THE DEVELOPMENT OF GHANA'S ALUMINIUM INDUSTRY

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by

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ABSTRACT

The problems of Ghana's single crop (cocoa) economy led, for several decades, to the active pursuit of the Volta River Project in the belief that the economy would be diversified.

The alluring externalities of the bauxite-to-aluminium aspect of the project seemed to justify the substantial outlay of scarce resources for the project, together with the inducements which facilitated the entry of the KAISER-REYNOLDS consortium to install and operate a 200,000 tonne/year aluminium smelter. In the first instance, the agreements allowed the use of imported alumina.

The smelter's outstanding success since its inception in 1967 notwithstanding, Ghanaian bauxite is still exported to Scotland for refining, alumina is imported, the smelter's aluminium output is exported, and the semi-fabricated aluminium requirements of local fabricators are imported. This institutionalized fragmentation is sanctioned by the 1962 agreements whose consequences, it can be argued, reveal undue weighting in KAISER-REYNOLD's favour.

Given the availability of cheap power and the fact that proven bauxite reserves can support a 300,000 tonne/year mine-to-metal complex for 182 years, many have queried such fragmentation.

It is argued that the industry's high transport costs and energy-intensiveness favour Ghana's production costs. Also, Ghana's position has been improved by the pollution-consciousness and rising power costs in the traditional locations which have given an impetus to relocate refinery-smelter facilities in non-traditional sites.

After a discussion of the industry's capital-intensiveness, the proliferation of aluminium ores throughout the world, the competitiveness of non-bauxitic ores, economies of scale, restricted trading in bauxite and alumina, long-term demand and prices, and aluminium's competitiveness relative to its rivals, a proposal for

an integrated metal production in Ghana is assessed and confirmed to be viable.

Viability means that, at recent price levels, a bauxite/alumina plant would be profitable. But doubts about future demand and price, the ending of the tax advantages of the present situation, together with current politico-economic problems in Ghana make it unlikely that an alumina plant can be established in the forseeable future. In the circumstances, alternative strategies for the Ghana Government are suggested.

Explanatory Notes And Conversion Tables

1. Reference to dollars ($) are to United States Dollars unless otherwise stated.

2. Reference to tonnes or metric tons are:

   1 tonne = 2204.62 lbs. avoir dupois
   = 0.98 long tons (where, 1 long ton = 2240 lbs.)
   = 1.10 short tons (where, 1 short ton = 2000 lbs.)

3. The use of hyphen between dates, for example 1967-1977, indicates the full period involved - that is, including the beginning and end years.

4. A full stop (.) with numbers indicate a decimal point.

5. A comma (,) is employed to differentiate between thousands and millions.

6. A "mill" is the unit used in the sale of electrical energy. It represents one tenth of a United States cent for each kilowatt-hour.

7. A watt is a unit of electrical power.
   1 kilowatt = 1,000 watts
   1 giga watt = 10^6 kilowatts

8. The kilowatt-hour (kwh) is the unit employed in the sale of electrical energy.

MAJOR CHANGES IN GHANA CURRENCY

GHANA CURRENCY	REMARKS	Equivalent to £ sterling			Cedi/Dollar rate	Dollar/ Cedi rate	Average cedi/£ sterling
		£ sterl: US$	Old cedi	New cedi			
West African Pound (until July 1958)	Issued by West Africa currency Board on par with £ sterling.	£1:$2.80	¢2.40	¢2.00	¢1=$1.40	$1=¢0.71	
Ghana Pound (£G) July 1958-July 1965	Issued by Bank of Ghana on par with £ sterling.	£1:$2.80	¢2.40	¢2.00	¢1=$1.40	$1=¢0.71	
							1958-1967:¢1=£0.50
Cedi (¢) July 1965-Feb. 1967	Decimalised currency (8s.4d) = one cedi). Issued by Bank of Ghana	£1:$2.80	¢2.40	¢2.00	¢1=$1.40	$1=¢0.71	
New cedi (N¢) Feb.1967-July 1967	Cedi replaced by New cedi and revalued by 20% (10s. = one cedi)	£1:$2.80	¢2.40	¢2.00	¢1=$1.40	$1=¢0.71	
July 1967-Nov. 1971	New cedi devalued by 30% (US dollar replaced the £ sterl. as the major currency to which the cedi was pegged.	£1:$2.40	¢2.88	¢2.45	¢1=$0.98	$1=¢1.02	1967-1971:¢1=£0.42
Dec.1971-Feb. 1972	New cedi devalued by 44%	£1:$2.55	¢5.58	¢4.64	¢1=$0.55	$1=¢1.82	1972:¢1=£0.317
Feb.1971-June 1978	New cedi revalued by 42%	£1:$2.61	¢4.08	¢3.34	¢1=$0.78	$1=¢1.28	1973:¢1=£0.354
	Rates as at 19 June,1978.	£1:$1.83	-	¢2.10	Rate as at 30 Nov. '73 ¢1=$0.87	$1=¢1.15	1974:¢1=£0.370
June 1978-Aug. 1978	Cedi put on flexible exchange rate with an initial rate of ¢11.30= US$1 (devalued by 11%)	£1:$1.83	-	¢2.38	¢1=$0.77	$1=¢1.30	1975:¢1=£0.395
	Rates as at 25 August 1978	£1:$1.93	-	¢3.26	¢1=$0.59	$= ¢1.69	1976:¢1=£0.488
Aug.1978	Cedi devalued by 39% as at rate of 25 August 1978	£1:$1.91	-	¢5.26	¢1=$0.36	$1=¢4.75	1977:¢1=£0.49

Note: Compiled from data obtained from Ghana Commercial Bank.

ABBREVIATIONS

AID	Agency For International Development (U.S.A.)
ALCAN	Aluminium Company Of Canada
ALCOA	Aluminium Company Of America
ALUSUISSE	Swiss Aluminium
ARDECO	Aluminium Resources Development Company (Japan)
BACO	British Aluminium Company Limited
BASCOL	Bauxite Alumina Study Company Limited
CPP	Convention Peoples Party
ECG	Electricity Corporation Of Ghana
GDP	Gross Domestic Product
GNP	Gross National Product
IBA	International Bauxite Association
IBRD	International Bank For Reconstruction And Development (World Bank)
IDA	International Development Association (Part of the World Bank Group)
IPAI	International Primary Aluminium Institute
KAISER	Kaiser Aluminium And Chemical Corporation
KATSI	Kaiser Aluminium Technical Services, Inc.
LME	London Metal Exchange
OPEC	Organisation Of Petroleum Exporting Countries
OPIC	Overseas Private Investment Corporation (U.S.A.)
PDD	Permanent Delivery Date (established as 25th April, 1967)
PUK	Pechiney Ugine Kuhlman (France)
REYNOLDS	Reynolds Metals (U.S.A.)
UNCTAD	United Nations Corference On Trade And Development
UNEP	United Nations Environmental Programme
UNIDO	United Nations Industrial Development Organsiation
USBM	United States Bureau Of Mines
VALCO	Volta Aluminium Company Limited
VRA	Volta River Authority
VRP	Volta River Project
WAFAL	West African Aluminium Limited

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My greatest debt, of course, is the one that I owe my wife, Dora, and our children. I am grateful for their unbounded support and inexhaustible supply of good humour during very trying and frustrating moments. In particular, their understanding for me during periods of aloofness has been highly appreciated.

Errors may be found in the supporting data or the interpretations of them. Such errors merely reflect my inability to take

full advantage of the perspicacity and support of my supervisors under whom I have been extremely privileged to study. Therefore, besides the expression of my very deep gratitude to them, I request that they are absolved from any responsibility for these remaining errors.

A. O. BARNAFO

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PREFACE

The most essential pre-requisite for the commercial production of aluminium is the combined availability of cheap and adequate supplies of bauxite and electricity. Then, depending on the quality of the ore, 2-3 tonnes of the bauxite is transformed in the first stage, using the Bayer Chemical process, to the intermediate product, alumina. In the second stage, the Hall-Heroult electrolytic process is used to convert the alumina into aluminium. Overall, the conversion ratio is as follows: 4-6 tonnes of bauxite : 2 tonnes alumina : 1 tonne of aluminium. This means that, by weight, only 16-25% of the original bauxite input is aluminium. The rest (i.e. 75% or more) is waste material which has to be discarded in one form or another at the various stages of production.

Cost-wise, this huge loss of weight represents potentially significant savings in overland and ocean transportation costs where the decision is taken to localize all the phases of production. The cost-conscious aluminium producers would, on this basis, be expected to seize this opportunity to localize their production in those geographical locations which have both bauxite and power.

However, the international aluminium industry is fragmented. The various phases - bauxite mining, alumina production, smelting and fabrication - are generally dispersed geographically.

Ghana's problem, given this preamble, is that it has cheap power as well as adequate and processible bauxite. Yet, decades of persistent efforts by successive governments have failed to achieve a bauxite-to-aluminium processing complex.

Bauxite, mined by BACO since 1942, is still exported to Scotland to be refined. The alumina required by VALCO's 200,000 tonne/year smelter is imported by VALCO's owners - principally from their offshore operations in Jamaica. And VALCO-produced aluminium is exported while the aluminium sheets and slabs which are required

by local fabricators have to be imported from overseas companies in which BACO, KAISER and REYNOLDS could very well be having equity holdings. And with a price ratio of about 1 : 6 : 41 : 80-100 for bauxite, alumina, aluminium ingot and aluminium coil sheet, it appears (from the viewpoint of the Ghanaian Government) that the maintenance of the status quo would perpetuate not only the inefficient usage of Ghana's resources but also the unfavourable terms of trade in bauxite, alumina, aluminium and semi-processed aluminium implicit in the existing arrangements.

Moreover, the precarious dependence of the Ghanaian politico-economic system on the single crop, cocoa, has added some urgency to the plan to convert Ghana's cheap bauxite with the low-cost power into the higher-priced aluminium ingot in a localized processing complex. For, besides the improvements to the terms of trade, the externalities of an integrated complex is alluring.

Because of the attractive externalities of the aluminium industry, Ghana has not been alone in wanting to re-structure its economy with aluminium-led industrialisation. The United Kingdom and Australian Governments also took political decisions in the 1960/1970's to facilitate the establishment of downstream processing plants. Over the years, Ghana offered even more wide-ranging politico-economic inducements to the major producers in order to attract the necessary investments. It is clear now that this effort has not been altogether successful in Ghana.

The root causes of Ghana's failure are multi-faceted, although the disputants in the ensuing debate have tended to stereotype the problems. On the one hand, it has been claimed that Ghana has become the victim of neo-colonialism as well as multi-national intrigues and anything short of nationalization cannot redress the problem. On the other hand, the benefits which the status quo confers on the Ghanaian economy are extolled and it is implied that these sub-stantial contributions have not been adequately acknowledged.

The problem with these two positions is that they beg the real questions involved in the continued fragmentation of the Ghanaian aluminium industry. The questions begged are:

(i) To what extent do correctable but deteriorating internal problems make the economics of integration increasingly unfavourable, and hence, discourage the requisite inflow of investible capital and expertise?

(ii) To what extent do the GHANA/VALCO agreements of 1962 paradoxically provide the means, the justification and the obstacles to the establishment a bauxite-to-aluminium complex?

(iii) To what extent does the modus operandi of the international aluminium industry, the market considerations for bauxite, alumina and aluminium, together with marginal cost considerations justify the hesitation of the aluminium producers with respect to the mine-to-metal complex proposals?

Critics of the aluminium producers have also yet to answer the question: Is Ghana, in its present state, a place where the foreign investor would commit large sums in long term investments?

Over the years, stability has deteriorated and inflation has remained very high. Coupled with these, the Ghanaian currency - the cedi - has been maintained at an unrealistic exchange rate. While the official exchange rate has been maintained for some time at 2.75 cedis to the U.S. dollar, the cedi has been changing hands unofficially at 15-20 times this official rate. The combined effect of high inflation and unrealistic exchange rate renders the economics of a bauxite-to-alumina complex (which would complete the integration of Ghana's fragmented aluminium industry) increasingly unfavourable.

The role of the aluminium producers in the economies of developing countries has always been contentious. In spite of this, there is a need to recognize that not all the objectives of the host country and those of the producers diverge. Even those that diverge

are not necessarily mutually exclusive.

In Ghana's case, the country wants and, actually, badly needs all the benefits that it rightly believes are producible from the latent wealth of its power and bauxite endowments. Besides the impact on the balance of payments and the country's budgetary policies, there is a general expectation that an integrated aluminium industry will also contribute towards capital formation which is an essential pre-requisite to economic take-off.

The shareholders of the producers, however, want to repatriate, as fast as possible, their capital and profits. The consequent outflow of scarce resources undermines capital formation.

In spite of the apparent divergence of interests, the record of the Ghana/VALCO relationship demonstrates clearly that economic progress has not been zero-sum. The record also shows that the objectives of VALCO's owners and those of Ghana need not necessarily be mutually exclusive. What has emerged is a mutually dependent relationship that has produced benefits for either party. Arguable, however, is the equitability of the appropriation of the surplus.

The entry of KAISER and REYNOLDS into Ghana was welcomed by the Nkrumah Government because of their demonstrated ability to mobilize capital and expertise, transfer technology and managerial know-how, seek, identify and develop the crucial markets for aluminium. Above all, the participation of KAISER and REYNOLDS in the VRP had clearly, become the key to the successful development of the bauxite-to-aluminium project. A large commercial user had to be found for a large percentage of the power to be generated in order to make the scheme viable. In this regard, VALCO's guarantee that it would pay for large and pre-determined blocks of power (whether or not this power was to be utilized) must not go unnoticed. This ensured that the debts incurred in the construction of the dam and power house would be repaid - whether or not VALCO utilized the power supplied by the VRA.

For its part, the Nkrumah Government granted to the KAISER-REYNOLDS consortium exclusive access to the hydro-electric power and other inputs, favourable tax incentives and a free hand to run its operations. In addition, the company was exempted from Ghana's exchange regulations. Therefore, not unexpectedly, the VALCO investment has turned out to be highly profitable.

Although Ghana has gained immensely from the VRP, it can and, in fact, has been argued in Chapter 5 that the outcome of VALCO's smelting operations demonstrate that the appropriation of the direct financial results have been weighted in favour of the KAISER-REYNOLDS consortium. Nevertheless, it is neither justifiable for critics to imply that Ghana's share of the result is insignificant, nor to suggest that all the gains made by VALCO's owners were necessarily and entirely at Ghana's expense, nor recommend the termination of the present arrangements.

Some of the issues that have not been answered so far relate to the opportunity cost to Ghana of the entry of the KAISER-REYNOLDS consortium. Some of the questions that need to be asked are as follows.

(i) Had the KAISER-REYNOLDS consortium not executed the 1962 Agreements, would it have been possible to build the hydro-electric power facilities on the Volta, and if so, at the cost of what other socio-economic development programmes in Ghana?

(ii) Given that Volta hydro-electricity now accounts for over 99% of the electricity generated in Ghana, and the fact that the number of units generated have been augmented from 484.536 million kilowatt-hours in 1964 (a year before Akosombo came on stream) to 4,631.338 million kilowatt-hours in 1979 - a compounded annual growth rate of 16.2% - what would have been the foreign exchange cost to Ghana of importing fossil fuel to generate, by thermal means, the same amount of energy?

(iii) Although Chapter 5 of the thesis argues that only 18% of the estimated turnover from aluminium production has been returned

to Ghana in the 1967-1980 period, would Ghana have earned similar or even higher dollar incomes if the KAISER-REYNOLDS consortium had chosen to withdraw in 1962?

(iv) Is the true value of the periodic dollar transfers made by VALCO's owners at the official exchange into Ghana to cover the company's liabilities being acknowledged - given the fact that the Ghanaian currency (the cedi) is changing hands unofficially at 15-20 times the official rate?

(v) Is the proposal to integrate the industry backwards from smelting into mining and refining a viable and economic proposition - bearing in mind the international context against which Ghana's proposals must be set?

(vi) If the proposal to integrate backwards (i.e. establish a bauxite-to-alumina complex) is viable, can the formidable problems of implementation be overcome - given Ghana's present difficulties?

(vii) Does Ghana really need to establish a bauxite-to-alumina plant at all - given the wide range of unexplored options which the status quo offers?

The pros and cons of the VRP is certainly too large a question to argue effectively here. This would call for a social cost-benefit analysis for the entire VRP - a study in which the scale and impact of the direct and indirect benefits are assessed alongside the concomitant costs. Additional issues such as employment, generation of skills, the improved potential for irrigated and large scale mechanised farming, lake fishing and lake transport cannot be ignored because they have a positive impact on the economy.

In the light of the foregoing, the Ghana Government (which has invested substantially in the VRP) needs to build a careful policy based on detailed enquiry of the foregoing questions (among others). The facts that emerge from such a detailed enquiry could very well yield results which contradict popularly held opinions in Ghana.

Notwithstanding the interesting ramifications of the Ghana/VALCO debate, as outlined above, this thesis concentrates on the economic justification for integrating the aluminium industry (items (v) and (vi) above) and the policy options open to the Ghana Government (item (vii) above).

On the basis of recent costs and prices, backward integration is shown to be viable. However, there is the proviso that the growing uncertainty over the country's stability, the maintenance of unrealistic rates of exchange coupled with the high inflation rates of recent years mean that the economics of integration is not as favourable as it was.

Moreover, the excess alumina capacity of KAISER and REYNOLDS and marginal cost considerations mean that a bauxite-to-alumina complex (which would complete integration) is at present superfluous to these companies whose support Ghana would be wise to seek.

In the attempt to argue these development problems in Ghana, a neutral approach is adopted. The aim is neither to attack nor defend opposing claims but to highlight the interesting paradoxes of the aluminium industry (both in the internal and international contexts) and the conflicts that can arise when developing nations attempt to use aluminium-led industrialization to stimulate overall economic growth.

If the nature of the internal and external factors which constrain the realization of the mine-to-metal complex are appreciated, the inevitable cost of its pursuit would be realized and accepted in Ghana. More importantly, the re-negotiation between Ghana and VALCO on the backward integration of current operations would be approached with greater circumspection.

The data on which this study was based was drawn from a variety of scattered sources. Primary sources included a number of feasibility study reports, annual reports of the companies associated with the aluminium industry, discussions with and information supplied by the

officials of the Bank of Ghana, Ghana Commercial Bank, VALCO, VRA, the Aluminium Industries Commission (Accra, Ghana), the Ministry of Lands And Natural Resources (Ghana), and the Central Bureau of Statistics (Accra, Ghana). Secondary sources included books on the aluminium industry, articles in newspapers and periodicals which attempt to interpret, comment on, and/or offer critiques of relevant aspects of the mineral industry.

It is hoped that the contents of the thesis will justify the underlisted claims to originality.

(i) First, the thesis outlines the interplay of internal and external factors which have hitherto institutionalized the fragmentation of the Ghanaian aluminium industry.

(ii) Secondly, the case is argued that, on the basis of the estimates of the KAISER-led BASCOL feasibility study in 1975, backward integration (i.e. the establishment of a bauxite-to-alumina complex) is profitable. Viability notwithstanding, the inflow of KAISER-sponsored investible capital for this purpose is unlikely.

(iii) Thirdly, the thesis seeks to demonstrate that, notwithstanding the widespread disquiet over the role of KAISER and REYNOLDS in the politico-economic affairs of Ghana, the appropriation of the direct financial benefits from VALCO's operations have not been zero-sum. Overall, the identifiable benefits derived by Ghana from the VRP is far greater and significant than hitherto acknowledged.

(iv) Fourthly, after outlining the rationale behind the unwillingness of VALCO's owners to integrate their operations backwards into mining and refining, the thesis determines the most probable strategy that might be adopted by VALCO and its owners to contain and ward off the mounting pressure for their utilization of indigenous alumina in lieu of imports.

(v) Fifthly, the alternative counter-strategies open to the Ghana Governments are explored. The option which is feasible, easy

to implement, and likely to succeed under existing conditions is suggested.

In the pursuit of these five objectives, the thesis approaches the problems of fragmentation along the following lines.

To introduce the politico-economic context in which the problems of fragmentation arose, Chapter 1 attempts to outline how the precarious dependence of Ghana on the single crop, cocoa, led to the active pursuit of the VRP (among other projects) in the hope that its full implementation would diversify export incomes and stimulate overall economic growth.

Chapter 2 discusses the 1962 Ghana/VALCO agreements which facilitated the implementation of the power project, the public works programme and the smelter project of the VRP. The objectives of Chapter 2 are four-fold. First, it attempts to demonstrate how the 1962 agreements effectively "freeze" (using Girvan's terminology) the Ghana/VALCO relationship. Secondly, the mutual dependence of Ghana and VALCO is demonstrated. In particular, Ghana's dependence on VALCO's owners for any further developments in the aluminium industry is argued. Thirdly, the provisions which enable the direct financial benefits to be assessed are discussed. This forms the background to the establishment of what is financially at stake for either party in the event of changes in the status quo. And fourthly, it is argued that the agreements paradoxically provide the means, the justification and the obstacles to the integration of the aluminium industry.

