherwise a pacemaker in the application of aluminium for instance is behind in using aluminium in transport (21 per cent whereas Western Europe uses 28 per cent). For high speed-trains, metro-cars, rapid transit, containers of all kinds, we use a lot of aluminium in Europe whereas in the USA it is mostly steel. But this is changing in the States because the energy crisis asks for a more economic use of energy. I cannot spend a lot of time with this table but I give this material to UNIDO for your own reading and conclusion.

By looking sectorially into this table you can come up with some predictions: lets just pick the 2 per cent aluminium for packaging in Japan, vis-à-vis 17 per cent in the USA. Now we are confronted with the perspectives of aluminium beverage cans. There is a tricky point where the persons dealing with prognoses are getting into trouble: there are two quite different scenarios: one is the glass bottle or steel-can scenario, the other one is "a lot of aluminium cans" scenario.

I wish to stress this point that there is a lot of talk about recycling and I agree there must be recycling centres, economic and well-designed and with good technology in all developing countries. No ton of aluminium should be wasted by poor remelting or by avoidable throwing away. But one fact is important: recycled aluminium represents 21 - 22 per cent of total consumption. But even if someone puts a big advertisement in the New York Times that aluminium is a wonderful metal good for recycling, it will still be only 21 to 22 per cent. It will be 23 or 24 per cent in maybe five years. Recycling is not the big thing. We have to be realistic.

Only if the car industry increases their aluminium consumption a great deal, recycled aluminium may contribute, in 12 or 15 years, 30 per cent of total consumption.

We finally came up with some conclusions: aluminium demand will grow even if per capita consumption would remain unchanged - "zero growth" per capita. Total aluminium demand will grow by the population increase. Even this improbable scenario will require new capacities = investment opportunities. You see, (Fig. 4), we had one scenario where it is said the HDCs will have almost no growth in aluminium - this was our most pessimistic scenario which we do not believe in. When careful sectorial analysis was done, like the car industry would certainly use more aluminium etc., we come up with 4 or 5 per cent in the HDCs.

Certainly in the next ten years developing countries will have high growth rates in percentages but not in total quantity.

The developing countries will increase their use of aluminium in line with growing GNP. The so-called factor of correlation has been always that aluminium grows faster than GNP. In Japan, for instance, the factor in the last 10 years was around 1.5. If GNP grew (all without inflation) 8 per cent, aluminium grew 12 per cent. In Western Europe today the factor is about 1.2, whereas in some developing countries, because of being lower in the S-curve, it is probably in the order of 2.

We have used in Fig. 4 three scenarios, one with two per cent, one with four per cent, one with six per cent, referring to the Western World. So, we have calculated what we need: how many alumina plants, - an alumina plant is a one million tons per year - how many smelters; - a smelter is 100,000 tons/year. When we have the assumption of four per cent growth, we need about 1.2 million tons of alumina and about six smelters p.a. When we look at the projects that are in the pipeline, they represent about six smelters a year for the next five years, that is about four per cent growth. We certainly were only considering projects with a good probability to be realized within five years. Certainly in the HDCs the energy price and the availability are two different things. And in the United States - I believe it is even to be read in the Annual Report of ALCOA, - it is said 55 c/lb. is about today's lowest selling price of aluminium ingot to make a new smelter attractive. I hope I am quoting correctly.

It is interesting to see that the unused water power potential is enormous, (Table 2). For instance, in Africa, only two per cent of hydropower is used, which is 8000 MW, in South America seven per cent. There is in South America a hydropower potential of 288,000 MW. Now I will mention a simple thumb-rule which some of you will know. A smelter of 100,000 tons needs 200 MW, so for the entire Western World primary aluminium capacity of 15 million tons, i.e. 30,000 MW. You see, in South America alone you could increase the world production of aluminium almost ten times. Only in Brasil, you can increase today's world production three times, easily. In Zaire, you can triple today's world production. There is so much hydropower in "electrical islands" (Iceland, Labrador, North Canada) where nobody can use electricity anyhow, so we can draw the conclusion that there is no shortage at all of energy to make aluminium. We firmly believe this. This is why we are here.

The diagonal line in Fig. 5 is what we call the "watershed". Fig. 5 is our "heuristic model". This comes from Greek "heureka" = I have found it. There is one thing, somewhat misleading in Fig. 5, Australia was put into Oceania. Fig. 5 comes from a French journal which put Australia to the developing countries. But this only has a meaning there for the bauxite. It is easy to see, with one look on Fig. 5, that the less developed countries have 90 per cent of the bauxite and that the HDCs consume 90 per cent of the aluminium metal. These are the two interesting points, that 2/3 of the alumina plants are in HDCs but when you add Australia to the HDCs then it would be almost 90 per cent of the alumina plant capacity in HDCs. The key element of our perspective and the reason why we are here is that the "watershed" -line will move down. That means new smelters, new alumina plants might be preferably in lower developed countries. It is also interesting to see that Asia has a very small segment up to now and this is perhaps kept in mind that various Asian countries have an enormous potential for alumina and smelting. It is actually a heuristic model because it tells you a lot of the various continents, how much they have in bauxite, alumina, smelting and consumption of aluminium. It is interesting to see that those who produce aluminium consume it nearby, in the same continent actually.

I think we should also take this home. If somebody wants to build a smelter - every year one, or two, new companies emerge who build smelters. Further, the "do-it-yourself" smelter appears to be very attractive for certain emerging nations, we have heard several examples yesterday (India, Iran). So we have a second point which is no problem: energy is plentiful and the availability of technology will not be a problem. But then the question is where there is the problem? Answer: The main problem is in good models of co-operation. Fig. 6 is a superficial and by no means complete map of the African continent and adjacent OPEC countries and Europe. We just picked only a couple of countries which, when this picture (Fig.6) was drawn, were in negotiations in the Ayé-Koyé project in Guinea where there is this huge amount of bauxite. Perhaps one third of the world's bauxite with about 45 - 50 per cent of alumina. For smelter siting we chose, as an example, Zaire because of the huge Inga dam hydroelectric power potential. What happened is that agreement was made between several countries to co-operate: the capital, C, comes from the Gulf countries, technology, T, comes from Western Europe and the natural resources from African countries. Some of the bauxite and energy reserves are marked, further existing and planned smelters in countries like Algeria, Iran, Bahrain, Dubai, and Egypt.

For every new smelter four "P"s are important: port, electric power, people and we have to watch the pollution at the working place and into the surroundings of the plant. There are some more "P"s later on. A port is desirable for economical transport of raw materials and finished products. Nobody would build a smelter without a good sea going or river harbour. There are plenty of smelters without this but not in the future I guess.

New smelter projects should be based on hydropower or local abundant coal to remain competitive for the coming decades. As for people, the labour force in emerging nations will require training and motivation. First you need people trained to train others. People trained in training are very important. Companies operating in many nations have an advantage in this respect. Their personnel are accustomed to different custome and languages.

Pollution - I wish to stress this last "P". Industrialization does not have to mean pollution. It is less expensive to consider control of effluents at the beginning of the project than to put in retrofit controls at a later date.

In east and west, developing countries and in HDCs as well, there is a keen understanding that this has to be taken very seriously. I can only mention perhaps the in-plant pollution. Because if you look at the importance of the emissions versus the workers health and safety, the emission control legislation in HDCs has reached a peak already, that means de-emphasising the emission issue. Whereas the workers' hygiene just in contrary is gaining momentum, is gaining importance. That is why I put some specific emphasis on the workers' health issue because this problem is ahead of us. I quote three groups of investigations on mortality studies. In Canada and in the United States three such studies have been published just recently, indicating that there is increased cancer among the workers in the potroom, especially the paste anode type Söderberg plant. This is certainly an immediate signal to do something about it. There were similar publications in the USSR and our friends in Russia take this issue very seriously. They perhaps were the first country issuing certain standards like 0.15 microgramme benzpyrene per m^3 being the maximum being permitted at the working place. In the USA there is a pending proposed standard which says 0.2 milligramme ppom (particulate polycyclic organic matter) which is 1000 times more than the Russian standard but it is ppom; that is all the vapors and droplets of this organic matter. In some countries Government authorities have carried out investigations recently and found out that the benzpyrene in Söderberg plants is many times higher than anyone of these two standards. So, I am sure that such questions will be with us for a long time. We have to remember that in Geneva there is a World Health Organization (WHO). I do not have to speak of other relevant organizations like UNEP and ILO, issuing standards which are obeyed by Eastern countries, Western countries, developing countries and are taken seriously and that is why the last "P" is so important.

You all know about the controversies about fossile and nuclear power plants. So the hydro-electric power seems to be the best bet for new smelters.

Back to the last "P": Pollution. We have talked about it already. I want to add that the Environmental Committee of the IPAI figured out what it costs to retrofit a dirty plant and I can tell you it costs a lot. If somebody builds a new plant by all means he should hood the cells and recycle the fluoride. It turns out that this costs about five to eight per cent more in investment, but the extra operating cost amounts to only approximately two or three per cent, because recycled fluoride is valuable. That means to build a new smelter with unhooded cells for saving two or three per cent in operating costs is real nonsense, especially if later national or international standards become valid and tell you that you are not permitted to operate this smelter.

There are two more "P"s: political stability and partnership. This is another heurietic model (Fig. 7), I call it the project triangle because I have seen several successful operations in the mining area in a triangle kind of approach. Just to quote one non-aluminium case: Saudi Arabia, Sudan and a German metallurgical group joined in a triangle of co-operation. They use the ore reserves of the Red Sea sludges for producing tin, zinc, and lead. To me, a triangle is an awfully stable thing. You know like a tripod is the most stable seat. I do not think that any of the three partners will ever kick the other out, because they need the metallurgical company to do the prospecting, marketing and sales, etc. The other triangle project which is well known to our Chairman, Dr. Ismail, is the one I mentioned before, the capital from the Gulf and the raw material from Africa, mainly Guinea. Other resources are the energy in several of these countries. In conclusion, I think what we need is the combination of these two "P"s with enough capital, because technology is available but the technology has to be put in a workable triangle. This "soupbowl" if I may say, should not have too many cooks in the first ten years. I have seen an obviously successful agreement which says that in the first ten years there is one cook and he trains all the other cooks and then the master cook has to leave. Thus, it is in the best interest of the country having the raw material and also to protect the interest of the donators of the capital and of the know-how.