Chapter 3 supplements the background information (which was discussed in Chapters 1 and 2) with a review of the international dimension of the problem of fragmentation.

Chapter 4 addresses itself to the question: Given the 1975 estimates of BASCOL for a 600,000 tonne/year bauxite-to-alumina plant as well as the modus operandi of VALCO's "tolling" operations,

is the proposal to integrate the aluminium industry in Ghana viable? The answer is in the affirmative - although BASCOL had reached a negative verdict in 1975.

Profitability notwithstanding, the owners of VALCO are not enthusiastic about promoting the project. Because of vital nature of their support, Chapter 5 explores the rationale behind the attitude of KAISER and REYNOLDS and the probable strategy that might be adopted to dampen the pressure on them to integrate. For the Ghanaian Government, the range of alternative counter-strategies are discussed.

Bearing in mind the constraints outlined in Chapters 1 - 3, Chapter 6 draws the conclusions and recommends one of the counter-strategies discussed in Chapter 5. The recommendation is made on the basis that it would be easy to implement and likely to succeed because such a strategy takes into account the interests of VALCO as well.

CHAPTER 1: THE BACKGROUND AND INTRODUCTORY SURVEY

Chapter 1.1. Ghana's Economy

To understand why so much importance was attached to aluminium-led industrialisation in Ghana, one needs to look at the structure of Ghana's monocultural economy. As demonstrated by Table 1-1, the single crop, cocoa, has continued to account for well over 50% of the country's export proceeds. Taken together, cocoa, minerals and timber exports represent over 90% of the country's export income. Such overwhelming dependence on the export revenues of these raw materials, and in this regard the pre-eminence of cocoa, constitutes a pressing weakness of the Ghanaian economy[1].

In spite of this dependence on cocoa, the cocoa industry has always faced an array of problems some of which have worsened considerably since independence. The whole of the output of cocoa is accounted for by inefficient, labour- and land-intensive peasant methods of production. As such, the migration of rural labour to the urban centres during the period of Nkrumah's high-speed industrialization coupled with disincentives, such as low producer prices (Table 1-2) has meant that many cocoa farms are now bereft of young farm hands. Additional problems such as weather, and diseases of the cocoa plants have also led to fluctuating but generally declining output[2].

In the light of these problems, Ghana has lost its leadership in cocoa production to the Ivory Coast and Brazil. Ghana's cocoa output in the 1978/79 season was just about 46% of the country's output in the 1964/65 season. Considering Ghana's cocoa output in terms of its share of total world production, production has declined from a share of 37.9% for the 1964/65 season to around 25% now (See Appendix A1-1).

Externally, the tendency of total world production of cocoa to outstrip its demand and the ever-present threat of synthetic substitutes have tended to depress the price of the commodity. One

TABLE 1-1: Export Earnings of Ghana by Commodity Class (in million cedis - ₵)

COMMODITIES	1938+		1948+		1954+		1960*		1970*		1975*		1976*		1977*		1978*	
	₵	%	₵	%	₵	%	₵	%	₵	%	₵	%	₵	%	₵	%	₵	%
Cocoa, minerals and timber	21.9	96	109.2	97	221.6	97	271.8	97	417.3	91	842.1	85	792.0	84	1,035.7	86	1,380.9	84
Cocoa[1]	9.1	40	84.3	75	169.2	74	165.4	59	331.6	72	637.0	64	593.1	63	797.3	66	1,152.2	70
Timber[2]	12.6	55	4.9	4	13.4	6	38.9	14	37.0	8	83.7	9	80.0	8	90.1	8	83.5	5
Minerals[3]	0.2	1	20.0	18	39.0	17	68.2	24	48.7	11	121.4	12	118.9	13	148.3	12	146.2	9
Aluminium	-	-	-	-	-	-	-	-	-	-	99.7	10	107.6	11	99.5	8	NA	NA
Others	1.0	4	3.0	3	7.7	3	8.4	3	42.9	9	53.3	5	48.7	5	72.8	6	263.7**	16
TOTAL	22.9	100	112.2	100	229.3	100	280.2	100	460.2	100	995.1	100	948.3	100	1,208.0	100	1,664.6	100

The data in the above table were calculated and compiled from information from the following sources:

* Central Bureau of Statistics, Accra, Ghana.

\+ From the Report of the Gold Coast Mines Board of Inquiry, 1956, p.18.

Notes: 1. Cocoa exports are predominately in the form of cocoa beans.
Export figures include minor contributions from the export of cocoa, butter and cocoa paste.

2. Timber is exported as logs as well as sawn.

3. Mineral exports are made up of Gold, Diamonds, Manganese, Bauxite.

** Aluminium and Kola nut earnings included in this figure. Not yet disaggregated.

NA Means not available.

TABLE 1-2: Disparities Between The London Average Spot Prices And The Producer Prices Paid To Ghanaian Cocoa Farmers

Year	The Average Spot Prices Of Ghanaian Cocoa (London Market) - £ per tonne	Producer Prices Paid To Ghanaian Cocoa Farmers	
		£ per tonne	Cedis per tonne
1964*	188.0	73.8	148
1965*	138.8	82.7	165
1976*	1,399.0	650.7	1333
1977**	2,944.0	650.7	1333
1978**	2,006.0	480.0	2,667
1979**	1,728.0	720.0	4,000

Estimates above calculated from data from the following sources:

* Central Bureau of Statistics, Accra, Ghana, "Economic Survey 1966", Table 21, p.48, and paragraph 200, p.50.

Note: It was assumed that ¢1.00 = £0.5.

** Central Bureau of Statistics, Accra, Ghana, "Preliminary Economic Survey, 1977-1979, paragraph 24, p.5 and paragraph 30, p.6.

Note: Exchange rates were assumed as follows:

1976 - ¢1.00 = £0.488

1977 - ¢1.00 = £0.499

1978 - ¢1.00 = £0.18

1979 - ¢1.00 = £0.18

of the major external problems of the cocoa industry is the volatility of the price. It may very well be due to high price elasticities of demand as well as to the lack of control over supply.

Because of the internal and external problems which face its main export crop, Ghana's continued dependence on the commodity has become the Achilles heel of all economic development strategies. Consequently, successive governments have actively sought economic strategies which would diversify the economy. The bauxite-to-aluminium industry offered these prospects - hence, the active interest.

Apart from the contributions of the cocoa sector, the export of gold, diamonds, manganese and bauxite, together represent the second most important source of Ghana's export income. Over the years, the mineral sector has, on occasions, accounted for up to a quarter of the country's export revenues. The problem with this sector is one of stagnation. For since the 1930's, no new mines have been established. Furthermore, existing mines have been faced with low or stagnating prices while the cost of production have continued to rise sharply. As such, profit margins have been squeezed, a number of mines rendered marginal, other mines have been closed down completely, and overall investments held back. The international gold price, for example, remained fixed at US $35.00 per troy ounze from 1947 to 1968 after which period, the dollar crises, and speculative pressures led to much higher gold prices.

Against this backdrop, the economic planners identified the development of a bauxite-to-aluminium complex as a feasible and desirable means to diversify the Ghanaian economy. The advantages perceived included the utilization of cheap hydro-electricity (from the proposed Volta dam and powerhouse) in the transformation of the country's low-priced bauxite into the much higher-priced aluminium ingots[3]. Besides, bauxite was seen as the only mineral resource which offered a real scope for expansion at the turn of the 1950's.

Also, from a social cost-benefit angle, successive governments

and particularly that of Nkrumah's Convention Peoples Party (CPP) considered the direct financial benefits accruable from aluminium-led industrialisation as well as the industry's alluring externalities as an additional justification for placing the Volta River Project (VRP) at the central stage of the development strategy.

The VRP, as the scheme came to be called, involved three distinct sub-projects. The first aspect was the power project which entailed the construction of a dam and hydroelectric powerhouse on the Volta River and the establishment of the power distribution network. The second aspect of the VRP was the development of the supportive infrastructure through a public works programme. And the final aspect was the bauxite-to-aluminium processing complex. Each of these sub-projects promised a wide range of externalities.

The public works programme was expected to open up the hinterland for further economic development.

The power project involved the impoundment of a 3,275 square mile lake (one-twentieth of Ghana's total land area) and a shore line of 4,500 miles in length. This was expected to lead to the development of lake fishing, low-cost lake transport and the establishment of large scale, mechanised and irrigated farms in the arid plains which adjoin the lake.

As Table 1-3 demonstrates, although Volta Lake fishing is still well below its potential, it still contributes significantly to the requirements for fish in Ghana. The domestic catch from the Volta Lake accounts for over 10% of the fish consumption in Ghana. Besides the savings on the import bill for fish, the nutritional value in the diets of the riparian communities is enhanced.

In order to develop and improve the Volta Lake transport, the Volta Lake Transport Company (a subsidiary of VRA) was established to manage the operations. Here also, although an overall Lake Transport system is yet to be developed, comparative data for passenger

TABLE 1-3: The Contribution Of Volta Lake Fishing To Ghana's Fish Consumption

	1972		1973		1974		1975		1976	
	Tonnage	Value ¢'000	Tonnage	Value ¢'000	Tonnage	Value ¢'000	Tonnage	Value ¢'000	Tonnage	Value ¢'000
Imports of fish products	16,367	11,834	17,981	11,858	22,130	16,864	16,974	14,533	42,898	18,230
DOMESTIC CATCH:										
(a) Marine	249,068	45,949	155,315	53,033	182,080	60,608	212,680	102,888	195,750	110,111
(b) Volta Lake	32,383	4,858	40,732	8,961	37,300	11,900	41,945	12,584	39,000	11,700
(c) Sub-Total	281,451	50,807	196,047	61,994	219,380	72,508	254,625	115,472	234,750	121,811
Landings From Foreign Vessels on Contract.....	518	129	1,000	222	4,881	2,148	872	262	1,261	441
Tuna Sold Locally.....	332	143	433	152	887	390	2,868	861	2,985	896
TOTAL	298,668	62,914	215,461	74,225	247,278	91,910	275,339	131,128	281,894	141,378

Source: Central Bureau of Statistics, Accra, Ghana, "Economic Survey 1975-1976", Table 5.10, p.84.

traffic handled by the Volta Lake Transport Company indicates that, if the growth is maintained, the Lake transportation could, in the course of time, have a significant impact on the overall transport system.

TABLE 1-4: Comparison of passenger traffic on the Volta Lake and the Railways - 1972-1976

Year (a)	Passenger Traffic on the Volta Lake (b)	Passenger Traffic on the Railways (c)	Passenger Traffic on the Volta as a % of railway traffic (d) = (b)/(c)
1972	14,601	6,984,000	0.2
1973	19,569	7,566,000	0.3
1974	26,480	7,843,000	0.3
1975	30,666	6,934,000	0.4
1976	27,651	6,450,000	0.4

Data compiled from the following sources:

(i) Column (b) - VRA 1978 Annual Report, p.37

(ii) Column (c) - Central Bureau of Statistics (Accra), "Economic Survey 1975-1976", Table 7.2, p.108. Figures quoted above were for 1971/72, 1972/73, 1973/74, 1974/75 and 1975/76.

The potential for irrigated farming is yet to be developed and this has assumed increased urgency as the country's import bill for food is increasing.

Most important of all, the power project was going to make available, in one step, a long-term supply of plentiful and low-cost power for additional industrial development and for private use. The bauxite-to-aluminium complex also promised highly skilled jobs with the concomitant multiplier effects.

Thus, put together, the anticipation of multiplier effects of the entire project as well as the direct socio-economic benefits gave an impetus to the pursuit of the VRP.

The views of Dr. Kwame Nkrumah also added a sense of urgency.

Nkrumah held the view that industrialisation is synonymous with development because all rich countries are industrialised[4].

On the basis of this view, Nkrumah emphatically rejected the theory of comparative advantage. In a statement reported by Killick, Nkrumah observed that:

> "There is an argument that contends that young nations emerging from colonisation are indulging in wasteful expenditures by duplicating industries and ventures which have already been perfected by the older industrialized nations of the world, whose products are available at lower cost than for which can be manufactured by us. It may be true in some instances that our local products cost more, though by no means all of them, and then only in the initial period. But even if it were substantially the fact, it is not an argument that we can accept. It is precisely because we were, under colonisation, made the dumping ground of other countries' manufactures and the providers merely of primary products, that we remained backward; and if we were to refrain from building, say, a soap factory simply because we might have to raise the price of soap to the community, we should be doing a disservice to the country".[5]

This view is instructive in the sense that it explains the drive and determination of Nkrumah's Government for high-speed industrialization (particularly, those projects with a high technology content). Nkrumah believed that the cost of protecting the infant industries could be offset easily by the spill-over effects. This firm belief in rapid industrialization as the only effective mechanism for reversing underdevelopment explains Nkrumah's drive - at times precipitate - to implement the Volta River Project (among others), whatever the cost. To Nkrumah, the availability of large amounts of cheap power is the pre-requisite for high-speed industrialization. Success of his strategy, therefore, depended on the success of the VRP.

With the benefit of hindsight, it is possible to say that, notwithstanding the alluring prospects offered by Nkrumah's strategy to diversify the economy, the precipitateness with which the Nkrumah government tried to implement the VRP may have obscured an urgent need for circumspection. Krassowski reports of the "undisguised displeasure" of the Ministry of Finance which was concerned about reducing expenditure on long-maturing schemes and the need to investigate the "relative priority in relation to alternative uses of funds".[6] This latter view accords with that of Habenicht, who also urges caution in relation to the tendency of Third World Governments to take hasty investment decisions regarding downstream processing.[7]

In spite of these well-founded doubts, Nkrumah's Government firmly decided that underdevelopment could best be dealt with by adopting the twin objectives of: supplanting small-scale peasant agricultural production with large-scale mechanised farms owned and operated by the state; and of embarking on high technology, energy-intensive industrial projects, starting with the VRP, to diversify the monocultural economy inherited at independence.

In the implementation of this strategy of development, government expenditure rose very sharply, while fluctuating export incomes hardly kept pace. The deepening foreign exchange crises became exacerbated as the established import-substitution industries failed to yield the expected results, and yet, continued to make demands on scarce foreign exchange to cover the import costs of their inputs. This outcome was disastrous. It stands in sharp contrast to Nkrumah's optimistic belief, expressed earlier on, that: "the growth rate of the public and co-operative sector of our economy will exceed the growth rate of the private sector, particularly in industry and agriculture".[8] The failures of all sectors of the economy, the increasing burden of debt servicing, and the growing insufficiency of the country's export income made it even harder and costlier to float loans. The inflow of investment capital reduced to a trickle and domestic capital sought sanctuary overseas.

Given these severe strains, the dramatic fall of the price of

cocoa in 1965 (to half of its 1954 value) triggered the first military coup on 24th February, 1966.

The legacy of the 15 year attempts by Nkrumah's government to re-structure the economy are summed up by three manifestations. First, most of the import-substitution industries had clearly failed to take off and the scheme to establish an integrated aluminium complex remained incomplete. Second, the country's foreign exchange reserves dwindled from about £286 million ($800 million) in 1957 to less than £0.2 million ($0.5 million) at the time of the military intervention in February 1966.[9] Thirdly, Ghana's liabilities covered over 200 separate debts of total value £254 million ($710 million) and their repayments were claiming a quarter of the country's export revenues in 1966.[10]

The successor regimes to Nkrumah were the National Liberation Council (24th July, 1966 - October 1969) and the government of Dr. K. A. Busia (October 1969 - 13th January, 1972). Faced with the same structural problems in the economy, they chose to sell off all loss-making state enterprises and used retrenchment to minimise government liabilities. Although such cost cutting measures won acclaim in the international business community, they left virtually untouched the main structural problems. Meanwhile, while the economy was registering very little growth to permit the accumulation of reserves, exchange controls were relaxed. This led to uncontrollable boom in the import of consumer items. As the balance of payments crisis loomed, the international price of cocoa fell to a 5 year low. The cedi was devalued by 42% and the elected government was forcibly replaced by the military government of the National Redemption Council (NRC).

A temporary rise in the international price of cocoa eased the balance of payments problem. The National Redemption Council (later reconstituted and renamed Supreme Military Council), at first, wisely embarked on the policy of self-reliance aimed at boosting domestic food production. This was soon to be offset by the ill-

advised repudiation of some of the country's external debts and the partial nationalisation of private mining and timber companies. International confidence was lost. It soon became apparent that the partial successes of the self-reliance policies were being negated by economic mismanagement and corruption. Besides the deterioration in the balance of payments problems, the rising budgetary deficits and widespread shortage of all goods helped stoke up inflation. The deterioration in the economy and the government's failure to develop a diversified source of export income led to a palace coup. However, on 4th June, 1979, the Supreme Military Council was itself overthrown in Ghana's fourth military coup since independence in 1957. The new military government headed by Flight-Lt. Jerry Rawlings, executed eight senior military officers including three former Heads of State in an attempt to purge the country of corruption.

After handing over power to an elected Government headed by Dr. Hilla Limann on 24th September, 1979, declining export revenues, charges of economic mismanagement and corruption led again, on 31st December, 1981, to Ghana's fifth coup d'état.

As of 1978, the large external debt stood at US$1.4 billion and domestic debt at ¢6.2 billion (where ¢1.00 = US$0.364). Table 1-5 below illustrates the external debt position for 1976-1978.

Short-term debts represent one of the greatest problems now facing the Ghanaian economy. As at 1978, short term debts were valued at $488.6 million out of a total external indebtness of $1.4 billion. The medium and long-term debts totalling $877 million are manageable even in the present parlous state of the economy because debt servicing now accounts for only 5% of export income.

In 1978 and 1979, the end-of-year reserves stood at $287.6 and $299.7 million respectively. At this level, it has been difficult to finance the cost of importing the necessary raw materials and to service the economy. Existing industry is now operating at 20-30%

TABLE 1-5: Ghana's Outstanding Foreign Debts (U.S.$ millions) - 1976 - 1978

	1976	1977	1978
Pre-1972 arrears	70.0	67.4	58.2
Post-1972 arrears	65.0	80.2	329.3
Backlog of profit and dividend remittances.....	58.0	57.2	58.9
Remittances under the Investment Policy Decree	40.0	39.7	42.2
TOTAL SHORT TERM DEBT	233.0	244.5	488.6
Pre-1966 Suppliers Credits	270.0	269.0	323.2
Post-1966 Suppliers Credits	4.7	2.8	56.2
TOTAL MEDIUM TERM DEBT	274.7	271.8	379.4
Bilateral loans from governments	208.6	253.2	288.2
Loans from international agencies	106.3	125.2	209.4
TOTAL LONG TERM DEBT	314.9	378.4	497.6
TOTAL DEBT OUTSTANDING	822.6	894.7	1,365.6

Source: Compiled from Bank of Ghana data.

of installed capacity. With less economic activity, the tax base for the treasury is reduced and deficits are now incurred each year.

The inability to control the ever-increasing budgetary deficits which jumped ten-fold from its level in 1972 to that in 1978 and the fact that about two thirds of the budgetary deficits is, each year, financed from borrowings from the central bank has led to a very sharp rise in the money supply. Consequently, inflation has been running at 100-125% for several years now.

A more serious consequence of the budgetary problem is that the Ghanaian currency - the cedi - has been consistently overvalued for several years. The Cedi changes hands at 15-20 times its official value of ¢2.75 to the dollar.

The vicious circle in which Ghana now finds itself is that these economic problems have been reinforcing one another. And because of these distortions, the vital inflow if investible capital and expertise is effectively discouraged. Export growth is also being hindered by the high rate of inflation and an artificially low exchange rate. And existing industry is operating well under capacity.

In the light of these inherent problems in the economy, aluminium-led growth has attracted, increasingly, the attention of development planners. However, the case for the VRP as the means by which the Ghanaian economy could be diversified and overall growth stimulated rests on the availability, the processability and the adequacy of the raw materials for a bauxite-to-aluminium processing complex. As such, an attempt is made in Chapter 1.2 to assess these resources.

1.2. Ghana's Resources for Integrated Aluminium Production

Given the problems of the cocoa industry and the stagnation of the mineral sector, it has been very clear that the development of the bauxite industry is one of the few non-agricultural projects in Ghana which have a realistic hope for expansion. Therefore, efforts were intensified during and after the six year dyarchy (1951-1957) to assess and evaluate the availability, adequacy and processability of local raw materials used in the traditional Bayer/Hall/Heroult technologies for the commercial production of aluminium.