Well, operation triangle is my last heuristic model for this morning and I wish to thank you for your attention.

Figure .

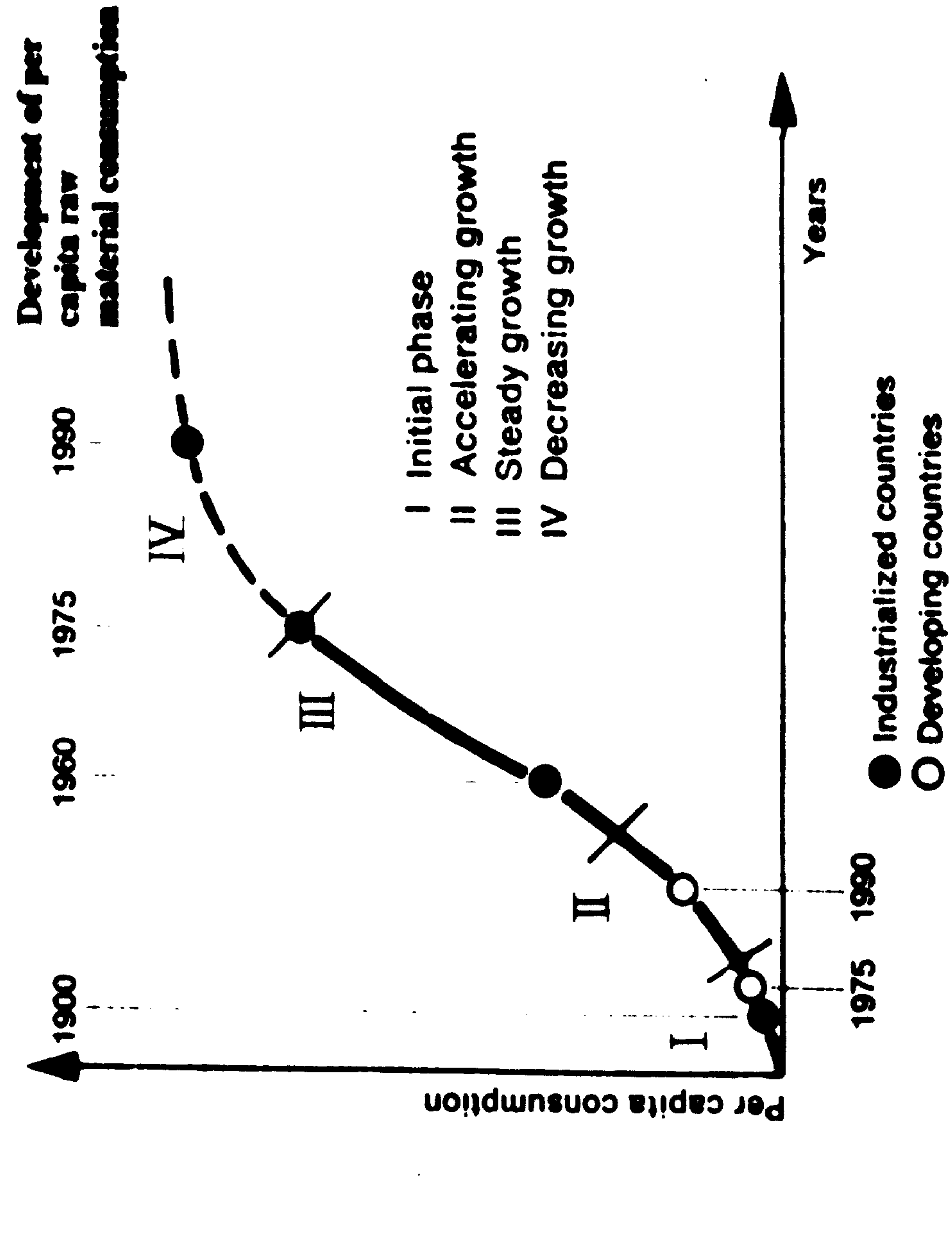
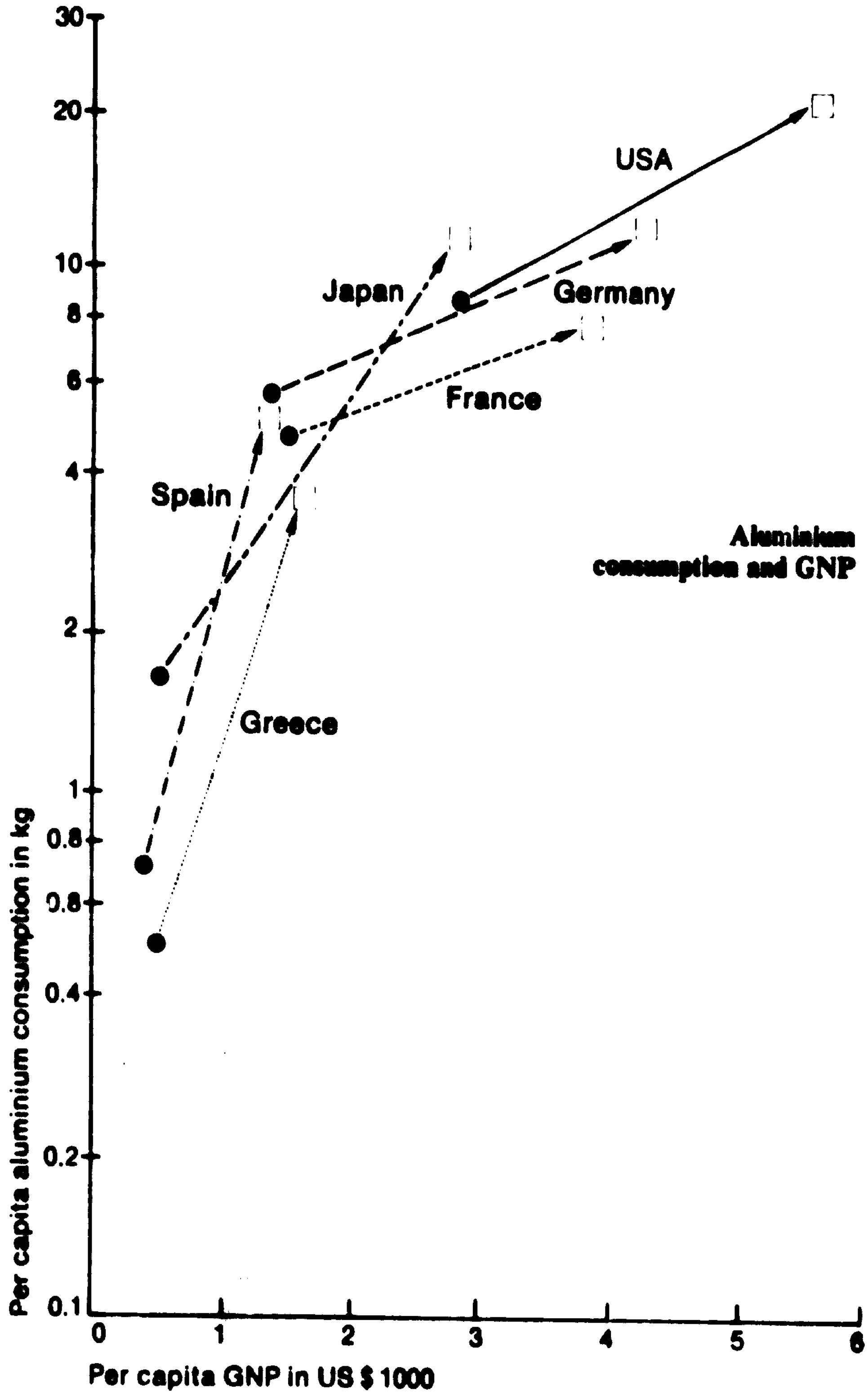

Development of per capita raw material consumption
Per capita consumption
Years
1900
1960
1975
1990
1975
1990
I
II
III
IV
I Initial phase
II Accelerating growth
III Steady growth
IV Decreasing growth
Industrialized countries
Developing countries

Figure 2.



● 1960 □ 1972

Source: Revue économique de la Banque Nationale de Paris

Figure 3

Primary Aluminium Consumption in the Western World by Continents

1965 – 1976

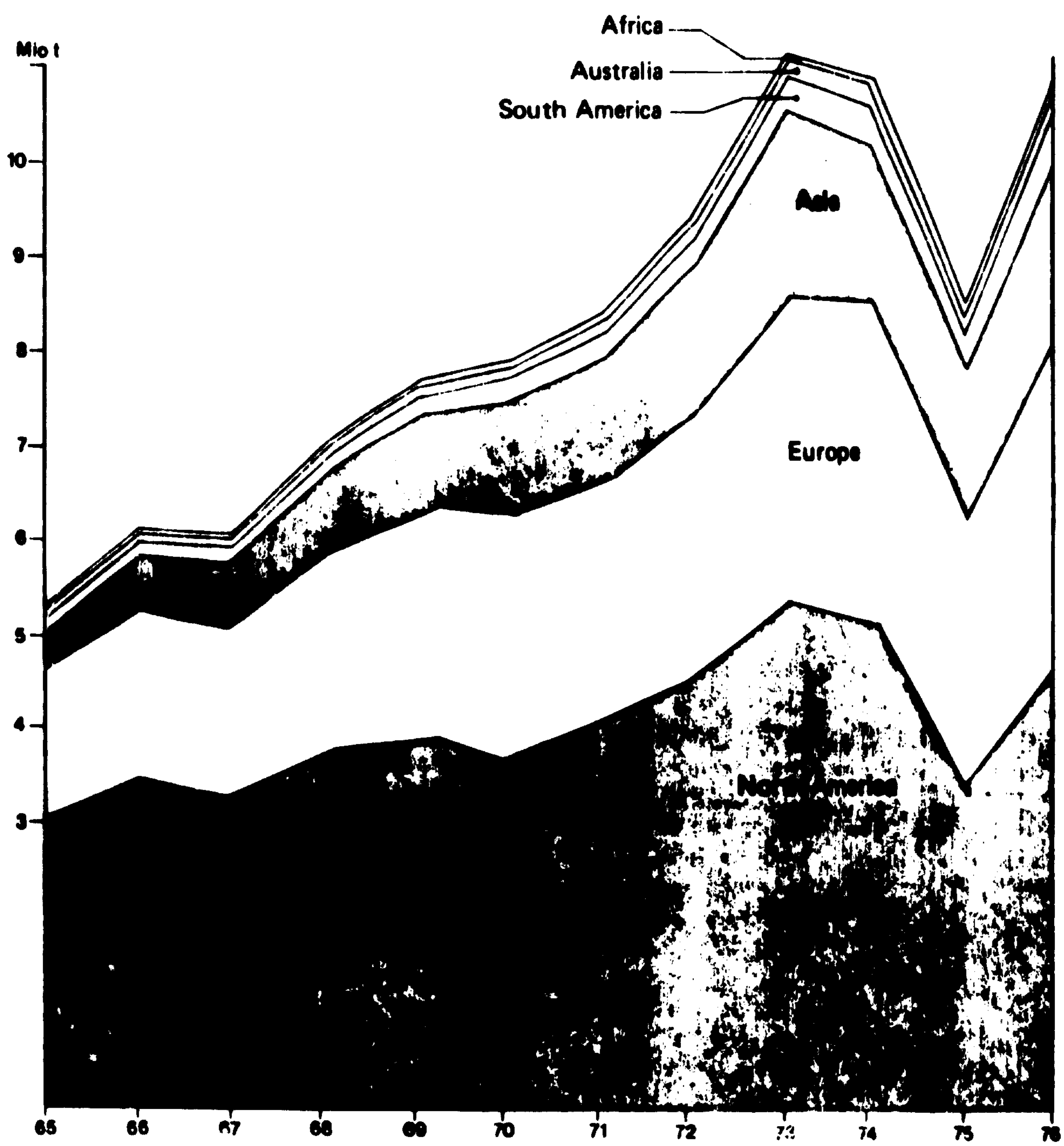
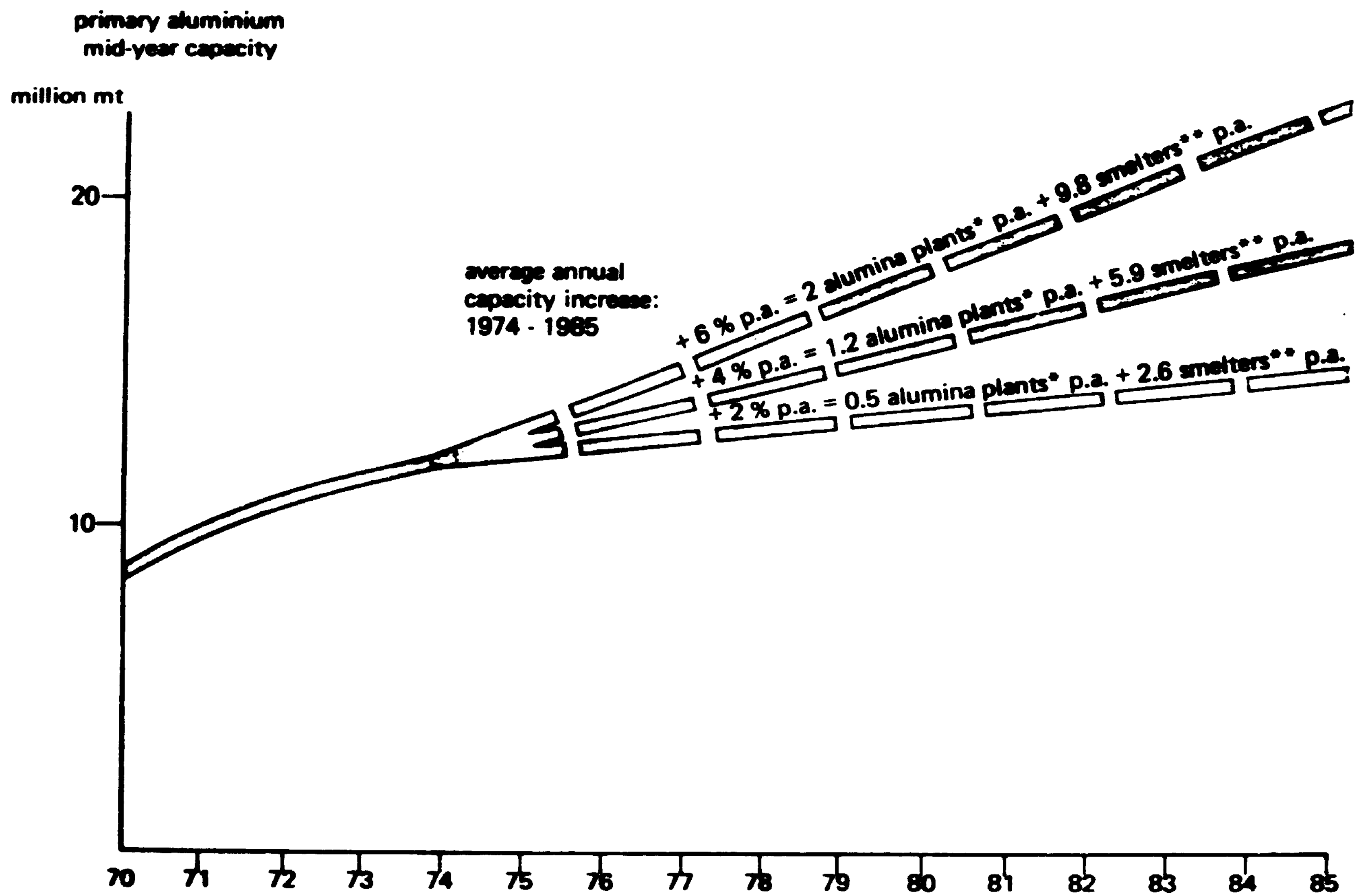