In an attempt to estimate the threshold price for aluminium ingot beyond which it would be attractive to invest in a new mine-metal complex in the United States, Langton demonstrates that the main cost elements are bauxite, electricity and capital. They account for 8.7%, 26.7% and 34% respectively of the total manufacturing costs (that is, the threshold price) - Table 1-6. Therefore, any serious considerations for a bauxite-to-aluminium processing complex in Ghana must be on the basis that these inputs are available in sufficient quantities to support such an operation.

There are 13 occurrences of bauxite deposits in Ghana. (See Figure 1.1). Of these, 3 are of sufficient size and quality to be of commercial interest. In fact, one of these - the Sefwi Group - has been worked, on a small scale, since 1942 by British Aluminium Company (BACO) which exports kiln-dried bauxite to its refineries in Burntisland, Fife, Scotland. These constitute the bulk of the input into BACO's refinery at Burntisland.[1]

TABLE 1-6: Cost-based Target Price For Aluminium Necessary To Justify New Investment In A Mine-to-Metal Complex In The U.S.A. (US cents per pound).

Cost element	1979	1990
Bauxite	5.9*	13.4*
Caustic Soda	1.2	2.0
Other materials	3.9	8.8
Electricity	18.1*	43.8*
Fuel oil	2.6	7.5
Natural gas	0.6	3.2
Direct labour, including fringes	4.6	10.0
Maintenance	4.3	10.5
Delivery	0.9	2.1
General, Sales, Administration	2.7	5.9
TOTAL DIRECT COSTS	44.8	107.2
Capital costs	23.1*	56.3*
TOTAL (i.e. Target Price)	67.9	163.5

Source: Thomas G. Langton (Chase Econometrics, Bala Cynwyd, Pennsylvania), "Economic Aspects of the Bauxite/Aluminium Industry", JOURNAL OF METALS, August 1980, p.13.

* Dominant cost factors.

Note: It was assumed that underlying costs would escalate at an annual rate of 8.3% through to 1990.

Estimates of Ghana's total proven bauxite reserves are 287.7 million tonnes. Indicated and Inferred reserves are 160.3 and 194.7 million tonnes respectively (See Table 1-7).

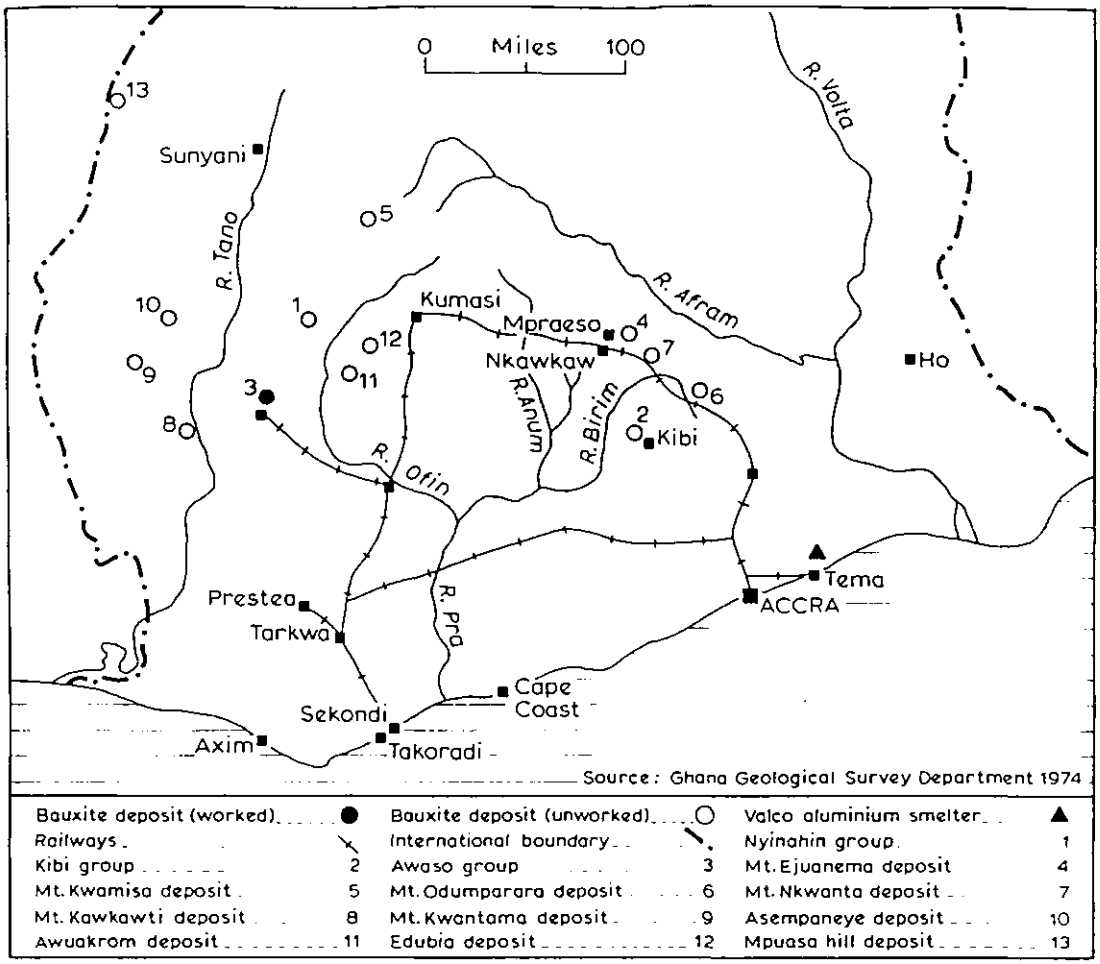


Figure 1.1 Ghana's Resources of Bauxite

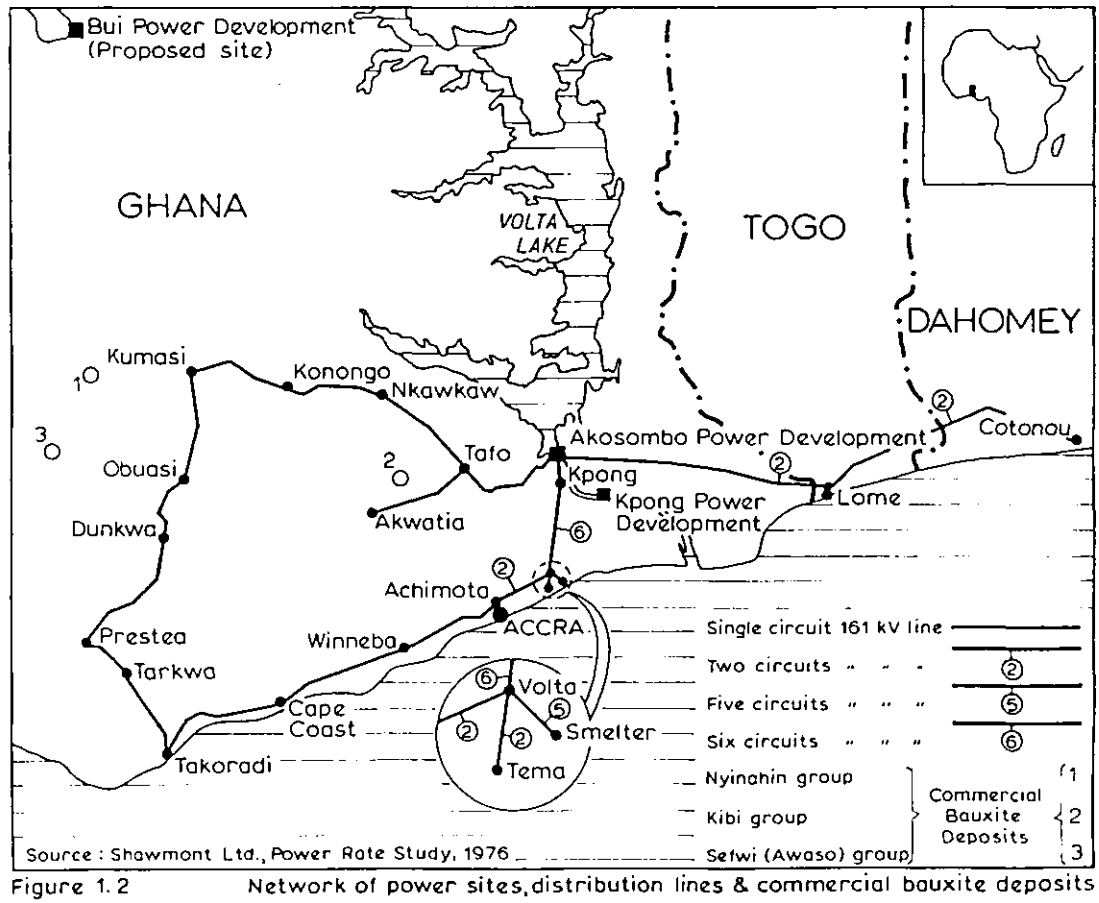


Figure 1.2 Network of power sites, distribution lines & commercial bauxite deposits

TABLE 1-7: Reserves of the Main Bauxite Deposits in Ghana

DEPOSIT	ORE RESERVES (million tonnes)			
	Proven Ore	Indicated Ore	Inferred Ore	TOTALS
Nyinahin Group[1]	134.8	143.1	101.0	378.9
Kibi Group[2]	120.0	17.2	45.4	182.6
Sefwi (Awaso) Group[3]	32.9	-	48.3	81.2
TOTALS	287.7	160.3	194.7	642.7

Compiled from the following sources:

1. GHANA GEOLOGICAL SURVEY DEPARTMENT, "Bauxite Deposits of Ghana", Report No.75/2, 7th December, 1974, pp.16-17.
2. BAUXITE ALUMINA STUDY COMPANY LTD. (BASCOL), Feasibility of Bauxite and Alumina Production", July 1975.
3. GHANA GEOLOGICAL SURVEY DEPARTMENT, op. cit. p.25.

Of the three major deposits, the Kibi Group is nearest to the established power lines, the Tema smelter and the Tema port facilities (See Figure 1.2). For an industry which is noted for its significant transport costs, attention is naturally concentrated on the Kibi deposit for the initial development.

As Table 1-8 below demonstrates, the quality of Ghanaian bauxite (which is similar for all the other deposits) is of medium grade.

TABLE 1-8: The Characteristics of the Kibi Bauxite

Total Alumina	45.70%
Total Silica	2.50%
Total Available Alumina (470°F)	40.80%
Trihydrate Alumina (302°F)	39.60%
Reactive Silica	2.00%
Carbon	0.11%
Free Moisture	40.00%

Source: BAUXITE ALUMINA STUDY COMPANY (BASCOL), "Feasibility of Bauxite and Alumina Production", July 1975.

Commenting on the quality of the Kibi bauxite deposit, BASCOL study concluded: "The overall processing characteristics of the bauxite are quite good except for the desilication of some of the low silica bauxites. Also, no problems from minor impurities in the bauxite are anticipated".[2]

Furthermore, the same study established that the specific consumption of bauxite per tonne of alumina producible from the Kibi deposit is 2.624 and that the annual requirement of such bauxite for a 600,000 tonne/year refinery plant (hence a 300,000 tonne/year integrated liquid aluminium plant) would be 1.574 million tonnes. At such a rate of comsumption, the 'proven' reserves at Kibi alone can guarantee a life of 76 years. On the basis of the total proven reserves of 287.7 million tonnes (for the deposits at Nyinahin, Kibi and Awaso), a project life of 182.8 years could be assured. Therefore, the adequacy and processability of Ghanaian bauxite to sustain a 300,000 tonne/year mine-to-metal complex cannot be considered as a hindrance to the localization of the phases of commercial aluminium production.

Apart from bauxite, the second most critical input item is power. Ghana's ability to provide adequate low-cost electricity has to be assessed. To facilitate such an assessment, the power requirements of a 300,000 tonne per year integrated complex have to be compared to the power supply available in Ghana.

However, as Appendix A1-2 demonstrates, the Volta River Authority (VRA) which generates power and administers its sale anticipates that the potential energy of its power system will grow from 5,400 million kwh (1980) to 7,515 million kwh (in 1990).

Were there to be an integrated aluminium complex in Ghana by 1990, one could theoretically suggest that the VRA would be capable of meeting the demand from the aluminium industry and still have surplus energy of about 3,015 million kwh to meet the non-aluminium demand in the rest of the economy.

TABLE 1-9: Estimated Power Requirements For A 300,000 Tonne/Year Integrated Aluminium Complex In Ghana

Item	Specific usage (kwh) (a)	Annual usage (million kwh) (b)	Remarks (c)
Bauxite Mining[1]	29.2	17.5	Specific usage given in kilowatt hours per tonne of alumina produced.
Slurry Transport[1]	105.0	63.0	Specific usage given in kilowatt hours per tonne of alumina produced.
Alumina Plant[1]	275.6	165.4	Specific usage in kilowatt hours per tonne of alumina produced.
Smelter[2]	14,000.0	4200.0	Specific usage in kilowatt hours per tonne of molten metal produced in the smelter.
TOTALS	14,819.6	4445.9	PER TONNE OF MOLTEN METAL.

The estimates in the table were calculated on the basis of data from the following sources:

1. BASCOL study, op. cit., Table 10-A.
2. ALUMINIUM COMPANY OF AMERICA (ALCOA), 1980 Annual Report, p.6. It is reported that electricity consumption in Hall-Heroult electrolytic cells of smelters has, in the last 40 years, been reduced from an average of 12 kwh/pound aluminium (26,455 kwh/tonne) to 6 kwh/pound (13,228 kwh/tonne) in the most efficient plants now.

It is evident from Table 1-9 that the annual requirement of power for a 300,000 tonne per year integrated complex, based on BASCOL's recommendations, would be 4445.9 million kilowatt-hours

(i.e. about 4500 million kwh).

The VRA expects, however, to sell 6,040 million kwh by 1990. Out of this, sales to non-aluminium customers is expected to reach 2,692 million kwh. Should the VRA be required to supply 4,500 million kwh to the 300,000 tonne/year mine-to-metal complex (as shown to be required in Table 1-9 above), the margin required to ensure the power system's reliability would be significantly reduced.

Under these circumstances, the options open to the Ghana Government, if it wishes to pursue actively the establishment of a bauxite-to-aluminium complex, are four-fold. The first option is to proceed with the Ghana/Ivory Coast intertie for which negotiations have already reached an advanced stage. Secondly, it could pursue policies which would check the growth in the electricity demand of non-aluminium customers. The third option, which may be pursued in conjunction with the foregoing, is the development of additional hydro-electric power generation facilities (Appendix A1-3). The fourth option is to maintain the capacity of the smelter at Tema at 200,000 tonne/year and export any excess alumina that would be dictated by economies scale for the bauxite-to-alumina plant. This fourth option would have the effect of limiting the electricity demand to currently manageable levels.

In these circumstances, the hydroelectricity which is available and planned are enough to meet the requirements of a bauxite-to-aluminium processing complex.

Besides bauxite and power, other raw materials required for the production of alumina are also available in Ghana. The feasibility study conducted by the Bauxite Alumina Study Company (BASCOL) in 1975 demonstrated that Bunker "C" oil can be supplied by the petroleum refinery at Tema. The absence of sources of fossil fuel in Ghana means that the high OPEC-induced prices will be a constraint. In addition, the requirements of lime can easily be met for a period of 20-25 years from two deposits on the banks of the Volta.

The existence of these indigenous raw materials mean that the mobilization and the cost of capital, besides the vital inflow of technical and managerial expertise, are the critical obstacles to the successful development of a bauxite-to-liquid aluminium production complex in Ghana.

The major aluminium producers are, by common agreement, capable of mobilising capital, transferring technology and expertise, seeking, identifying and developing the markets for such an export-oriented investment in Ghana. Hence, the international connection of the VRP to the aluminium multi-nationals.

This explains the genesis of the relationship between Ghana and the major aluminium producers. The present state of the relationship is just the result of the compromise reached between the social cost-benefit aims of the Ghana Government (i.e. the maximisation of social welfare) and the companies' private cost-benefit considerations (where the aim was to maximise corporate profits per se).

The power project and the public works aspects of the VRP were successfully implemented on schedule and under the original cost estimates. Ghana's inability to maximise the socio-economic benefits derivable from these sub-projects is outside the scope of this study but has been noted.

But, the incomplete implementation of the mine-to-metal complex deserves to be examined because it has been criticised by many observers in and outside Ghana[3]. As a preamble to the analysis of the reasons for fragmentation and the feasible policy options for the Ghana Government for the future, the fragmentary structure of the aluminium industry in Ghana needs to be outlined to demonstrate the nature of the problem at stake.

Chapter 1.3: The Fragmentary Structure of Ghana's Aluminium Industry

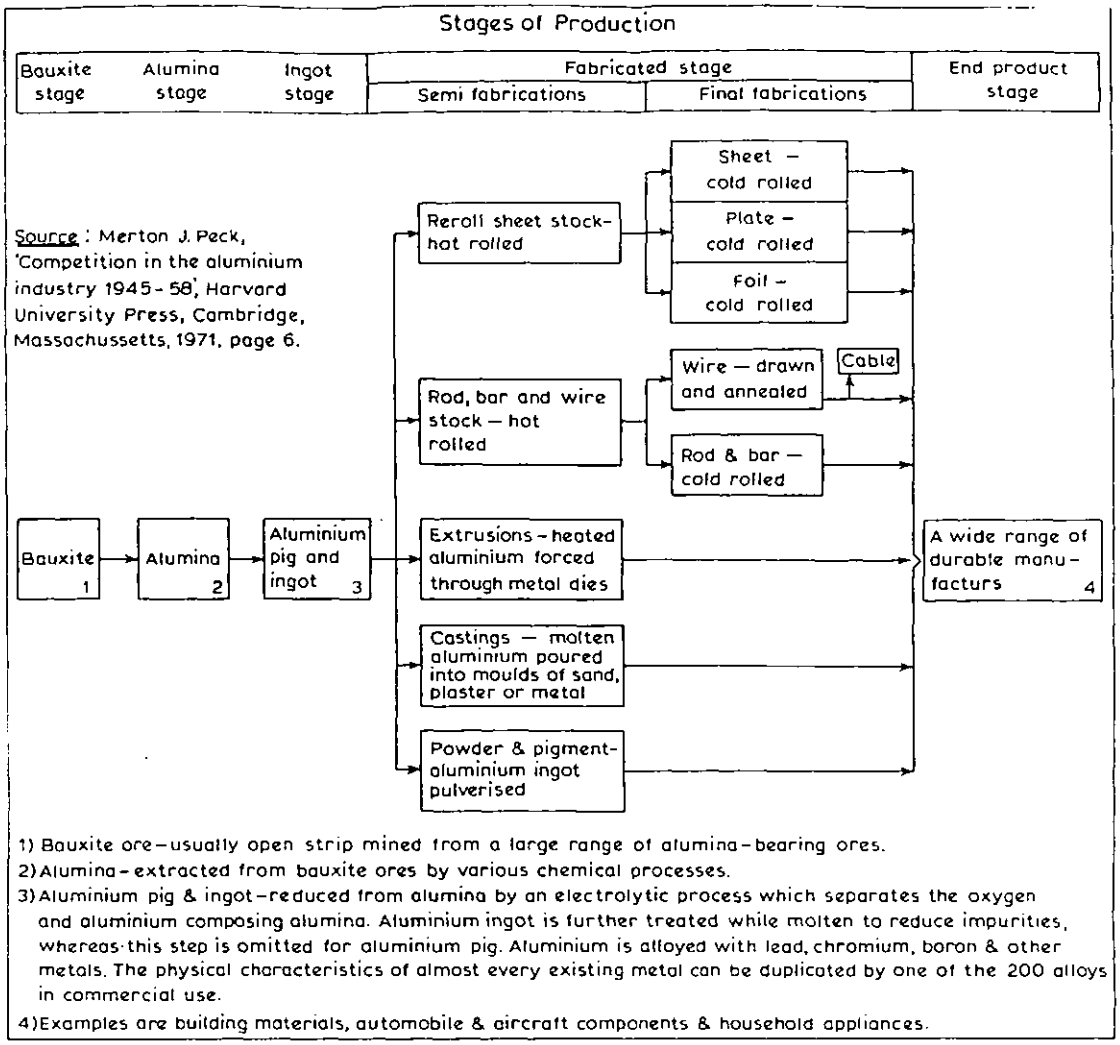
The fragmentation of the aluminium industry is best illustrated by a comparision between Figures 1.3 and 1.4. Figure 1.3 demonstrates that in an integrated production complex, the mining, refining and metal aluminium production are localized.

In Ghana's case, as demonstrated by Figure 1.4, the bauxite which is mined is exported to Scotland. The absence of an alumina plant means that smelting operations depend on imported alumina. And since there is no rolling mill to transform the aluminium metal into slabs and sheets, local fabricators have no alternative but to import all of their requirements of semi-processed aluminium from the overseas subsidiaries of the major aluminium producers.