Fig. 1

New Capacities Required for Various Growth Rates

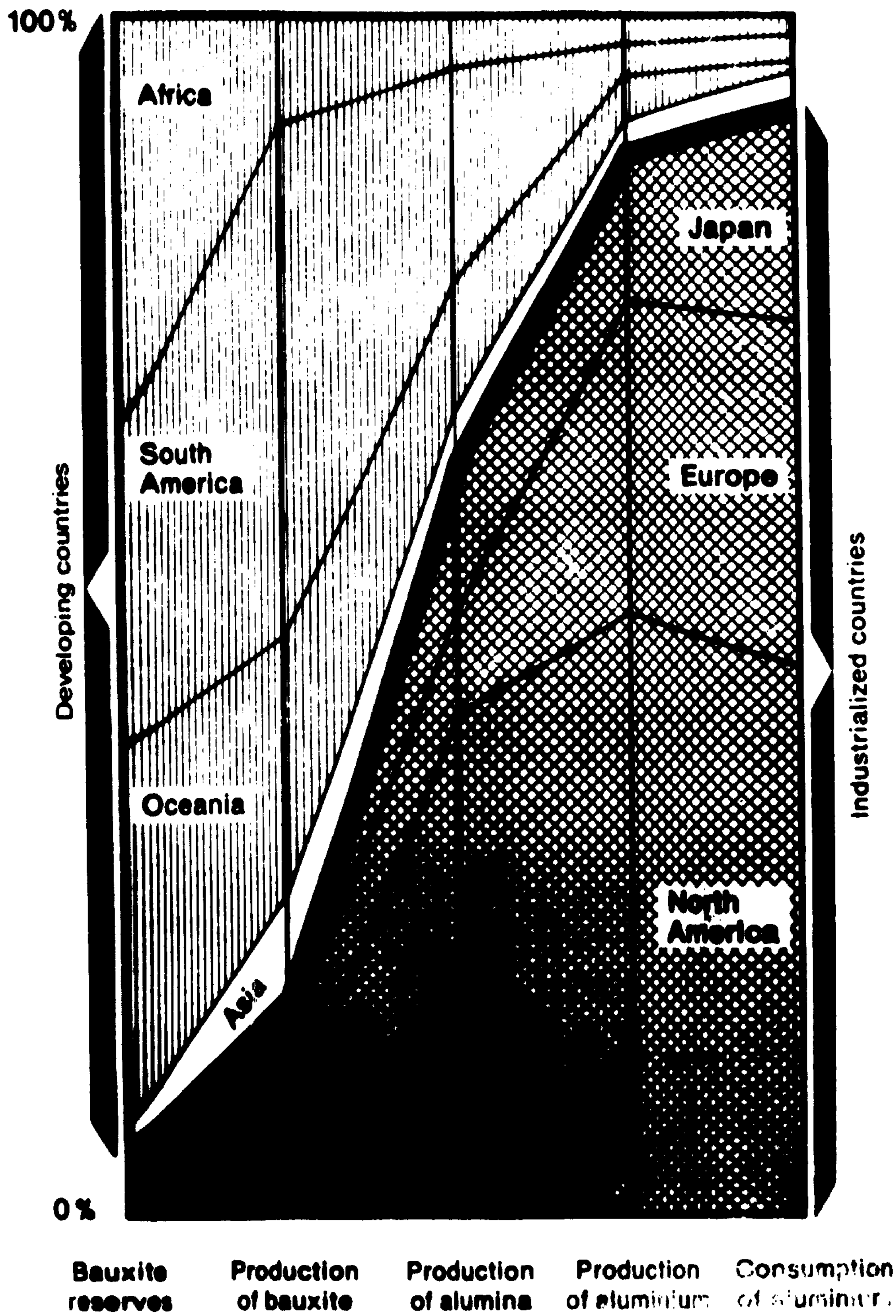


* the annual capacity of an average alumina plant is estimated to be 1 000 000 mt alumina