The Awaso bauxite mine, which was wholly owned by British Aluminium Company (BACO) until 29th October, 1974 when it was partially nationalised by the military government in Ghana at the time, came into being because of the exigencies of the Second World War. The operations continued subsequently as part of the raw materials policy of the United Kingdom Ministry Of Supply until 1950[1].

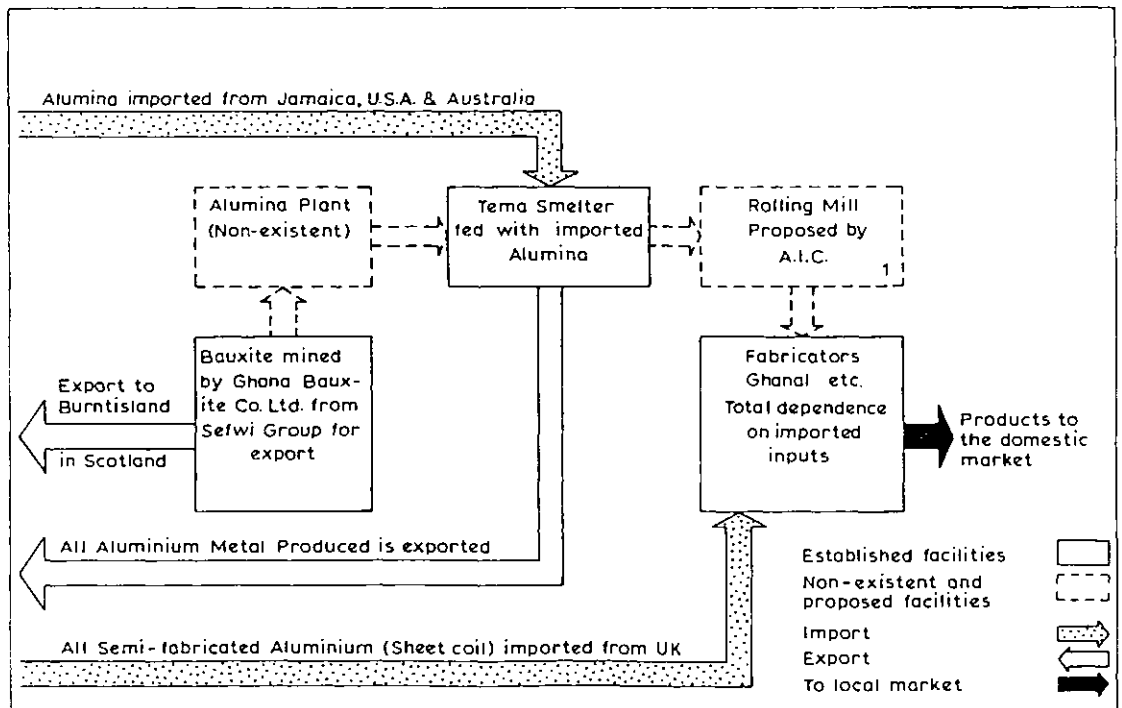
The mining operations at Awaso, then and now, are not in any way linked to any Ghana Government strategy to optimize the benefits derivable from the exploitation of indigenous raw materials. The facts that the mine is now run by Ghana Bauxite Company (Ghana Government 55%; BACO 45%), and that until 1978, BACO was controlled by Reynolds Metals (a junior partner in VALCO) has made no change whatsoever in the role of Awaso. This role remains - the supply of low-cost bauxite to refineries in Scotland.

The installed capacity, however, of Awaso is small - 500,000 tonnes per year. Annual output has been around 300,000 tonnes. Bauxite shipments to the United Kingdom are sometimes lower because of bottlenecks on the Ghanaian railway system (See Appendix A1-4, Columns (a) and (b)).



1) Bauxite ore – usually open strip mined from a large range of alumina-bearing ores.
2) Alumina – extracted from bauxite ores by various chemical processes.
3) Aluminium pig & ingot – reduced from alumina by an electrolytic process which separates the oxygen and aluminium composing alumina. Aluminium ingot is further treated while molten to reduce impurities, whereas this step is omitted for aluminium pig. Aluminium is alloyed with lead, chromium, boron & other metals. The physical characteristics of almost every existing metal can be duplicated by one of the 200 alloys in commercial use.
4) Examples are building materials, automobile & aircraft components & household appliances.

Figure 1·3 The production processes in a totally integrated aluminium industrial complex



1) A consortium of 14 international banks are to lend Ghana $28·6 million to build an aluminium rolling sheet plant at TEMA. The loan, which is guaranteed by SACE (an Italian Credit Agency), is repayable over 8 years at 7·75% per year fixed interest rate — See West Africa No. 3334, 22nd June 1981, page 1438. See 1980 Valco Annual Report. Valco ready to sell this plant aluminium ingots.

Figure 1·4 The fragmented state of Ghana's aluminium industry

The impact of the Awaso mine on the rest of the economy is small. Contribution to export revenues has been estimated to be less than 1% (Appendix A1-4, Column (e)), and employment is less than 500. Other contributions such as freight and wharfage payments are also insignificant. In contrast to the average annual contribution of ¢2.9 million (Appendix A1-4, Column (c)) to Ghana's export income for the 1967-1977 period, the export revenues that would have been obtainable, had the aluminium content of the Awaso bauxite been exported instead, averages out to $38.84 million per year (Appendix A1-5, Column (d)). At the exchange rate of ¢2.75 = US$1.00, the export of the equivalent metal content of Awaso bauxite represents an export income of ¢106.8 million - i.e. 15% of Ghana's average export income/year. Therefore, it should not really matter to the Ghanaian economy if the Awaso operations were to be closed (as recently threatened by the Managing Director of the Ghana Bauxite Company[2]). What would appear to be a mutually good arrangement (and BACO appear not to be opposed to this) is for a long-term contract to be arranged to cover the supply of this bauxite to a proposed refinery if it could be established.

In the absence of a refinery, the second active sector is the 200,000 tonne/year smelter which is located at Tema. The smelter is owned and operated by Volta Aluminium Company (VALCO) in which KAISER owns 90% of the equity holding and the remaining 10% is held by REYNOLDS.

VALCO is a company registered in Ghana to "toll-process" (i.e. convert) alumina which is delivered to it by VALCO's shareholding companies. VALCO's income (which is taxable under Ghanaian law) is derived from the fees which it charges its shareholding companies. The agreements (discussed in Chapter 2) show that these fees are 56-60% of the aluminium sales revenues which are determined from the lower of the published prices in the United Kingdom and the United States.

The supply of alumina is completely divorced from the

registered function of VALCO in the sense that it is the shareholders, under the Long-Term Tolling agreement, who pay for the cost of procuring the alumina and the cost of transporting the alumina to Tema. In addition, the cost of transporting, selling and distributing VALCO-produced aluminium is borne by the parties which supplied the alumina and not VALCO. This distinction is crucial because it affects plans to the integrate production.

VALCO, therefore, pays for the costs of other raw materials, and supplies, spare parts, salaries and wages, power, interest on debts, depreciation and all other expenditures incurred in the "tolling" operations.

The annual energy consumption of VALCO has risen from an initial intake of 1.9 million kilowatt-hours in 1968 to 2.9 billion kilowatt-hours in 1979. VALCO's 1979 energy consumption represents 64% of the total amount energy sold by the Volta River Authority.

Because of the competitive price of the large block of non-interruptible power, together with the range of fiscal inducements enjoyed by VALCO, the operations of the Tema smelter has turned out to be highly successful.

The continuing success of VALCO and the deterioration in the Ghanaian economy have given rise to criticisms of KAISER and REYNOLDS for not integrating their production backwards into mining and refinery. The critics of VALCO tend to play down or even ignore the opportunity cost to Ghana of not having the dam built or financing the construction of the dam entirely from the resources of the Ghanaian exchequer without the long-term external loans which were made possible by KAISER's entry. Such critics tend to see the continued fragmentation of the aluminium industry as a manifestation of the failure of the VRP.

The third active sector of the aluminium industry is the fabrication of rolled aluminium sheet into a host of products in-

cluding roofing sheets, grain storage bins, fish freezing trays, van vodies, pots and pans. The absence of the rolling mill means that even if VALCO agrees to supply the ingot, it cannot be of much use to the fabrication plants which require rolled aluminium sheet instead of ingots.

There are about 8 small fabricators in Ghana. The biggest is Ghana Aluminium Products Ltd. (GHANAL) which is located next door to VALCO's smelter at Tema. GHANAL is owned by ALCAN (60%) and Ghana Government (40%). Operations started in 1959 with the output directed at domestic as well as West African market. On account of the absence of any links with the rest of the industry, these fabricators have simply turned out to be import-substitution industries. GHANAL demands scarce foreign exchange from the Bank of Ghana to cover the import costs for rolled aluminium sheet which is obtained from sources abroad which could very well be part of the international network of operations by ALCAN, KAISER, REYNOLDS and BACO.

Because of the perennial shortage of foreign exchange in Ghana, GHANAL has always had the acute difficulty in purchasing sufficient semi-processed aluminium to keep pace with the company's growing orders. Forward firm orders for GHANAL stood at 10,000 tonnes and yet sales totalled only 1,122 tonnes in 1978[3].

With a price ratio of 1 : 6 : 40-50 : 80-100 for bauxite, alumina, aluminium ingot, and rolled aluminium sheet, it is needless to emphasize that the export of Ghanaian bauxite, the continued importation of alumina, the export of aluminium, and the importation of semi-processed aluminium, together represents an effective economic loss.

When GHANAL's sales (Appendix A1-6) are compared to VALCO's output of aluminium (Appendix A4-3, column (b)), it becomes apparent that GHANAL's sales are just 1.6% of VALCO's output. The existence of a rolling mill to process part of VALCO's output will enable

GHANAL to operate more consistently, at a higher capacity levels and at less cost.

In recognition of this need, the Ghana Government recently negotiated a syndicated loan valued at $28.6 million at a fixed rate of interest of 7.75% and repayable in 8.5 years to help establish the semi-fabrication plant.[4] For this development, KAISER has agreed to sell 500 tonnes/year of VALCO-produced aluminium in quarterly lots of 125 tonnes and, in addition, has acquired about 1% of the equity in ALUWORKS Limited (See VALCO Annual Report for 1981). To acquire the 1% shareholding, VALCO invested $91,000 for 2,500 shares. VALCO's new commitments to support the plans of the Ghana Government is a noteworthy development.

Form the foregoing, it would appear obvious that the establishment of a mine-to-metal complex would be highly advantageous to Ghana. What is, however, not at all obvious is that the major producers, who on account of the wishes of their shareholders, are primarily concerned with private cost-benefit considerations would find the entire scheme favourable to promote. Several reasons account for such hesitation. Some of the reasons are: the cost of the project and the perceived risk; the marketability of the output at profitable price levels during the anticipated life for the project; the sufficiency of their existing productive capacity for bauxite and alumina in other parts of the world in meeting the requirements of their smelters; the marginal cost of additional capacity - given the uncertainty about the growth in aluminium demand; the size of the domestic and regional markets and the convertibility of their earnings, should the companies decide to operate in the West African market; and finally, the probable loss of existing tax advantages as negotiated in 1962.

Even if the aluminium producers were to express interest in the scheme to integrate the Ghanaian aluminium industry backwards, the ensuing negotiations and bargaining would be long, hard and complicated.

Chapter 1.4 attempts to outline the long, tortuous and complex trail of events that led to the 1962 agreements and the fragmentation of the aluminium industry. Its purpose is two-fold. First, it will show that the Ghanaian Government at the time saw it as the best and fairest compromise possible between the developmental aims of the Government and the objectives of the aluminium producers. Secondly, the disquiet over the role of VALCO's owners (KAISER and REYNOLDS) in Ghana can be seen in the proper perspective.

Chapter 1.4: Circumstances Leading Up To The 1962 Agreements

The disquiet over the continued fragmentation of the industry necessitate a brief look at the tortuous history of the VRP. By examining the history of the VRP - right from the embryonic stages in the 1920's to the eventual signing of the Master Agreement and its Scheduled Documents in 1962 - the difficulties that will always dog such large development schemes will become apparent. The main problem was to attract a consortium of major producers from abroad. Entry terms had to be negotiated on the basis that: the host country could offer access to low-cost raw materials and other inputs as well as a favourable tax regime and a free hand to operate. In exchange for these concessions, the host country sought the inflow of investible capital, expertise, managerial know-how and, an in addition, receipts of resource rents and a stimulus for overall economic growth. Since some of the host country development objectives are incompatible with some of the goals of the major companies, a compromise had to be reached in order for the project to be launched.

The GHANA/VALCO agreements of 1962 represent, in microcosm, such a compromise - reached after a long and frustrating search for partners. With a government which was known to be over-anxious to press ahead with the VRP and one whose initial and fall-back position were known well in advance, it is not surprising that substantial concessions had to be yielded (Chapter 2).

The period covered is inextricably linked to the four distinct politico-economic phases in Ghana's history: the pre-independence era (i.e. the period up to 1951); the dyarchy (1951-1957); the Nkrumah era (1957-1966); and the post-Nkrumah era (i.e. 1966 onwards). Transpiring from the discussion of the events which occurred in these eras will be the fact that the direction of investible capital flows in the world aluminium industry is, to a large extent, determined by political rather than purely economic considerations.[1] Therefore, the success of the present efforts depends very much on Ghana's ability to cultivate the right political image.

The idea of integrated aluminium production in Ghana is, itself, not new. The discovery of Bauxite deposits at Mount Ejuanema (Mpraeso) in 1914, followed shortly in 1915 by the recognition of the hydro-electric potential of the Volta River, marked the genesis of the scheme. Credit for the almost simultaneous discovery goes to Sir Albert Kitson - the Director of the Gold Coast Geological Survey at the time. Kitson presented a paper on the subject to the First World Power Conference in 1924[2], and subsequently in the Bulletin of the Gold Coast Geological Survey in 1925. Kitson was not particularly explicit in these papers about the use of hydro-electricity from the Volta for the specific purpose of processing local bauxite into aluminium for export.

However, the public airing of these potentialities brought in the South African speculator - Duncan Rose. Before the endeavours of Rose began, British Aluminium Company (BACO) had acquired in 1928 the Sefwi Group concessions. At the outbreak of the War, BACO started open cast mining at Awaso as 'agents' for the United Kingdom Ministry of Supply. This arrangement continued until 1950[3]. The aims of the Ministry of Supply then were two-fold. They were to meet wartime demand and to cater for general industry's requirements from sterling area sources.[4]

Rose enlisted the services of another South African engineer - C. St. John Bird - to carry out a number of technical investigations. Rose encountered a number of difficulties in getting his scheme off the ground. Not least of his problems were the demands of the traditional chiefs for higher compensations and the lukewarm attitude of the colonial administration. However, in spite of these initial problems, Rose managed to enlist the support of BACO and United Africa Company (a subsidiary of Unilever) in the formation of a new company called West African Aluminium Limited (WAFAL). After previous failures to interest BACO, it would appear that success this time was due to a number of possible factors. First, since aluminium has been a growth industry, BACO could have enhanced its financial position through the operations of the consortium. With

BACO and Unilever involved, the colonial administration was likely to be more favourably inclined towards such an investment, and as a result, could have secured far more beneficial terms of entry such as, low power rate, concessions on rail freight and port charges and low taxes.[5] Second, it is also possible that, within such a framework, BACO could have enhanced its own financial position to meet the growing challenge of the powerful American producers. And thirdly, since Rose held the rights to some of the important deposits, it would appear that this joint effort might have opened up the deposits to which he held concessions to the whole group.

In spite of the collaboration in the formation of WAFAL, the rivallry between Rose and BACO apparently continued. Consequently, Rose sought links with ALCAN which led to ALCAN's purchase of 25% of the WAFAL shares in 1949.

At this point, the political agitation for independence had begun with the riots of 1948. Politicians of all parties were beginning to express publicly the view that the private enterprise-oriented proposals required to be investigated thoroughly and, if necessary, modified to protect the national interest. Sir William Halcrow and his Partners were therefore commissioned in 1949 to carry out a thorough investigation of the development of the entire Volta Basin before any water rights were issued to any private investor. Their report was published in August 1951 - six months after Dr. Kwame Nkrumah's Convention Peoples Party (CPP) had been invited by the authorities in the United Kingdom to form a transitional government to administer partially the affairs of the Gold Coast (later Ghana).

This was the beginning of the dyarchy and it was notable for the specific manifesto commitment of the CPP to endeavour to implement the Volta River Project. Before the transitional government of the CPP was the Halcrow report which recommended a dam at Ajena with a capacity of 564 megawatts and a mine-to-metal complex.[6]

It was now obvious that the dyarchy (beginning in February

1951) had introduced an entirely new dimension. The project was no longer an affair for the private investor. The new government had not only embraced it but made it one of their principal manifesto commitments. These developments, needless to say, paved the way for the demise of WAFAL as a significant force in the politics of aluminium development in Ghana.

Following Halcrow's report, the U.K. Government also publicly stated its interest in the project, but the commencement of the actual project development was to be subject to the findings of a yet-to-be appointed Preparatory Commission.[7]

The Preparatory Commission was established in May 1953 and it published its report in January 1956 - just 14 months before Ghana became independent.

The issues dealt with by the Preparatory Commission included: the power project; mine/refinery/smelter complex; and the social, economic and health problems that the various sub-projects of the scheme would have on the riparian communities. By the estimates of the Preparatory Commission, the project was "economically and technically sound" and total costs were to reach £231.3 million as compared to £144 million of the U.K. 1952 White Paper estimate (See Appendix A1-7).

The report of the Preparatory Commission came in for some very sharp criticism from some quarters. Balogh, for example, is reported to have criticised the report on four specific points.[8] First, it was faulted for paying insufficient attention to the potential conflicts of interest between the Government of Ghana, on the one hand, and those of private enterprise participants, on the other. Second, the Commission was accused of not being sufficiently discreet about the importance attached to the project in Ghana's developmental plans and the extent to which the Government of Ghana wanted to grant concessions to facilitate the realization of the scheme. Thirdly, the Commission failed, in Balogh's view, to

enquire into the justification for the allocation of 91%[9] of the power output to the proposed aluminium industry and whether the importation of alumina should be permitted. And, finally, the scheme, as considered by the Preparatory Commission, would have a minimal impact on employment in Ghana. Therefore, Balogh concluded:

> "From the point of view of the Gold Coast, the failure of the Preparatory Commission to take these possibilities into account not merely reduces the value of its work considerably but creates a situation of artificial strength for the companies in their bargaining".[10]

Even at this stage, it had become apparent that the Preparatory Commission's estimates were pessimistic. Not unnaturally, negotiations which began between the colonial administration, ALCAN and BACO during this period failed to yield substantive results. ALCAN, for example, stiffened its demands to include a very low initial power rate of 2.5 mills per kilowatt-hour (a mill is the unit used to calculate electricity payments and it is equivalent to US$0.001). Moxon even reports that ALCAN expected this power rate to be lowered in succeeding years. The UK Government also started hedging on its earlier plans outlined in the 1952 Government White Paper. Reasons - the overcapacity in the industry, the easing of the dollar problems and the uncertainties and the turbulent politics in Africa. Ghana was also to accept, ab initio, a non-integrated production complex to forestall the possibility of future nationalization. Also, Ghana was to have no equity in the investment. The change in attitudes towards the project put the scheme on ice.

So the ending of the eras of direct UK rule and the transitional phase to independence were marked by the lack of any real achievement except a number of reports on the various intermittent examinations of the scheme - all of them reporting favourably on the scheme. The only investment that had materialized was that at Awaso

mines by BACO. Even here, the investment was the result of the exigencies of the Second World War and the subsequent raw materials policy of the colonial administration and not as part of the overall scheme. In effect, the closure of the colonial chapter meant that the now moribund Volta River Project could be revived only on the attainment of independence when new initiatives could be taken.

By the time Ghana became independent on 6th March, 1957, the implementation of the Volta River Scheme had become a special dream of Nkrumah who saw the project as the cornerstone of his strategy of high-speed industrialization. In Nkrumah's view, self-sustaining and rapid growth was achievable only by the establishment of heavy and high-technology industries and, in Ghana's case, the logical starting point was the aluminium scheme.

It is topical to point out that, when faced with the usual problems of capital mobilization for such development projects, Nkrumah, who in his jaundiced view of Western capitalism had once remarked that "capitalism is too complicated a system for a newly independent nation",[12] became convinced that his strategy of high-speed industrialization of Ghana could succeed only if Western capital and expertise were attracted. In this context, it is not surprising that Edgar Kaiser was able to say that "Nkrumah and I achieved good rapport, but it wasn't so much the cut of my hair he liked. He liked our money".[13]

Of all the difficulties that dogged Ghana's attempts to obtain Western finance and expertise, a very trivial incident may have marked both the watershed in the long trail and the genesis of Ghana's aluminium industry in its present form. Nkrumah's Finance Minister, K.A. Gbedemah, on a visit to the United States in October 1958, stopped at a restaurant in Delaware. His request for a glass of orange juice was turned down on the grounds that he was coloured. The ensuing publicity to this embarrassing experience led to an invitation from President Eisenhower for breakfast. The breakfast was also attended by Vice-President Nixon who later visited Ghana.

It was at this meeting that President Eisenhower, who had heard of the Volta River Project for the first time offered to help - a promise later taken up by President Kennedy.[14]

Following this, Nkrumah visited the U.S. in July 1958 to pursue the pledges further. On this trip, Nkrumah met Edgar Kaiser (President of KAISER Industries, Inc.). The initial intention of Kaiser was to secure contracts for his engineering division. However, Edgar Kaiser became more involved in the scheme to the extent that he was commissioned by the Ghana Government to carry out a re-appraisal of the entire project. The re-appraisal report, which was published in February 1959, significantly concluded that:

> "There are ample reserves of acceptable quality bauxite to support a substantial aluminium industry in Ghana".[15]

It was added that: "Because of the massive reserves of bauxite in Ghana, in relation to the proposed aluminium plant capacity and estimated electric power availability, it is suggested that the aluminium producer should examine the feasibility of building additional alumina capacity for sale and export".[16] More significantly, KAISER's re-appraisal confirmed that "such a scheme would be technically feasible and enable Ghana to compete with other low-cost producers"[17].

KAISER took the view that the project should be implemented in 4 phases. The main conclusions are in Table 1-10 below.

If a comparison is made between KAISER's findings and those of the Preparatory Commission, significant differences become apparent. First, by proposing that the dam be sited at Akosombo instead of Ajena, the KAISER option was going to reduce the construction time by up to 4 years. Moreover, under the KAISER plan, a total power of 896 megawatts were producible from Akosombo and Kpong (20 miles downstream from Akosombo) at a total power project cost of £85.7 million (1959), whereas, the Ajena proposal of the Preparatory Commission was going to yield only 564 megawatts at a cost of £67.6 million (1955)

TABLE 1-10: KAISER's Programme For The Development of the VRP And Cost Estimates (February 1959)

	◄----------PHASE----------►			
	(1) Akosombo 4 generators and Transmission	(2) Akosombo 6 generators	(3) Kpong (20 miles downstream from Akosombo	(4) Bui
Hydro-electric capacity (Megawatts)	512	768	896	1086
Aluminium capacity tonnes per year	120	120	220	220
COST ESTIMATES (£ millions)				
Hydro	48.7	55.7	71.2	96.7
Transmission	13.3	13.3	14.5	16.1
Aluminium	56.7	56.7	97.9	97.9
Railroad	2.5	2.5	3.4	3.4
TOTAL COST	121.2	128.2	187.0	214.1

Source: Hart, op. cit., p.26.

(See Appendix A1-7 for the comparison). In effect, KAISER offered more power at less cost.

However, a major drawback of the KAISER proposals for the VRP (played down at the time) was that, whereas the recommendations of the Preparatory Commission were comprehensive, KAISER's plans were notable for the postponement of the refinery project. The KAISER plan also omitted the irrigated farming scheme. It also separated the lake transport and lake fishing aspects to be developed later.

The acceptance of these apparently innocuous provisos probably marked the genesis of today's fragmentary character of the industry.

In the meantime, Ghana's balance of payments was deteriorating

rapidly. Deficits which began in 1959 onwards started increasing. The politico-economic pressures on the government mounted. Increasingly, there was a need to provide tangible benefits conceived by many Ghanaians to be inherent in a scheme. For a scheme which had been promoted with so much vigour, the public disappointment and its political price would have been immense, had the project not come off the ground. The Government's bargaining position could certainly not be enhanced under such a self-inflicted straight-jacket. As a mark of desperation at the time, Nkrumah is even reported to have told his negotiating team to "negotiate the best terms possible, but there must be terms".[18]

For the next 18 months, following the publication of the KAISER re-appraisal report in March 1959, the government undertook very tough bargaining with the financiers and the aluminium producers. The efforts to mobilise capital for the power project as well as the formation of a consortium to operate the aluminium project were simultaneous.

Partly because of the overcapacity in the industry at the time and partly because of perceived uncertainties of the politics in Africa, a number of potential participants from the international aluminium industry withdrew from the VRP. ALCAN withdrew in 1960 pleading excess capacity and the completion of a new reduction process which was expected to bring about changes in traditional production practices.[19] Olin Mathieson withdrew in 1961 on the grounds that it had adequate bauxite/alumina investments in neighbouring Guinea. So that, in the end, KAISER, who had planned to have no more than 50% of the equity in the smelter project, ended up having 90% and leaving Reynolds the remaining 10%.

There is no doubt that, without the commitment of Edgar Kaiser to establish and operate the Tema smelter and to use over half of the electrical energy generated, the project could not have received the support of the U.S. Government, the World Bank, and the British Government. This issue is fundamental and needs to be

recognised by present day critics of the role of VALCO's owners.

However, it is also fair to point out that, in view of the lingering doubts of investing in Ghana, KAISER and REYNOLDS decided to press ahead with the investment for three reasons. First, it was going to be implemented at little cost to themselves. Second, the concessions obtainable from the Ghanaian Government, which was over-anxious to implement the project were going to be very favourable. Thirdly, apart from market risks, all other risks were to be borne by the U.S. and Ghanaian Governments.

An examination of the schematic presentation of the inter-relationship of the agreements which were executed in 1962 bears this out (See Figure 1.5). For the $128 million smelter, the equity of KAISER and REYNOLDS amounted to $12 million, while pre-payments to VALCO amounted to $20 million - thus bringing the cash outlay of the two companies to $32 million. The remaining $96 million came from loans made by the Export-Import Bank. The total investment was guaranteed by the U.S. Government. For the Kaiser-built power project, Ghana paid 50% of the cost (i.e. $98 million) from its own resources. The remaining $98 million came as loans from U.S. Government, the World Bank, and the U.K. Government. These comprised of: Export-Import Bank loans for equipment ($10 million), Agency for International Development ($27 million), World Bank loans ($47 million) and British Government export guarantees of $14 million.

Apart from an initial outlay of $98 million (50% of the cost of the dam), there is the fact that these loans amounting to $98 million have to be repaid by the Ghana Government, which had already financed the necessary supportive infrastructure including the Tema harbour (£35 million), access roads and townships. Some might therefore find it logical to ask why Ghana's Government did not finance the power project entirely from its own resources. After all, Commander Jackson of the Preparatory Commission took the view that "if the worst came to the worst, Ghana could just

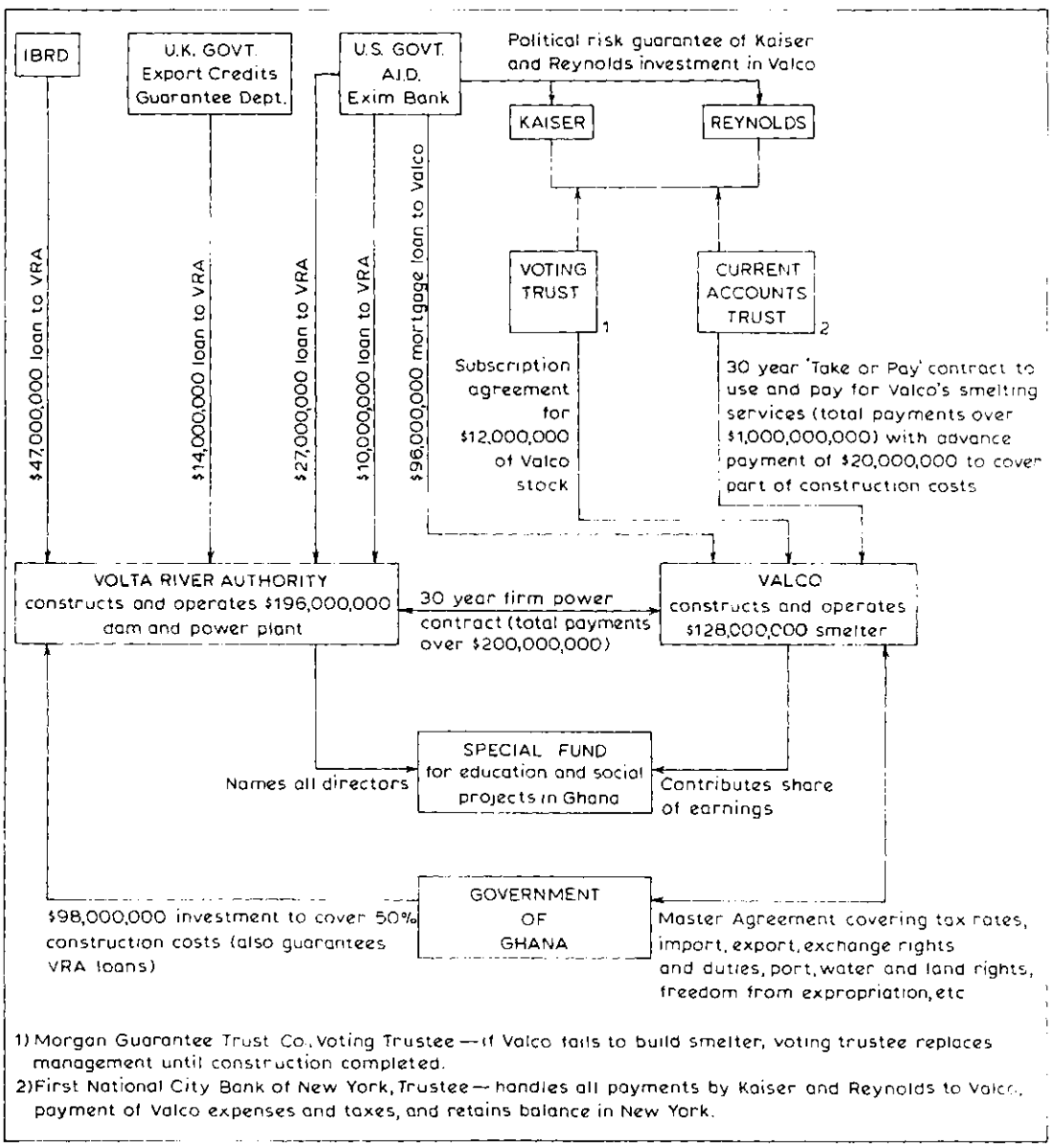


Figure 1·5 Schematic Diagram of Principal Agreements Executed Feb. 8th, 1962

Source : Commander Sir Robert Jackson, "The Volta River Project", Progress (Unilever)

afford to pay for it from the Government's resources".[20] A decision to self-finance the power project could have been facilitated very easily by using the foreign exchange reserves which stood at $800 million in 1957 and by curtailing some of the ambitious, state-owned projects - many of which turned out to be ill-thought out and unsuccessful. The problem was that the simultaneous pursuit of all these high-cost, and publicly-owned industrial and social projects inevitably led to severe strains on the country's financial position, the stifling of private productive enterprise, and overall deterioration of the political situation. Had a step by step approach been adopted and the power project financed wholly from internal sources, it is possible that Ghana could have negotiated from a stronger position. As Forbes describes it, Kaiser "succeeded in wringing out the necessary agreements".[21]

Even having decided that external borrowing was essential to the successful implementation of the scheme, there were a number of remarkable signs of undue precipitateness on the part of the Ghana Government at the time. To have authorised the developments of the highway from Tema to Akosombo (the dam site) in 1959; hotel facilities in Accra to cater for the expected influx of foreign technicians; the construction of residential accommodation at the dam site for engineers and workers, and to crown all this, the award of the contract to the Italian firm, Impregilo, to start constructing the dam - even before loans of U.S. origin had been approved - represents "a supreme act of faith",[22] as Jackson puts it.

It is significant that President Kennedy "held back approval of the loans until a few hours before the deadline when the Ghana Government could no longer back out on a contract with the Italian consortium, Impregilo, which will build Akosombo dam".[23] These loans were totalling $133 million (£47.5 million) and were to be released in stages "so that the U.S. can still back out if the project takes a turn for the worst".[24]

Having released the loan funds, the Master Agreement was

signed formally in Accra in January 1962 and the power project was inaugurated. In December 1964, construction of the VALCO smelter at Tema began. The power project was completed ahead of schedule and within cost estimates. In September 1965, commercially produced hydro-electricity was formally switched on. The coming on-stream of the smelter project in 1967 marks the end of the long history. Appendix A1-8 is a summary of the key dates in the history of the Volta River Project.

Two attempts by KAISER since then to reassess the feasibility of a refinery to complete the project as originally conceived have returned negative findings. The implication is that alumina of Ghanaian origin is uneconomic. However, the Hungarian firm of ALUTERV-FKI returned positive findings in 1977.

In the light of the conclusions of the 1959 KAISER Re-appraisal report, the positive conclusions of ALUTERV-FKI of Hungary (1977), and the apparently obvious justification of a mine-to-metal complex from a social-cost-benefit perspective, one may consider the negative conclusions of the 1966 and 1975 KAISER-led studies with suspicion. As such, the critics of the status quo would appear to have a highly defensible case for pressing ahead with the integration of the aluminium industry in Ghana.

However, given the precipitate handling of Ghana's entire political, economic and social affairs by successive governments and the damaging consequences of this mismanagement, there is a very good case for the detailed examination of the contentious problem of fragmentation. The various relevant factors which have to be taken into account in the formulation of Government policy towards the aluminium industry include: the implications of the 1962 agreements which justified and made possible the implementation of the VRP even in its present form (Chapter 2); the modus operandi of the international aluminium industry; market factors and marginal cost considerations (Chapter 3); and what is at stake both for Ghana and VALCO's owners.

A careful analysis of the problem from the perspectives of the producers is also necessary because their support is vital and indispensable. By this approach, it will become apparent that the continued fragmentation of the aluminium industry is neither explicable by simplistic reasons such as imperialism and multi-national intrigues, nor is its elimination necessarily the best policy goal whose achievement would generate the much needed wealth in Ghana.

To find out why VALCO's owners find the additional investments in the bauxite-to-alumina complex unattractive, it is necessary to review the 1962 agreements which provides the guidelines for VALCO's operations. This would prepare the way for formulating alternative policies for the Ghana Government.

CHAPTER 2: THE GHANA/KAISER-REYNOLDS AGREEMENTS OF 1962 - What they mean for integration

Chapter 2.1 Overview

The reluctance of VALCO's owners to integrate their smelting operations in Ghana backwards into mining and refining cannot simplistically be explained in terms of multi-national company exploitation as some have suggested.[1] The rationale behind the hesitation of aluminium producers is economic and political uncertainty. For Ghana to evolve an effective strategy in its relationship with the primary aluminium producers, it must try to understand the sources and nature of the uncertainty and try to establish the consequences for the various policy options.

The logical starting point is the assessment of the 1962 agreements. An assessment of the concessions and assurances which were traded provides an initial understanding of some of the constraints which hinder backward integration. Given these constraints, it would be clearly unwise for Ghana to resort to ill-considered and precipitately executed actions such as the partial nationalisations of the timber and mining firms in the early 70's.

Also, the examination of the terms of the agreement will establish the guidelines under which VALCO operates in Ghana and, in particular, what would be financially at stake for VALCO's owners if they were to countenance uncontrolled changes in the status quo. By approaching the problems of fragmentation from this starting point, it will also be possible to demonstrate the mutual dependency of the Ghana/VALCO relationship. Hence, in spite of the frustration engendered by the continued fragmentation, Ghana needs to avoid policy options which are not thoroughly thought through and those that are based on circumstantial evidence.

It was obvious after making the VRP the cornerstone of Ghana's development strategy that the success of the entire project very much depended on Ghana's ability not only to entice a consortium of the major aluminium producers to participate in the scheme but also to

live in symbiosis with them. Towards this end, the government embarked on a long and complex series of negotiations which culminated in the set of agreements which were executed on 8th February, 1962 between the Ghana Government (on one hand) and the KAISER-REYNOLDS Consortium (on the other).

The various agreements included:

(i) The Ghana Government and its foreign creditors;
(ii) VALCO and its owners - i.e. the Long Term Tolling Agreement;
(iii) VRA and VALCO - the Power Contract;
(iv) VALCO and its creditors;
(v) Ghana Government and VALCO - i.e. the Master Agreement.

Central to the case being argued is the Master Agreement. Appended to the Master Agreement are 8 schedules:

(i) Schedule A - The Scheduled Documents;
(ii) Schedule B - The Income Tax Ordinance;
(iii) Schedule C - The Power Contract;
(iv) Schedule D - The Smelter Site Lease;
(v) Schedule E - The Water Agreement;
(vi) Schedule F - The Port Agreement;
(vii) Schedule G - The Immigration Quota;
(viii) Schedule H - The Currency Agreement

The Master Agreement itself and the Power Contract are the subject of Chapter 2.

The Master Agreement and the Power Contract is examined on the basis that the following four questions can be answered. First, to what extent do the agreements "freeze",[2] using Girvan's terminology, the relationship between the Ghana Government and the KAISER-REYNOLDS consortium to the situation in 1962 when the agreements were signed? Second, to what extent do the agreements forcibly sustain Ghana's dependence on the KAISER-REYNOLDS consortium for any further developments of the aluminium industry? And third, to what extent do the agreements enable the direct financial benefits of the VRP to be assessed and thereby enable the establishment of what

is financially at stake for either party in the event of changes in the status quo? And fourthly, to what extent do the agreements paradoxically provide the means, the justification, and the obstacles to the establishment of a bauxite-to-alumina complex to complete the integration of the industry?

The main point in the agreement was that, VALCO's owners gave an assurance that, for each year after 1972, they would pay to the VRA the dollar value of 300,000 kilowatts of power - whether or not the company utilized this power in its "tolling" operations. It was a very significant concession because it ensures that Ghana is guaranteed adequate funds to service the Akosombo and Kpong debts as well as provide a fair return irrespective of what happens to VALCO-produced aluminium in the world market.

The Ghana Government, for its part, granted VALCO exclusive access to a large block of non-interruptible power (i.e. a power ceiling of 415,000 kilowatts). In addition, the company was granted: access to Ghana's bauxite resources and domestic capital markets; preferential and stabilized power price; exemptions from all indirect taxes such as customs duties on imports and export duties; a 5-10 year tax holiday; a stabilized tax rate of 40% (i.e. the rate in force in 1961) after the expiration of the tax holiday; and exemptions from foreign exchange control obligations. The company was also granted a free hand to conduct its operations.

The agreement was negotiated for 30 years at the end of which, at VALCO's option, it could be extended for a further 20 years.

In the event of a dispute which could not be settled amicably, the services of the International Chamber of Commerce were to be sought in arbitration.

It transpires then that, unless there is a mutual desire to re-negotiate aspects of the agreement, the relationship is "frozen"

for 30-50 years - effective from 25th April, 1967. Further, since the agreements do not explicitly link any of these concessions to a pre-determined timetable for the development of Ghanaian sources of alumina, or indeed, its utilization by the Tema plant, VALCO's owners are in no way obligated to integrate their smelting operations backwards into mining and refining. Also, on account of the non-discriminatory and most-favoured-company provisions, Ghana is effectively without an easy alternative but to depend on KAISER and REYNOLDS for the further development of the aluminium industry. Finally, the provisions dealing with VALCO's financial liabilities show that the appropriation of the direct financial benefits which have resulted from VALCO's "tolling" operations is not zero-sum, as critics have sought to imply. However, as the discussions in Chapter 2.2 enables it to be argued in Chapter 5.2, the appropriation of the direct financial results have been weighted in favour of KAISER and REYNOLDS.

These observations, together with others discussed in Chapter 3, necessitate a policy based on co-operation rather than one which will lead to confrontation.

Not least of the reasons for advocating co-operation between the Ghana Government and VALCO's owners are the paradoxes of the agreements. First, in spite of the substantial profits made in recent years by VALCO's owners, the company's guarantees on certain minimum dollar payments for power (which it may or may not use) in addition to its other fiscal liabilities mean that even if the status quo were to remain "frozen" Ghana would still be assured enough dollar income to finance some of the alternative strategies recommended in Chapter 6.1.

The second paradox is that Article 17 has enabled VALCO's owners to limit the proportion of the turnover assignable to VALCO as its taxable income under Ghana's tax laws to only 56%-60%. Yet, the same Article 17 and Article 18 can be applied to show that, on the basis of the 1975 BASCOL estimates, the 600,000 tonne bauxite-to-alumina plant is profitable (See Chapter 4).

Chapter 2.2: The Terms of the Master Agreement And The Power Contract

VALCO's 1979 Annual Report accurately points out that:

> "VALCO and the Akosombo dam grew out of a basic mutual dependency. Without an aluminium smelter as the major consumer of electricity, the dam and hydroelectric plant would not have been economically feasible. Without the assurance of sufficient and competitively priced power, the aluminium smelter could not have been built".