** the annual capacity of an average aluminium smelter is estimated to be 100 000 mt aluminium

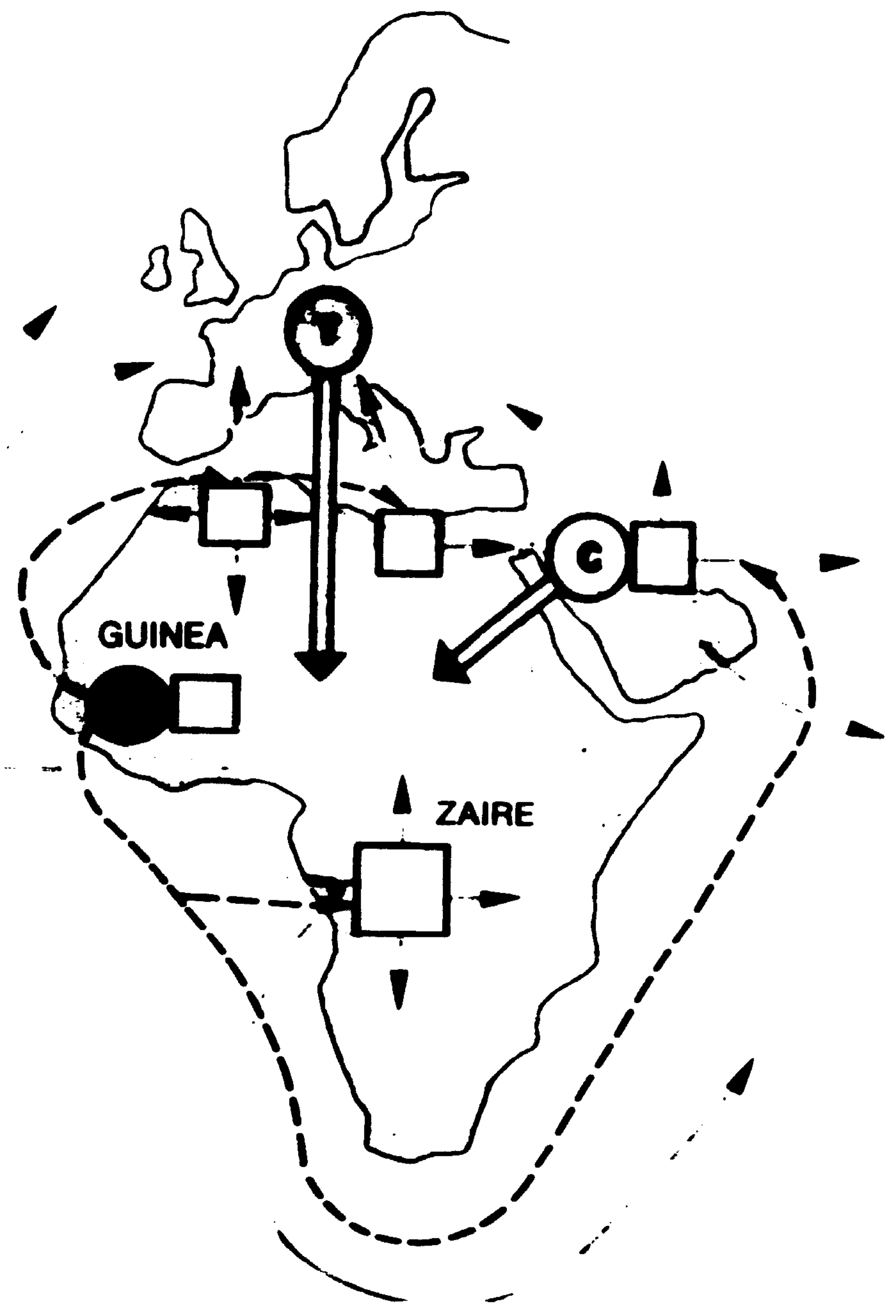
Fig. 5.

Structure of the aluminium industry (Western World)



Source: Revue économique de la Banque Nationale de Paris

Aluminium projects in Africa: interaction of raw materials, capital and know-how.