In a nutshell, this observation provides the rationale and framework within which both the Ghana Government and the KAISER-REYNOLDS consortium traded those concessions embodied in the 1962 agreements.

At the outset, the Master Agreement explicitly recognised the aims of the Ghana Government as being the "diversification of the national economy" and to "increase the opportunities available to the people of Ghana for employment in the industry." Concessions were therefore traded against a background of mutual dependency. In effect, the agreements reflect the compromise reached by both parties and considered fair at the time.

For its part, VALCO gave, under Article 13 of the Power Contract, the vital and significant assurance that it would pay for certain pre-determined blocks of hydroelectric energy - whether or not the company utilized this energy in its smelting operations. VALCO accepted the obligation to pay, in U.S. dollars, the following minimum amounts to the VRA irrespective of its power requirements:

(i) Year beginning the Permanent Delivery Date (PDD) - established as 25th April, 1967 .....66,000kw x 365 days x 24 hours x power price

(ii) Year beginning the First anniversary of PDD.....167,000kw x 365 days x 24 hours x power price

(iii) Each of the years beginning respectively on the second, third and fourth anniversaries of the PDD ..... 200,000kw x 365 days x 24 hours x power price

(iv) Year beginning the fifth anniversary of the PDD ..... 267,000kw x 365 days x 24 hours x power price

(v) Each year thereafter ..... 300,000kw x 365 days x 24 hours x power price

The power price has been re-negotiated several times since the original document was signed. VALCO's agreement to improve the power price had to be seen against the fact that in 1962, the agreements provided that the power price should be stabilized at 2.625 U.S. mills/kilowatt-hour for a thirty year period after which VALCO's owners had the option to have it extended for a further twenty years.

A summary of the increases in the power prices which have been re-negotiated over the years with VALCO is tabulated as follows:

(i) Prior to October 25th, 1972 - U.S. 2.625 mills/kilowatt-hour

(ii) From October 25th, 1972 through February 28th, 1973 - U.S. 2.75 mills/kilowatt-hour

(iii) From March 1st, 1973 through December 31st, 1975 - U.S. 3.25 mills/kilowatt-hour

(iv) For 1976, 1977 and 1978 - U.S. 3.5 mills/kilowatt-hour

(v) For 1979 - U.S. 4.6 mills/kilowatt-hour

(vi) For 1980 - U.S. 4.75 mills/kilowatt-hour

(vii) For 1981 and each year thereafter - U.S. 5.0 mills/kilowatt-hour

(viii) From 1976 onwards, for each kilowatt-hour taken and utilized by VALCO in excess of (370,000 x 365 x 24), then power rate applicable is 6.75 mills/kilowatt-hour.

(ix) An adjustment clause has been included which takes account of increases in labour and equipment costs and currency variations.

(x) For energy taken and utilized in excess of (370,000 x 365 x 24) kilowatt-hours, after Kpong has come on stream, a special formula has been negotiated to adjust the tariffs.

As of the moment, the dollar payment which VALCO is obligated to make to the VRA is the charge applicable to 95% of its maximum power demand (in kilowatts) utilized continuously for (365 x 24) hours each year.

In 1979, VALCO used 2.9×10^9 kilowatt-hours of the total amount of 4.6×10^9 kilowatt-hours of energy generated by the VRA.[1] At this level, VALCO consumed about 63% of the hydro-electricity generated. Yet, the company provides about 190% of the foreign exchange requirements to service the Akosombo debts incurred by the VRA.[2]

The Ghana Government, for its part, granted a number of concessions. These included VALCO's access to large blocks of non-interruptible power and bauxite (if the company required it), preferential power price, exemptions from import and export duties, exemptions from foreign exchange control regulations and tax advantages.

The rights of VALCO to the hydro-electric power generated from the Akosombo powerhouse were set out in Article 5 of the Power Contract. Under Article 5A (i) of the Power Contract, the VRA is obligated to supply VALCO with pre-determined blocks of non-interruptible power in accordance with a pre-determined timetable. The maximum power levels which VALCO is entitled to demand were defined as the "Power Ceilings". The reference date was established as 25th April, 1967 and it was defined as the "Permanent Delivery Date"(PDD).

The schedule is as follows:

		Power Ceiling
(i)	From the P.D.D.	: 158,000 kilowatts
(ii)	From the first anniversary of the P.D.D.	: 210,000 kilowatts
(iii)	From the second anniversary of the P.D.D.	: 315,000 kilowatts
(iv)	From the third anniversary of the P.D.D.	: 400,000 kilowatts

In addition to the supply of non-interruptible power, VALCO is guaranteed under Article 5A(ii) of the Power Contract a further supply of 15,000 kilowatts of interruptible power if, from 1st January, 1977 onwards, VALCO, at any time, gives a 24 hour notice that it requires this extra power. This clause raises the potential power demand of VALCO to 415,000 kilowatts. Before the commissioning of Kpong power project, the VRA was in a position to guarantee a total of 750,000 kilowatts to the entire economy. It is therefore a very significant concession that VALCO, as a single company, should have the first call on 53% of the total guaranteeable power available to the entire economy.

VALCO's access to the Volta hydro-electricity is exclusive. Article 5A(iii) of the power contract says that until VALCO has raised its power ceiling to 415,000 kilowatts, the VRA (hence the Ghana Government) cannot supply non-interruptible power to any other industrial user without "promptly" notifying VALCO of the quantity of power and the price involved in the sale. Under these circumstances, VALCO can exercise, within thirty days, its right to increase its own demand for power by the amount proposed in the sale.

In order to ensure the protection of VALCO's exclusive access to Volta power, Article 9(i) of the Master Agreement provides that:

> "The Government agrees for the period commencing with the date of this agreement and ending on the thirtieth anniversary of the Permanent Delivery Date that the governing body of the Authority shall include a member nominated by VALCO;"

VALCO's nominee to the governing board of the VRA is usually their Managing Director.

Besides, Article 25 of the Power Contract recognises VALCO as the 'most favoured commercial purchaser' of the power sold by the VRA. This provision stipulates that:

> "If the Authority (i.e. VRA) agrees to sell to any single commercial or industrial user, and not for any public service, Power or Energy from the Volta Development in an amount greater than 100,000 kilowatts or greater than (100,000 x 8760) kilowatt-hours per year and not being Power or Energy made available at a time of day or night when other takers could not be found to take and utilize it, and a lesser rate is stipulated therefore than the Contract Rate (i.e. the power rate applicable to VALCO's off-take of energy), then the Contract Rate shall as of the date of the agreement be reduced to the said rate stipulated for that Power or Energy ....."

The combined effect of Articles 5A (iii) and 25 are twofold. First, Ghana cannot sell any sizeable quantity of power to any other investor without advising VALCO of the amount and cost of supply. VALCO can then stymie the transaction by itself asking for its Power Ceiling to be raised by the same amount. Second, Ghana cannot use power rate subsidies to attract other overseas aluminium producers. If Ghana attempts to use power rate subsidies, it does so at the risk of loosing dollar revenues from VALCO.

Apart from granting exclusive access to over half of the guaranteeable power from the Akosombo power facility, VALCO's owners were empowered, under Article 14A of the Master Agreement, to prospect for and, if possible, exploit the bauxite in mineral concessions of up to 40 square miles in aggregate area. Furthermore, the Ghana Government agreed, under the same provision, that:

> "..... it will approve the transfer to VALCO of any concessions conferring such rights, licenses to work such concessions or rights to such concessions, for the transfer of which concessions, licenses or rights VALCO may agree with the owners thereof."

The response of KAISER and REYNOLDS to these rights to Ghana's bauxite resources (which are not exclusive) is non-specific and non-committal. Article 11C of the Master Agreement states that:

> "VALCO, or any company (hereinafter referred to as "the Mining Company") owned and created for that purpose by one or more of the Shareholders, may mine Ghanaian bauxite and process Ghanaian bauxite at the Smelter into alumina or aluminium ....."

Article 11C of the Master Agreement is an important loophole by which VALCO's owners can rightly claim that they are not by any means obligated to integrate their smelting operations backwards into mining and refinery. The agreement merely provides that VALCO "may", at an unspecified time (if ever at all), mine and process Ghanaian bauxite to replace current imports of alumina.

In connection with this, Article 11D of the Master Agreement allows:"VALCO may use all processes which it deems fit or convenient for production ....."

Besides bauxite and power, VALCO was also granted privileged access to local capital. Through Articles 6A and 8A of the Master Agreement, VALCO's owners were empowered not only to borrow money from domestic financial institutions but more importantly, to have such borrowed funds converted into other currencies - i.e. currency outflow.

Article 6A states:

> "VALCO shall not be restricted, hindered or prevented by the Government in any manner from borrowing or repaying with or without interest ..... such sums as it may require for meeting the expenditures necessary for the construction and operation of the smelter including provision for working capital, from any financial institution or institutions of its choice, domestic, foreign or international, or from the Shareholders, or from its customers, in any currency it may desire ....."

And Article 8A adds:

> "The Government undertakes that ..... it will lend to VALCO such amounts of Ghanaian currency (which the Government shall allow to be converted into such currencies as required by VALCO) as will be sufficient to defray any remaining cost of construction and completing such works and premises."

The implications of Articles 6A and 8A are significant because, if funds are borrowed from an affiliate, the interest charged could be high. Since interest is a deductible cost in the assessment of taxable income, it could provide a legitimate and convenient means by which earnings and/or profits could be transferred to subsidiaries in those geographical locations with lower taxes and less restrictions on currency convertibility. In effect, it enhances the flexibility of the parent companies intra-company transfer pricing policies. The possibility of losing such flexibility in any future changes partially accounts for the hesitation.

Operationally, the agreements dealt with issues such as the procurement of inputs, the disposal of the output, the "tolling" agreement, the allocation of income, the tax incentives, the exemptions from foreign exchange regulations and rights to expansion. In all, the Ghana Government agreed to discriminate positively in favour of VALCO's owners to facilitate their entry.

Yet paradoxically, the 1962 Agreements do not allow the Ghana Government to apply the same positive discrimination in favour of others in order to promote further economic development without a loss of income from VALCO. The non-discriminatory clauses are encapsulated in Article 35 of the Master Agreement which stipulates that:

> "The Government guarantees to VALCO, the Shareholders, the parties to the Long Term Tolling Contracts, and VALCO's creditors and employees, that neither it nor

> any competent Ghanaian authority will establish any law, statute, regulation, act or administrative measure whatsoever which either formally or in true effect discriminates against VALCO, the Shareholders, the parties to the Long Term Tolling Contracts, or VALCO's creditors or employees, or which in effect, and looking at the matter fairly, singles out any of these persons."

Specific operational concessions enjoyed by VALCO begin with Article 15 of the Master Agreement. The importation of machinery, equipment and all materials by or on behalf of VALCO at any stage of its operations in Ghana are exempt from "fiscal charges" which are defined by the Master Agreement as:

> "Any tax, customs duty, excise, income tax, profits tax, minerals duty, divident tax, sales tax, purchase tax, property tax or other taxation burden (including compulsory savings, involuntary purchase of securities and required contributions and other involuntary financial burdens payable to and imposed by Governmental authority), whether existing now or created in the future, but shall not include local government rates based on property values."

As with all the provisions of the 1962 agreements, they are valid, in the first instance, for 30 years - effective from the P.D.D. (i.e. 25th April, 1967). VALCO's owners have the option to extend the agreement for a further 20 years after the initial agreement has lapsed.

The blanket extension of this concession to "any expansion thereof or addition thereto" mean that VALCO could confine itself merely to the expansion of the smelter until its power demand reaches the power ceiling of 415,000 kilowatts of non-interruptible power, without using indigenous alumina. The absence of a linkage between the exemptions from direct and indirect tax liabilities and the use

of Ghanaian alumina also means that it is legitimate for the Tema smelter to be operated merely as a low-cost convertor of the excess alumina produced elsewhere. This observation does not, in any way, imply that VALCO's use of its entire power entitlement to convert exclusively non-indigenous alumina would, necessarily, be disadvantageous to Ghana. In fact, it is argued in Chapter 6 that the best counter-strategy for Ghana to adopt to cope with the problem of fragmentation is its acceptance as a fait accompli, and the encouragement of VALCO to use its entire power entitlements to process imported alumina.

For its operations, the smelter requires the supply of alumina, fuels, lubricants and spare parts. Under the provisions of Article 20 of the Master Agreement, the requirements of VALCO can be imported free from any customs duties for 30 years - effective from the P.D.D.

The agreements are notably reticent on the fact that, if these inputs are not available in Ghana, they should be purchased from the lowest cost source. Neither do the agreements specify what ought to be done if, at some future date, alumina which is of comparable quality and competitive in price to current imports are produced in Ghana by third parties not related to VALCO.

Apart from the exemptions from all customs duties on imports, VALCO's owners are free to dispose of their output as they wish. Article 19A of the Master Agreement frees VALCO's owners from any limitations or restrictions on the disposal of VALCO-produced aluminium. This provision stipulates that:

> "The Government agrees to permit the exportation of aluminium produced by VALCO in accordance with this Agreement and to impose no restriction, directions or control on or as to the disposition, purchasers, or destination of such aluminium. Such exportation of aluminium shall be exempt from export duties and other Fiscal Charges on exports whether or not VALCO has at stage acquires title to the said aluminium."

In other words, without the backing of VALCO's owners, forward integration can only be based on the importation of semi-fabricated aluminium into the country. As such, GHANAL, which fabricates aluminium into a number of consumer products for the Ghanaian and West African markets and whose factory is located next door to VALCO, has had to import semi-fabricated aluminium while VALCO exports all of its output. In this connection, KAISER's decision to sell VALCO-produced aluminium to the proposed rolling mill and, in addition, purchase 1% of the shares of this semi-fabrication plant could be interpreted as a willingness of KAISER to assist wherever there is a good economic case.

Apart from the exemptions from all levies on imports and exports, the nature of VALCO's operations are defined by Article 16 of the Master Agreement. VALCO's functions are defined in the following terms:

> "VALCO may for tolling charges process alumina (or, with the consent of the Ghana Government, bauxite) belonging to other persons into aluminium (whether or not cast or alloyed)."

The "tolling" arrangements means that, at an agreed fee, VALCO would transform bauxite/alumina which is supplied to it into alumina/aluminium respectively.

The "tolling" (i.e. conversion) fees levied by VALCO are defined by Article 17A of the Master Agreement. After deducting the tariffs (applicable to aluminium of Ghanaian origin) from the sales revenue, Article 17 allocates 56% of the remaining amount to VALCO to cover its costs and profit margins. The corollary is that 44% of the sales income less tariffs is assigned to the parties which supplied the alumina for conversion.

Purporting to provide the incentive to KAISER and REYNOLDS to process indigenous alumina instead of alumina imported from Jamaica and elsewhere, Article 17B of the Master Agreement raises

the "tolling" fees chargeable by VALCO from 56% to 60% if, after 25th April, 1977, the company continues to toll-process non-indigenous alumina. The rationale behind this provision is that, by increasing VALCO's income by 4% (of the turnover less tariffs), VALCO would then be liable to higher income taxes and VALCO Fund payments. The incentive for the company is to use nearby resources and thereby save itself this extra tax burden.

The effectiveness of Article 17B in promoting the use of indigenous alumina by VALCO is very much in doubt because of the wider considerations. Besides the uncertainties of the politico-economic situation in Ghana, the other factors are discussed in Chapters 3 and 5.

Quite apart from the blanket exemptions from indirect taxes, VALCO's owners sought and gained preferential fiscal treatment. Under the provisions of Article 31 of the Master Agreement, VALCO was granted "pioneer company relief." Paragraph A of this clause stipulates that:

> "the production of aluminium will be delcared a pioneer industry under the provisions of the Pioneer Industries and Companies Act and that aluminium will be declared a pioneer product."

On the basis of this provision, VALCO was granted a five to ten year tax holiday - such as was necessary to ensure the payback of the original smelter investment and a return.

In addition to the tax holiday, Article 30A of the Master Agreement stabilized for 30 years, VALCO's tax rate at 40% of its chargeable income - that is, the income tax rate which was in force in Ghana on January 2nd, 1961.

The final fiscal inducements offered by the Ghana Government covered not only the exemption of the company from the country's

foreign exchange regulations but also the company's entitlement to the most favourable exchange rate in force at any one time. These concessions were embodied in Article 33 of the Master Agreement.

VALCO's rights to the most favourable exchange rate in force were legitimized by paragraph B (ii) of Article 33 of the Master Agreement which stipulates that:

> "If two or more different rates of exchange are applicable to various transactions (such as imports, exports, remittances, investments, banking charges, or different types of such transactions), under the Ghanaian exchange control then in force, VALCO shall be entitled to make such exchanges at whichever of such different rates is the most favourable to VALCO, regardless of whether the purpose of VALCO's exchange falls within the type of transaction to which such rate is applicable or not;"

The Article 33B (iii) goes on to define the "rate of exchange" as including:

> "any tax, premium, retention or charge of whatever nature imposed by the Government or any agency of Ghana on the exchange transaction."

In the light of this provision, VALCO, in 1977, succeeded in its application to be granted the export bonus which had been introduced as an incentive to boost the export of non-traditional products. This has since been withdrawn by the Ghana Government and is being contested. The consequence of these provisions is that the Government cannot use a multiple exchange rate policy to influence its investment and development policies without incurring foreign exchange losses from VALCO.

The validity and duration of the provisions of the agreement, the arbitration procedures in the event of a breakdown in the relationship, guarantees for compliance and the penalties for non-

compliance are all dealt with in a series mutual assurances.

The validity of the agreement for 50 years is encapsulated in Article 46 of the Master Agreement which states that:

> "This Agreement shall become effective on the date hereof and shall, save as regards any right or obligation herein which is expressed so as to endure for any different period or to come into force at or after the expiry of that period, endure until the 50th anniversary of the Permanent Delivery Date."

From the corporate standpoint, such a long duration for the agreement is justifiable by the high cost of installation and operation which necessitate a long period of stable fiscal and operating conditions to facilitate payback and ensure a fair return to the investor. The converse of this viewpoint is that the income of the Government would be more or less fixed (stabilized) for the same period although socio-economic demands would be rising, particularly at a time of higher energy costs, higher global inflation and higher interest rates in the world capital markets. The critics of the current Ghana/VALCO relationship may very well have been motivated by the growing realisation of this point.

Envisaging the possibility of a dispute arising out of a different interpretation of the agreement or the actions of the Ghanaian authorities or any of the participants in the investment and operation of VALCO, Article 41 of the Master Agreement provides that:

> "Any of the parties to such dispute may commence arbitration proceedings by (i) giving notice to each of the other persons listed above (i.e. VALCO, the Government, the VRA, any shareholder, any party to a Long Term Tolling Contract, the Trustee of The VALCO Current Accounts Trust, or the Voting Trustee of the

> Voting Trust Arrangements) and to the International Bank for Reconstruction and Development (including in such notice a statement of the question or dispute and of the claim or contention of the person giving the notice), and (ii) cabling the Court of Arbitration, for the time being, of the International Chamber of Commerce, requesting the appointment of an arbitrator."

Any arbitration is to be conducted under the rules of the International Chamber of Commerce and the findings are to be final and binding.

Assurances that VALCO will not be wholly or partially nationalized are contained in Article 38. Should there be failure to resolve this within two months, then VALCO's liabilities automatically become the responsibility of the Ghana Government.

The topical comment about the arbitration procedures is that it removes the resolution of disputes from national jurisdiction to the International Chamber Commerce.

Besides, the agreement does not explicitly recognize the ultimate sanction of either the Ghana Government or VALCO's owners (i.e. the right to terminate the agreement, if either party should be found to be in the wrong in the case of arbitration). VALCO's rights to maintain and enforce certain contracts are guaranteed and clearly spelled out in Article 39 of the Master Agreement. These contracts are the Subscription Agreement, the Exim-VALCO Loan Agreement, the Long Term Tolling Agreement, The Voting Trust Arrangements, The VALCO Accounts Trust, The Management and Technical Assistance Agreement, The Managing Agreement and the Currency Agreement.

Article 40 of the Master Agreement provides a two-month period in which any alleged breaches of the agreements can be rectified by the errant party.

"If at any time either Party should be in default with respect to observance or performance of its duties and obligations under the Scheduled Documents and that default is in respect of some matter going to the substance of the relevant Scheduled Document and, where that relevant Scheduled Document is one of the Scheduled Contracts, the default is such that a breach of condition and not merely of warranty has been committed, then this Agreement shall not be terminated but, without prejudice to any rights of the other Party to damages and whether or not any arbitration proceeding has been instituted or is pending, that other Party may give notice to the Party in default and if such default is not remedied, cured or removed within a period of two months after the notice the Party not in default shall thereupon be relieved of performance and discharge of its duties and obligations under this Agreement and under the Scheduled Contracts until such default has been corrected."

Where failure to honour part(s) of the agreement is traceable to "force majeure", neither party becomes liable to consequences of such failure. "Force Majeure" is defined in paragraph E of Article 42 of the Master Agreement as:

"..... war (whether declared or not and including existing wars); revolution; invasion; insurrection; riot; civil commotion; mob violence; sabotage, blockade; military or usurped power; lightning; serious destruction; explosion; fire; storm; wind; shortage of water; drought; flood; earthquake; epidemic; quarantine; general boycott by foreign governments of aluminium exported or produced by VALCO; strikes; or (as regards VALCO) acts of the Government of Ghana or other Governmental authority in Ghana which adversely affect the operation of the Volta

> Development or the Smelter or other facilities upon which such operation is completely dependent; and acts of any foreign government adversely affecting the importation of equipment or materials by or far VALCO, including refusal to export or import licenses and restrictions, embargo, allotment, allocation or other limitation."

Because of the definition of force majeure, stability is important to minimise the risk of its occurrence.

Under Article 45 of the Master Agreement, the agreement cannot be assigned to any other party without mutual consent. Even in the event that VALCO, through reconstruction or amalgamation, becomes associated with business entities which are politico-economically unacceptable, the Ghanaian Government is powerless to terminate the relationship.

Article 45 states that:

> "Any reference to VALCO shall be construed as including any successor to VALCO which is such by reason of re-construction or amalgamation of VALCO, but subject as aforesaid in this Article this Agreement shall not without the consent of the other Party, which consent may be witheld in the other Party's discretion, be assignable by either party, and any purported assign-ment thereof, or of any part thereof, shall be void and of no effect."

The import of Article 45 is simply that, even if VALCO's present status changes, Ghana cannot initiate any re-assignment of the agreement unless the re-constituted VALCO agrees to the move.

Furthermore, if in its wider political and economic interest Ghana decides to join say a customs union, the agreements should also remain sacrosanct. This is contained in Article 48 which states

that:

> "The Ghana Government undertakes that the force and effect of this Agreement and the Scheduled Documents and the rights and immunities of VALCO shall not be impaired should Ghana enter into any confederation with other African States or enter into any customs union."

Overall, the agreement is a compromise between the objectives of the Ghanaian Government (anxious to attract vital investment and the expertise) and the aluminium producers (anxious for a low-cost location to process the excess alumina from their alumina plants elsewhere).

To stabilize the situation, the company sought and gained concessions which not only made them the most-favoured company in Ghana but more importantly "froze" its relationship to the situation in 1962. Even in the event of a re-constitution of VALCO or the accession of Ghana to regional confederations or customs unions, the 1962 agreements specify that the relationship should remain immutable.

The exclusive access of VALCO to more than half of the guaranteeable power as well as the non-discriminatory provisions of the Agreements reinforce Ghana's dependence on VALCO's owners for any further developments in the aluminium industry.

Notwithstanding these general effects of the 1962 agreements, Articles 17 and 18 of the Master Agreement have the paradoxical effect of limiting Ghana's share of the direct financial gains, and yet, as argued in Chapters 4 and 5, they also provide the justification for backward integration and the means to implement alternative policies.

CHAPTER 3: THE WORLD ALUMINIUM INDUSTRY - Implications For Ghana

Chapter 3.1: Overview

Chapter 1 sought to show that, for several years up until now, Ghana has been precariously dependent on the single crop, cocoa, with its fluctuating export income. This dependence has been the Achilles heel of all the attempts to develop the economy. In these circumstances, the simultaneous discovery of bauxite and the hydro-electric potential of the Volta by Kitson offered an obvious and desirable means to diversify the economy. The diversification of the Ghanaian economy was to be achieved within the framework of the Volta River Project (VRP) which consisted of three sub-projects - the power project, the public works programme (to provide the supportive infrastructure), and the bauxite-to-aluminium complex.

Chapter 2 dealt with the 1962 agreements which facilitated the full implementation of the public works and power projects. These agreements, however, led to the partial implementation of the bauxite-to-aluminium complex. From Chapter 2, it transpired that, although the 1962 agreements were formulated on the basis of mutual dependency, some of the provisions represent a barrier to the complete integration of Ghana's fragmented aluminium industry. For example, the Ghana/VALCO relationship is effectively "frozen" for a 30-50 year period while the absence of an explicit link between the concessions ceded to KAISER and REYNOLDS and indigenous alumina usage implies that backward integration of VALCO's smelting operations into mining and refining can be brought about only if the producers agree to it. In spite of these constraints, the agreements paradoxically provides the obstacles (Chapter 2), the justification (Chapter 4) and the means (Chapter 5) to implement the proposals to integrate the aluminium industry.

Taken together, Chapters 1 and 2 provide, from the local perspective, the background to the fragmentation of the Ghanaian aluminium industry.

From the Ghanaian perspective, the apparent attempt by VALCO's

owners to perpetuate the industry's fragmentation is inexplicable. There are two main reasons for this position.

First, besides capital, bauxite and power are the key determinants of the feasibility of integrated aluminium production. Ghana possesses these critical inputs as well as other raw materials at competitive prices and in sufficient quantities. Yet, the recent KAISER-led studies concluded that it is uneconomic to produce alumina in Ghana. Consequently, integration was to be deferred until a more opportune moment.

Secondly, by weight, only 16%-25% of bauxite is aluminium. The remainder, 75% or more, are waste products which have to be discarded at one stage or another. Yet, the cost-conscious producers appear prepared to ignore the potentially significant cost savings inherent in in-situ processing. Apart from the preponderant amount of waste inherent in bauxite, very large amounts of process chemicals are required in commercial aluminium production. This is demonstrated by the fact that approximately 2.85 tonnes of raw materials (mainly alumina (70%), anode carbon and fluorides) have to be shipped to a smelter to produce each tonne of metal.[1] If VALCO operates at full capacity, it could be assumed from this that the material inflow into Tema would be 570,000 tonnes/year while the outflow is 200,000 tonnes/year.

Consequently, by seeking to perpetuate the status quo, it is effectively implied that the additional cost of cross-shipping the large tonnage of waste products (only to be discarded) as well as the similarly large volumes of process chemicals are justifiable to cost-conscious VALCO. Critics of VALCO, however, believe that the localization of production offers significant saving opportunities and these must naturally be sought - particularly, in instances where the cost of local bauxite and power are competitive. It is from these unsettled queries that the disquiet over VALCO's role in Ghana stems.

However, to the neutral observer, the international dimension complicates the local problem of fragmentation. First, because of economies of scale, large refineries and smelters may have to be built. In so doing, there would be excess alumina as well as the metal itself, for which markets have to be found abroad. But, it is far from certain that the requisite export markets and/or profitable commodity prices could be secured.

Secondly, the neutral observer would want to know how the technology of aluminium production and trends in it could affect an investment decision to localize production in Ghana.

Thirdly, the comparative economics of production in the numerous alternative locations cannot be ignored.

Fourthly, the dispassionate observer may wish to know the extent to which the modus operandi of the world aluminium industry influences any investment decision in Ghana.

Fifthly, one needs to consider the state of the bauxite/alumina/aluminium market. Capacity/supply/demand balances, price trends, the proliferation of bauxite and the increasingly competitive non-bauxitic ores, and the increasing number of aluminium producers operating outside the six-member oligopoly, together, represent a serious source of uncertainty in the market situation. Therefore, it is not obvious that whatever is produced in Ghana can be sold at profitable prices.

Finally, the cost of greenfield capacities, the influence of international and domestic inflation on these costs and the nature of the competition for investible capital are issues which could easily scuttle any proposal to establish a mine-to-metal complex - however profitable it might be initially.

Consequently, there is a good case for examining the problem of fragmentation from the wider international context.

If there is to be a case for the re-structuring of Ghana's fragmented aluminium industry, an answer has to be found for the ultimate question: Is integration a viable economic proposition, given the structure and modus operandi of the world-wide aluminium industry, the demand/supply/capacity balances, the competitiveness of aluminium relative to its rivals, the competition of non-bauxitic ores (to bauxite) as an alternative source of soluble alumina, and finally, the challenges of new process technology in the commercial production of aluminium from its ores? All these wider considerations form part of the reasons which the foreign private investor may have in mind (but critics of the status quo in Ghana ignore) in deciding whether or not to help promote alumina/aluminium production in Ghana. In Chapter 3, these external factors are examined.

On the assumption that the Bayer/Hall-Heroult technologies for processing bauxite continues to be the basis of commercial aluminium production, it could be plausibly argued that the high transport costs and the copious energy usage, together, favour Ghana's relative production costs. Consequently, the case for the localization of mining, refinery and smelting phases of the process is, arguably, strengthened.

However, the world-wide proliferation of bauxite - currently, the preferred source of soluble alumina - coupled with the captive nature of existing refineries introduce complications for refinery investment in Ghana. On the grounds of economies of scale, viable refinery projects in Ghana have to be 600,000 tonne/year or more and this necessitates export markets to be secured in advance. It is not at all obvious that export markets or reasonable alumina prices can be pre-arranged without the active support and/or participation of the aluminium multi-nationals.

Consequently, as a preamble to the establishment of a case for the integration of Ghana's aluminium industry, Chapter 3 will clarify the likely impact of these external factors on the prospective proposal to develop integrated production facilities in Ghana.

Taking Chapters 1, 2 and 3 together, it would be plausible to argue that the unwillingness of VALCO's owners to promote the bauxite-to-alumina project is explicable by the following catalogue of reasons:

(i) uncertainty and the risks perceived in the worsening politico-economic situation in Ghana - from Chapter 1;

(ii) uncertainty over the outcome of a re-negotiation of the 1962 agreements which would be necessary in the event of VALCO processing indigenous alumina rather than imported alumina - Chapter 2;

(iii) the marketability of the excess alumina output in a highly restricted market - Chapter 3;

(iv) the companies' excess alumina capacity vis-à-vis their own smelter requirements - Chapter 3;

(v) marginal cost considerations with regard to additional alumina production in Jamaica and Australia as opposed to the greenfield facilities proposed in Ghana - Chapter 3;

(vi) the loss of flexibility in intra-company pricing policies that will accompany the proposal to integrate backwards - Chapter 2.

Because of these reasons as well as others due to emerge in Chapter 5, the profitability of the bauxite-to-alumina project per se (as shown in Chapter 4) is unlikely to generate any corporate interest in the project. Moreover, with these factors in the background, any feasibility studies conducted by KAISER and REYNOLDS is likely to be pessimistic - unless an acceptable package of wide-ranging concessions can be offered by the Ghana Government. If the owners of VALCO can show that the project would be loss-making, what then would be the justification for the pressure on them to integrate their operations backwards?

Chapter 3.2: The Technology Of Commercial Aluminium Production

The transition of aluminium from its ores into the metal can, at present, be achieved by a number of methods and from different types of raw material. The ores from which the metal is extracted can either be bauxite (the preferred source of soluble alumina) or non-bauxitic ores, such as, clays, anorthosite, alunite, shales, nepheline syenite. Until recently when the cost of bauxite rose sharply as a result of higher costs for mining, crushing, transportation and the resource rents charged by producer countries, bauxite remained the unchallenged economic source of alumina.

The escalating costs of bauxite and energy have led to increased research and development effort in a number of areas including the pioneering and the improvement of alumina extraction processes for non-bauxitic materials such as clays. Efforts have also gone into improving the efficiency of the fundamental technologies pioneered by Charles Martin Hall (of U.S.A.)/Paul T. Heroult (of France) in 1886, and by Karl Joseph Bayer (of Austria) in 1888. Attempts have been made to develop a one-stage process (that is, bauxite-to-aluminium in one step) as opposed to the two-phase processes of Bayer/Hall-Heroult, in which alumina has to be first refined from bauxite and then, the intermediate alumina product subjected to electrolysis to produce the metal.

Notwithstanding the substantial progress that have been made, the traditional Bayer/Hall-Heroult technologies for extracting alumina (first from bauxite) and aluminium (from the intermediate alumina) is widely expected to be the most competitive means of producing the metal.

On this assumption, the Ghanaian prospects for the development of its aluminium industry, within the overall international situation, is assessed on the basis of the continued use of the Bayer technology (for the extraction of alumina from bauxite), the continued international preference to use bauxite as the source of the intermediate product, alumina, and finally, the use of the Hall-Heroult technology

to produce the metal from alumina.

To produce the basic raw material (bauxite), open-cast mining techniques are used for near-surface deposits while the more costly underground extraction methods are employed for deeply-buried deposits. The crude bauxite mined may be upgraded by sorting, washing or wet screening to get rid of some of the clay minerals. If the bauxite is to be shipped abroad for refinery, the additional expenditure of kiln-drying has to be incurred in order to reduce the moisture content, and hence, reduce the volumes of the commodity to be shipped and thereby save on freight costs. In Jamaica, where the rotary kilns used for this purpose are oil-fired, one company is reported to have incurred a cost of $1.82/tonne of bauxite for the fuel used. Had the bauxite been processed in an in situ alumina refinery, this cost of drying would not have been necessary. Since 2-3 tonnes of bauxite are required to produce about 1 tonne of alumina, the localization of refinery reduces by 100% or more the weight of cargo shipments. The main environmental problem concomitant to the mining phase is the costly need (statutory in several developed countries) to restore the mined-out landscape to its original or some other pre-specified state.

To refine the bauxite, a mixture of the crude ore and caustic soda is heated to very high temperatures and under high pressures. The aim is to leech the alumina content from the bauxite. The mixture is held at these high temperatures and pressures for some time which could be up to 5 hours. The result of the leeching process is a slurry of sodium aluminate and the insolubles (silica, oxides of iron and titanium). The sodium aluminate slurry is sometimes called green and pregnant liquor. The insolubles is generally termed "red mud" and is enriched in impurities such as iron, titanium, silica, and calcium.

The red mud is separated and neutralised before being discarded to a tailings pond. The sodium aluminate separation is then filtered. First, caustic soda and any unprecipitated alumina are sent back to the leeching vessels for re-use. Secondly, an aluminium trihydrate separation is obtained which is then calcined to yield the intermediate product, alumina.

This leeching process is often termed "digestion". The cost of digestion is influenced by the quality of the bauxite input, the leeching temperatures, the holding time and the concentration of the caustic soda solution.

In the order of increasing cost of digestion, bauxite is composed of either trihydrate gibbsite ($Al_2O_3 \cdot 3H_2O$) and/or the monohydrates boehmite and diaspore. Gibbsite is generally digestible at 105^oC - 150^oC whereas boehmite and diaspore tend to be digestible at or above 200^oC.

The presence of impurities increases the cost of digestion. Principally, "reactive silica" leads to higher consumption of caustic soda and even loss of alumina. The United States Bureau of Mines estimates that 1.1 units (by weight) of alumina and 1.2 units of caustic soda could be lost for each unit of reactive silica present in the ore.[2]

The principal controlling reactions could be represented as follows:[3]

(i) $Al_2O_3 \cdot 3H_2O + 2NaOH \xrightarrow[\text{Digestion}]{105^oC - 150^oC} 2\ NaAlO_2 + 4H_2O$
Gibbsite

(ii) $Al_2O_3 \cdot H_2O + 2NaOH \xrightarrow[\text{Digestion}]{230^oC - 250^oC} 2\ NaAlO_2 + 2H_2O$
Boehmite

(iii) $2NaAlO_2 + 4H_2O \xrightarrow[\text{Precipitation}]{65^oC - 75^oC} Al_2O_3 + 3H_2O + NaOH$

(iv) $Al_2O_3 \cdot 3H_2O \xrightarrow[\text{Calcination}]{900^oC - 1200^oC} Al_2O_3 + 3H_2O.$
PRODUCT ALUMINA
↓
SMELTER FOR REDUCTION

According to the estimates of the USBM, the following are the order-of-magnitude estimates of the requirements for the production of 1 tonne of alumina[4]:

(i) Bauxite, Dry ..... 2.0 - 2.5 tonnes

(ii) Caustic Soda ..... 0.07 - 0.17 tonnes

(iii) Fuel Oil (steam and calcinating) ..... 0.28 - 0.38 tonnes

(iv) Electric Energy ..... 300 - 350 kwh

(v) Total Labour and Supervision ..... 2.5 - 5 hours

The environmental problems which arise from the Bayer process are mainly those concerned with the disposal of the "red mud". Useful land is sterilised by its disposal. And other problems could also arise from the containment of the "red mud" impoundment.

The resulting "sandy alumina" is then transferred to a smelter where the Hall-Heroult electrolytic reduction technology is used to produce the metal. The main inputs[5] into the reduction (or smelting) process are:

(i) Alumina ..... 1.92 - 1.96 tonnes/tonne metal

(ii) Petroleum Coke ... 0.40 - 0.47 tonne/tonne metal

(iii) Tar Pitch ..... 0.11 - 0.16 tonne/tonne metal

(iv) Fluorides ..... 0.02 - 0.03 tonne/tonne metal

(v) Electric Power ..... 13,228 - 16,094 kilowatt-hours/tonne metal

(vi) Labour and Supervision ..... 10 - 20 hours

From the foregoing, it is evident considerable energy is required to produce aluminium. Table 3.1 below demonstrates that, in terms of the amount of energy used, smelting and refining consume the most energy. However, in terms of the cost of energy as a proportion of overall costs, shipping, refining and smelting are the most expensive. The higher energy cost for shipping and refining is

TABLE 3-1: Bauxite/Alumina/Aluminium Energy Requirements

	GJ per tonne aluminium	% Total Energy	% of Total Cost	Energy Source
Bauxite Mining	2.54	1.1	11	Diesel
Shipping	2.51	1.1	30	Diesel, Residual oil
Alumina Refining	44.95	19.8	28	Residual oil and Gas
Aluminium Smelting	177.25	78.0	26	Electricity
	227.25	100.0		

Source: R. J. Robson, "The Energy Factor In The Bauxite/Alumina/Aluminium Industry", IBA QUARTERLY REVIEW, Volume 6, Number 3, January - March, Table 3, p.43.
This was quoted from:
Sittig, M., 1978, "Practical Techniques For Saving Energy. In The Chemical, Petroleum And Metal Industries", Noyes Data Corporation, New Jersey.
IGJ = 0.9478 million British thermal units.

explained by the fact that higher grade petroleum-derived fuels (hence costly) are required whereas, smelting largely depends on low-cost hydro-electricity.

In Australia, there are large deposits of coal to provide the energy required in refining. By contrast, Ghana has no known commercial deposits of coal or gas to produce the bulk of energy required in refining. This means that the economics of Ghanaian alumina production might be less favourable than one would suppose.

The foregoing also explain why KAISER and REYNOLDS chose to establish VALCO at Tema. The specific purpose of the smelter is the "toll-processing" of the excess alumina produced from their off-shore alumina plants. In their view, the key determinant of their presence in Ghana was, is, and likely to be the availability of large

blocks of competitively-priced and non-interruptible power. Barring a serious deterioration in the political situation, they are likely to remain in Ghana so long as this situation as well as the tax incentives negotiated in 1962 remain in force.

The principles of producing 1 tonne of alumina from Ghanaian bauxite, using the Bayer hydrometallurgical process, along the lines suggested in the 1975 study by Bauxite Alumina Study Company (BASCOL) is illustrated in Figure 3.1.

The transformation or conversion ratio of the Bayer/Hall-Heroult processes is, depending on the quality of the bauxite:

4-6 tonnes bauxite: 1.92-1.96 tonnes alumina : 1 tonne metal.
For Ghanaian ores, the conversion ratio is:

5.06-5.14 tonnes bauxite : 1.92-1.96 tonnes alumina : 1 tonne metal.

As with other extraction processes in the mineral industry, there are serious health and environmental problems attendant to the smelting process. These hazards arise from the effects of aerial emissions of both gaseous and particulate fluorides from the smelter operations. Other hazardous emissions are carbon monoxide, carbon dioxide, sulphur dioxide, distillation products of tar, cryolite, aluminium trifluoride and tetra fluoride. Serious reported damage arising from these smelter pollutants include fluorosis, skin lesions, lung cancer and kidney damage[6].

Given the stringency of environmental regulations in the traditional refinery/smelter locations in the developed countries, the relaxed or non-existent standards of developing countries for environmental protection have given an impetus to the relocation of new refinery/smelter investment in those developing countries who have both bauxite and cheap power. The view of KAISER is that this trend will continue[7].