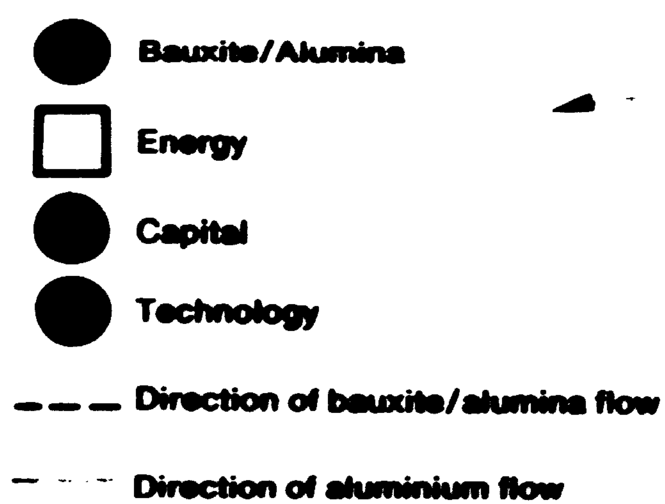


Fig. 7

Interaction of essential elements in the development of aluminium projects

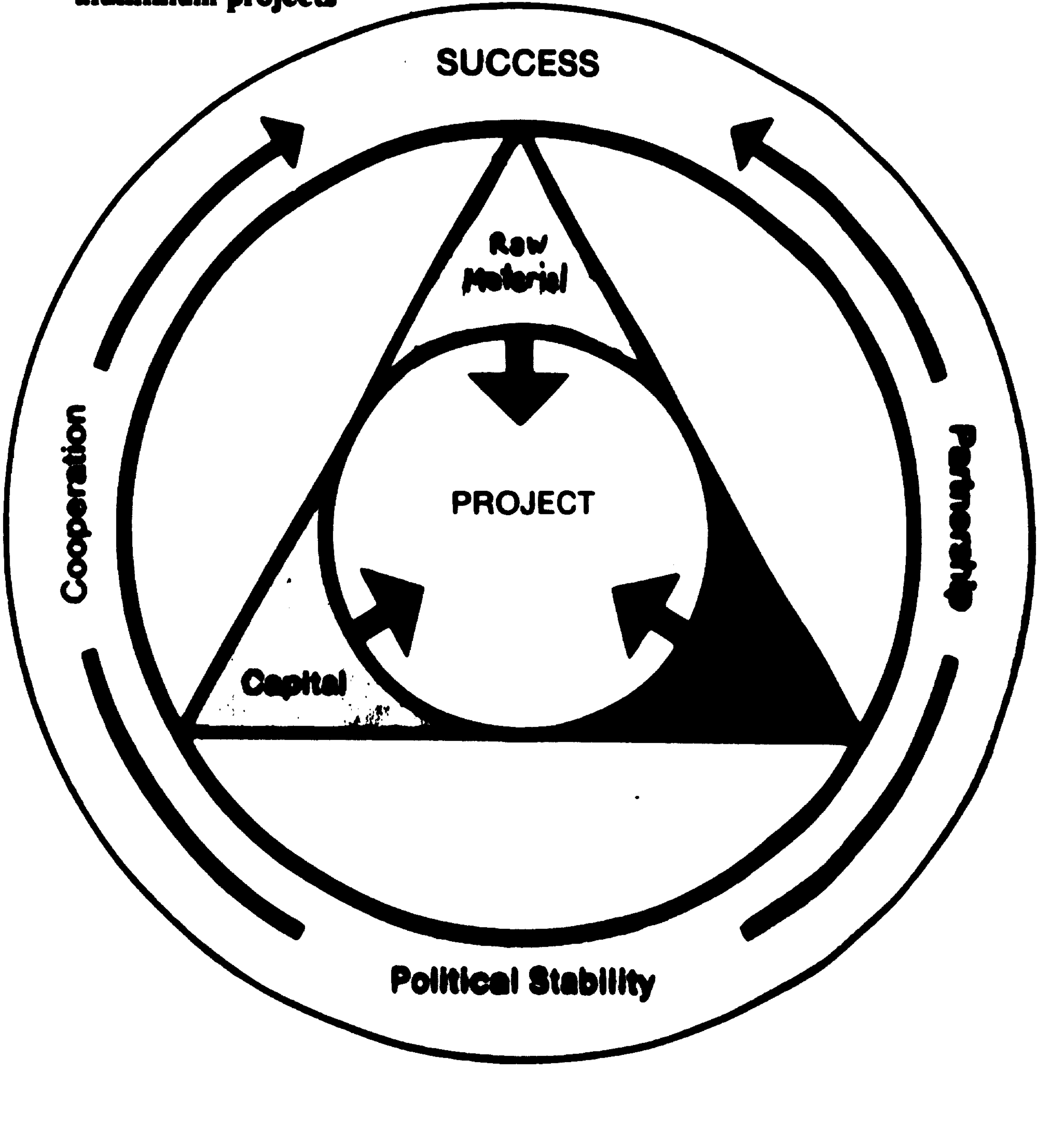


Table 1

Western World Aluminium Consumption: Breakdown by End-use 1973

	Western World		Western Europe		U.S.		Japan	
	'000 tons	%	'000 tons	%	'000 tons	%	'000 tons	%
Transport	3 036	22	1 154	28	1 200	21	344	18
Mechanical Engineering	828	6	330	8	345	6	87	5
Electrical Engineering	1 656	12	454	11	670	12	226	12
Building & Construction	3 589	26	700	17	1 590	28	654	35
Packaging	1 794	13	454	11	970	17	28	2
Domestic & Office Appliances	966	7	330	8	415	7	141	8
Other	1 933	14	700	17	546	10	381	20
TOTAL	13 803	100	4 123	100	5 736	100	1 862	100

Table 2.

World water power potential and its present utilization

	Total resources 1000 MW *	Utilization 1000 MW	Utilization %
Africa	437	8	2
Asia (excluding USSR)	684	47	7
South America	288	19	7
Europe (excluding USSR)	215	104	48
North America	330	90	27

* capacity useable under average annual flow conditions

Source: World Energy Conference 1974

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