On the issue of environmental pressures which could work to

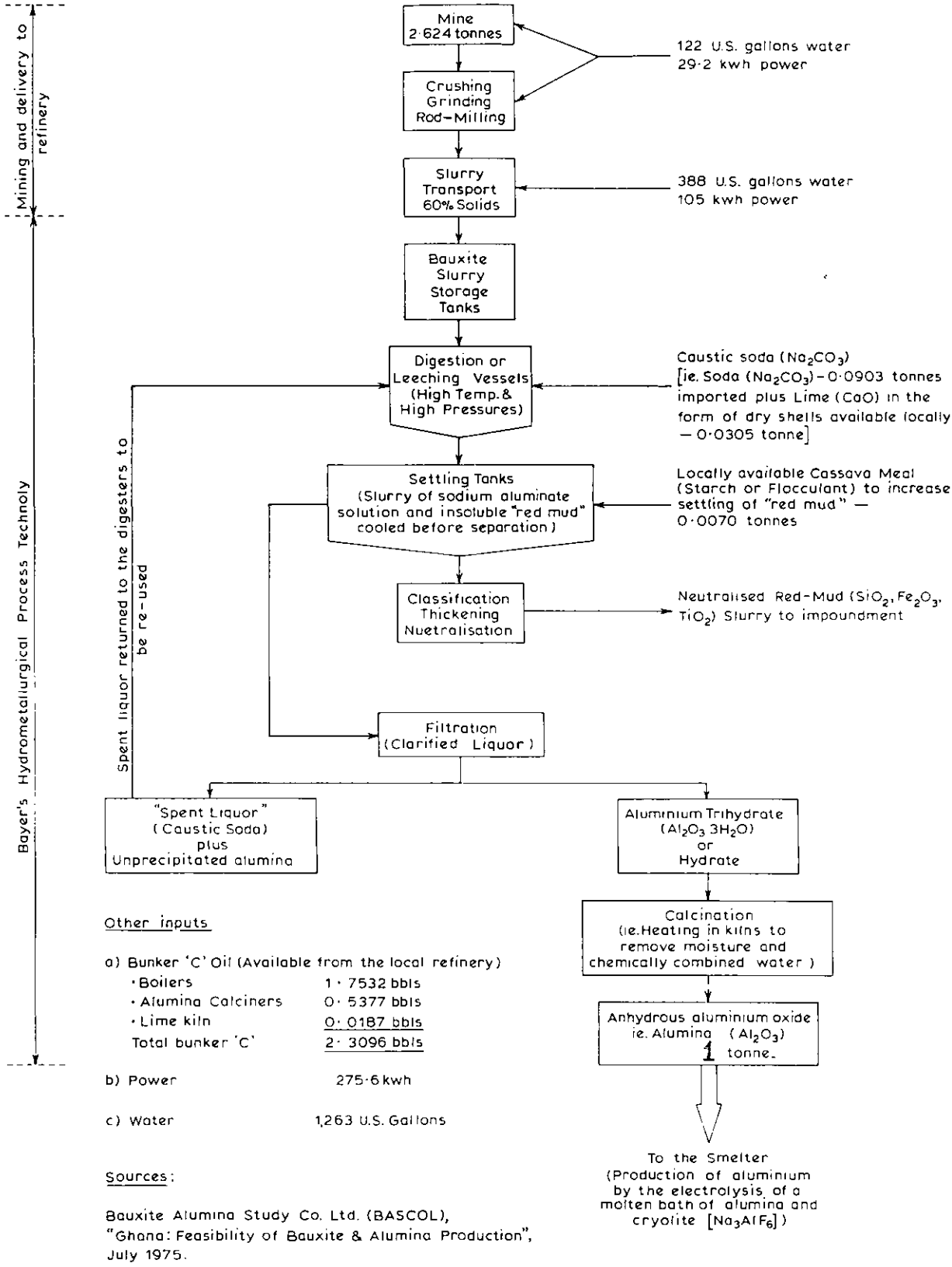


Figure 3·1 The principles of producing 1 tonne Alumina from Ghanaian Bauxite

Ghana's advantage, it is topical to refer to developments in Australia. The Australian government, having encouraged the rapid development of downstream processing facilities as a basis for re-structuring its economy, is now faced with concern and protest from active environmental groups which now threaten the entire expansion programme. In fact, it has been reported that the Conservative Council of Western Australia did file a suit in the United States aimed at preventing ALCOA and REYNOLDS from developing the bauxite resources of the state's Jarrah Forrest[8]. Pressures of this nature in the traditional locations for bauxite mining, refineries and smelters indicate that it is not at all obvious that important producers like Australia will continue to maintain its attractiveness for future investible capital.

If the costs associated with the compliance with environmental regulations in developed countries such as Australia are ignored, then one of the principal determinants of any investible capital inflows into Ghana would be the comparative economics of production at the alternative traditional sites and how Ghana's production costs compares with these.

Since the main channel for investible capital in the aluminium industry is the producers, it is essential to preface the production cost comparisons with a review of the structure and modus operandi of the international aluminium industry. This will show that production cost competitiveness, on its own, cannot attract the powerful and vertically-integrated firms who dominate the industry. Because of their geographically dispersed but vertically - integrated international operations, perceived local advantages are generally subordinated to global profit considerations.

Chapter 3.3: The Structure And Modus Operandi Of The World Aluminium Industry

The international bauxite/alumina/aluminium industry is characterised, on the one hand, by the power and influence of the six multi-national corporations (which form the aluminium oligopoly), and on the other, by the ineffectiveness of the loose, eleven-member producer cartel called the International Bauxite Association (IBA).

The six multi-national corporations, of all whom have world-wide and vertically-integrated operations, are: Aluminium Company of Canada (ALCAN); Aluminium Company of America (ALCOA); Reynolds Metals (REYNOLDS); Kaiser Aluminium and Chemical Corporation (KAISER); Pechiney Ugine Kuhlman (PUK); Swiss Aluminium (ALUSUISSE). ALCOA, REYNOLDS and KAISER are based in the U.S.A. ALCAN is Canada-based, while PUK and ALUSUISSE are respectively based in France and Switzerland. Between them, they accounted for 63% of bauxite production, 66% of alumina and 54% of primary metal production in 1970[1]. In 1976, these six principal aluminium producers controlled 58% of the installed smelter capacity in the Western world. Including the Eastern block smelter capacity, the multi-national corporations controlled 46% of the world's total smelter capacity (See Appendix A3-1). In 1979, the six-member aluminium oligopoly controlled 7.2 million tonnes out of the total installed world smelter capacity of 17.5 million tonnes - that is, 41.3% (See Appendix A3-2). For alumina capacity, the oligopoly controlled 19.1 million tonnes out of the world total of 34.4 million tonnes - that is, 55.7% (See Appendix A3-3).

These six major aluminium producers are all vertically-integrated from the mining of bauxite to the stages of fabricating and marketing of aluminium products. A number of them are involved in the shipment of the bulk bauxite/alumina cargoes and the requisite process chemicals to their various downstream processing plants in Europe and America. So important is the transportation business to KAISER, for example, that it has established two key departments - trans-

portation pricing and transportation services - to control the logistics of its off-shore trade (i.e. business that "never touches" its base in the U.S.A.). Since KAISER is a group of large multiplant companies which are geographically dispersed, a large profitable volume intra-company trade has developed as a result[2].

In addition, the business of transporting raw materials to its various plants, KAISER, ALUSUISSE and PUK also produce a wide range of chemical products which include all the process chemicals required for aluminium production. On account of this, the major producers are self-sufficient and need only small scale inter-company trade to supplement their own requirements. Their influence on the industry is more pervasive than the proportions of their control over installed capacities would suggest. In nearly all the aluminium-related operations in the Western world, one or more of these six multinationals have a stake - either as a partner in a consortium, or as foreign-based but wholly-owned enterprise.

Besides the six major producers, there are over 50 other companies, some of whom are multi-national corporations with wider interests beyond aluminium, and who control various aspects of the world bauxite/alumina/aluminium industry. Their aluminium operations are not integrated and have various long-term trading arrangements with the oligopoly and/or other governments. As Appendices A3-2 and A3-3 reveal, these companies with non-integrated aluminium production facilities controlled, in 1979, 20.7% of the world's total smelter capacity, and 18.9% of the installed alumina capacity in the world. The proliferation of such aluminium producers has led to the gradual reduction of the influence once held by the oligopoly on supply, demand and prices.

The trading relationships between members of the oligopoly and the other multi-national firms are characterised by "swapping", "toll-processing", and the "barter" mechanisms. Given the high degree of concentration and the pervasive influence of the oligopoly, the widespread use of such trading mechanisms has restricted the open trading in bauxite and alumina and, thereby, made entry difficult[3].

Cornish has estimated that in 1976, for example, 78.1% of the potential world demand for bauxite could have been furnished by intra-company transfers, 12.5% met by trade between affiliated companies and thus leaving a mere 9.3% of the global bauxite demand to be catered for by the open market[4].

To counter the influence of the aluminium multi-nationals, the eleven-member International Bauxite Association (IBA) came into existence in 1974. Membership of the IBA included Australia, Guinea, Jamaica, Surinam, Guyana, Yugoslavia, Dominican Republic, Indonesia, Sierra Leone, Haiti, and Ghana. These producer nations pledged themselves in the Association's charter to:

> "take action aimed at securing maximum national ownership of and effective national control over the exploitation of this natural resource within their territories and to support as far as possible any such action on the part of member countries"[5].

The estimates of the World Bank indicate that, in 1975, the IBA had 11.4 billion tonnes of the total world bauxite reserves of 16 billion - that is, 71% (See Appendix A3-4). Notwithstanding this substantial control of bauxite reserves, the IBA's contribution to the production of bauxite, alumina and aluminium in 1967 were 64.4%, 20% and 2.8% respectively. The respective contributions to world production in 1977 had changed to 73.9, 37.5% and 4.6% (See Appendix A3-5).

The structure of IBA's contributions to the world production for bauxite, alumina and aluminium clearly indicates that the international aluminium industry, on the whole, is conducted as separate, unintegrated and geographically dispersed operations.

Evident also is the fact, notwithstanding the global fragmentation of the industry, there is a discernible trend towards the relocation of downstream facilities in member countries of the IBA.

In other words, refinery/smelter complexes are increasingly being sited next to the deposits of bauxite. For example, in 1978, Australia, Guinea and Yugoslavia (all members of the IBA) had the following alumina capacities - 6.8 million, 0.7 million, and 1.0 million tonnes respectively. The expansions in their respective alumina capacities for 1978 - 1985 are 1.8 million, 0.6 million, 0.9 million (See Table 3-10).

This global fragmentation of the aluminium industry is explicable by three main factors. These factors cannot be ignored by Ghana in its attempts to encourage the establishment of a bauxite-to-aluminium production complex.

First, there is the obvious impact of the tariffs levied by the developed nations who account for about 90% of the consumption of aluminium. As Appendix A3-6 shows, none of the major developed countries impose levies on the import of bauxite. However, for alumina, the EEC tariff which stood at 11.1% of the value of alumina in 1961 has been reduced to 5.6% in 1973. The levies increase more sharply for the imports of primary aluminium and fabricated aluminium products. Current levies on primary aluminium range between 4% for Canada and the U.S., 7% for the EEC and 10% for Japan. These tariffs encouraged the establishment of refinery/smelter complexes in the developed countries (which provide the market) as opposed to the developing nations (who do not have the markets). Therefore, if Ghana is to attract investible capital into refinery (as part of the process to integrate its aluminium industry), it needs to offer inducements to the aluminium producers to counter the effects of the tariffs which would be levied on its exports.

The second reason for the global fragmentation of the aluminium industry is to be found in the proliferation of aluminium - bearing deposits, and bauxite, in particular. The abundance and widespread distribution of bauxite deposits offers the vertically-integrated aluminium multi-nationals a very wide choice from which their raw material requirements could be obtained. Although the relative cost

of production is important in attracting investible capital, the site chosen must (besides other politico-economic considerations by the parent company) be such as to minimise the companies' costs and to maximise the profits in their overall world wide operations. The companies would therefore not automatically invest merely because a particular location has an attractively low costs of production.

To illustrate the widespread distribution of bauxite and its abundance, reference has first to be made to Figure 3.2 and Appendix A3-7. It is topical also to point out that although 1,079 million[6] tonnes of bauxite had been mined throughout the world by January 1977, known and proven reserves of bauxite have continued to increase. The reserves of bauxite rose from 120 million tonnes in 1900 to 3.4 billion tonnes in 1958 and 28.5 billion tonnes in 1978. And in spite of the continuing depletion, the world's bauxite reserves are expected to reach 31.8 billion tonnes by the year 2000.

In these circumstances, the policies of non-BIA members such as Brazil, Cameroon and others could attract some investible capital by undercutting the bargaining strength of the IBA.

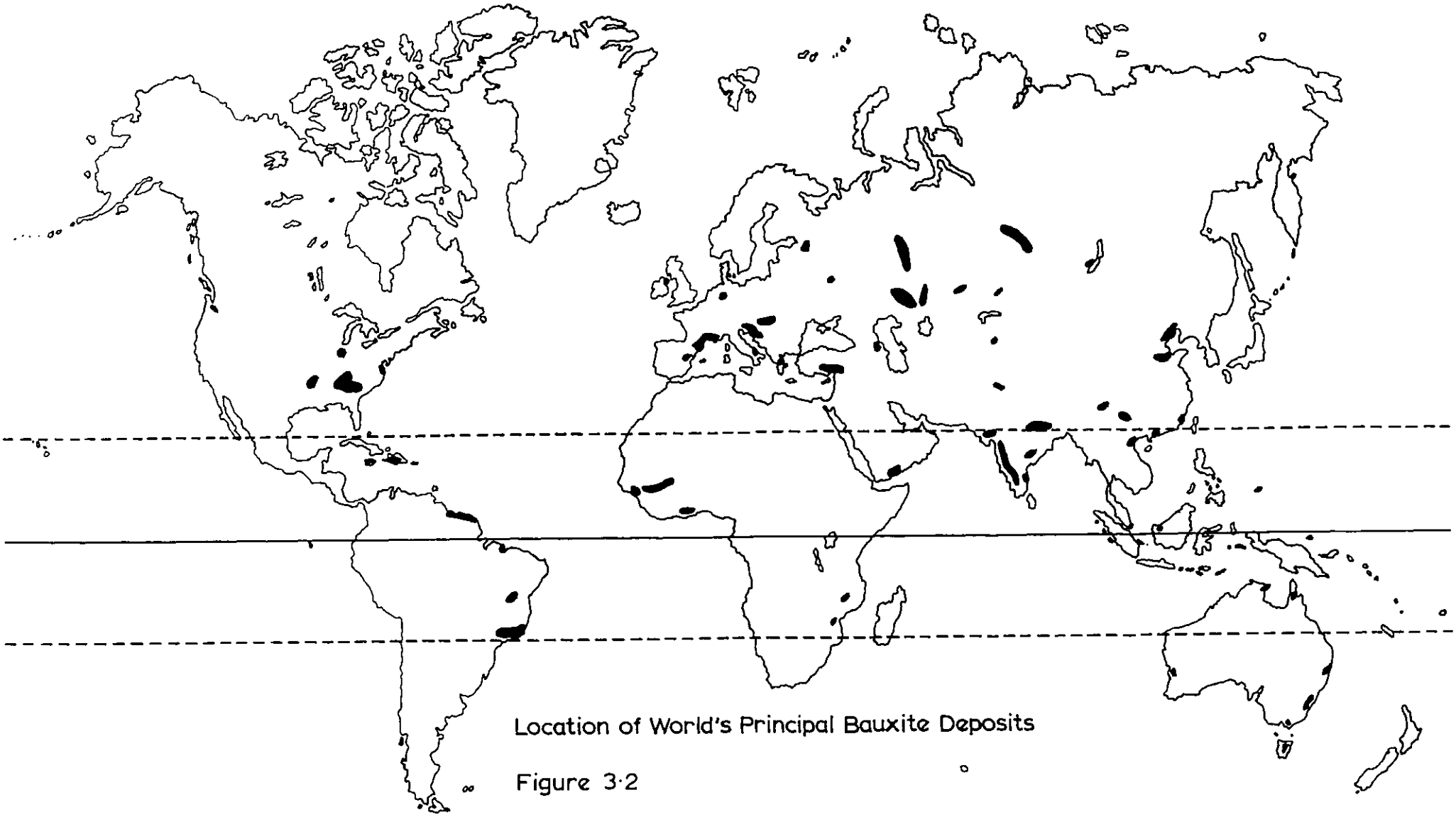
The third reason concerns the future. As Appendix A3-8 illustrates, besides the massive reserves of bauxite, there are inestimable quantities of non-bauxitic reserves which are located principally in the developed countries who account for the bulk of the demand for the metal. The existence of alternative sources of alumina mean that production could easily be switched away from the traditional sources of bauxite. Pyndick has argued that with the cost of producing alumina from clays being $153.4/tonne (1976 U.S. dollars), the threshold price beyond which clays would replace bauxite as a competitive source of alumina is $26.7/tonne[7]. As Table 3.1 shows below, the danger signs for bauxite have appeared already.

TABLE 3-2: Prices of Bauxite Imported Into The U.S.A. ($/tonne)

Country of Origin	C.i.f. U.S. Market
Guinea	26.0
Jamaica	28.1
Surinam	29.7

Source: United States Bureau of Mines, Minerals Yearbook, 1976.

Note: The different grades of bauxite also influence the price.



Location of World's Principal Bauxite Deposits

Figure 3·2

Source : Made available by British Aluminium Co.

In fact, some observers have, for these reasons as well as others, questioned the wisdom of attempts by producer countries, such as Jamaica, to raise the resource rents on their bauxite and alumina exports[8].

Because of the abundance and widespread distribution of bauxite as well as the effect on investment of the tariffs levied on alumina and aluminium by the developed countries who account for over 90% of the consumption of aluminium, the IBA as a producer cartel has been largely ineffective in channelling downstream investments into member countries.

The recent trends in relocating downstream plants near sources of bauxite and power in IBA member countries are traceable to and explicable by the competitiveness of the production cost structures vis-à-vis alternative locations. Those locations which succeed in attracting downstream investments are generally considered to be stable and have as well very few restrictions on pollution control. Chapter 3.4 assesses the comparative economics of alumina/aluminium production in the traditional locations and in Ghana.

Chapter 3.4: The Comparative Economics Of Alumina/Aluminium Production In The Traditional Locations And In Ghana

As pointed out in Chapters 3.2 and 3.3, an important determinant of the decision by any company to invest in the aluminium industry is the relative costs of production at the various alternative locations. Langton provides estimates of relative production costs (in U.S. cents/pound metal) applicable to hypothetical greenfield smelters which are located in the U.S., Australia and the Caribbean (See Table 3-3 below).

TABLE 3-3: Relative Production Economics Of Hypothetical Greenfield Smelters In The United States, Australia and the Caribbean in 1980 (cents/lb)

	United States	Australia	Caribbean
Alumina	18.8-20.7	17.4-19.1	18.3-20.2
Other raw materials.....	4.2-4.9	4.4- 5.0	4.5- 5.0
Electricity	18.7-20.6	12.9-14.2	13.3-14.5
Direct labor	4.3- 4.7	4.7- 5.2	4.5- 5.0
General sales, administration, maintenance	6.1- 6.5	6.0- 6.6	6.4- 7.1
Delivery	1.0- 1.1	2.9- 3.2	2.0- 2.2
Variable production costs	53.1-58.5	48.3-53.3	49.0-54.0
Servicing of capital	17.7-19.5	18.4-20.2	24.1-26.6
Total costs (including normal profit)	70.8-78.0	66.7-73.5	73.1-80.6

Source: Thomas G. Langton (Chase Econometrics), "Economic Aspects of the Bauxite/Aluminium Industry", JOURNAL OF METALS, August 1980, Table 6, p.15.

Note: Prices depend on sources of import as well as the location of the smelter.

Although hypothetical, an important inference could be drawn. It is evident from these estimates that the critical factor inputs are clearly alumina, electricity, and capital. As a percentage of total costs : power costs represent (18% - 26%); cost of alumina (26%);

debt servicing charges (25% - 33%). Together, these major expense items could account for over 70% of total costs. Consequently, the relative competitiveness of a particular location for investible capital could be very much dependent on the location's relative competiveness for each of these factor inputs.

On the question of power, Ghana's position is highly competitive. Ghana sells a very large block of non-interruptible electricity to VALCO at a price of 5 mills/kwh. However, if the average energy usage is taken to be 7.3 kwh/pound metal (as reported by ALCOA in its 1980 Annual Report), then Langton's estimates of power costs/pound metal (Table 3-3) imply the following power prices at the traditional and alternative locations:

(i) United States ..... : 25.6 - 28.2 mills/kwh

(ii) Australia ..... : 17.6 - 19.5 mills/kwh

(iii) Caribbean ..... : 18.2 - 19.9 mills/kwh

In recent years, the rapid escalation in power prices (which are now reported to be accounting for 50%[1] of the cost of processing bauxite into aluminium) has not only led to the closure of several plants in the OECD but also prompted the renegotiations of existing power contracts and given an impetus to the relocation of greenfield refinery/smelter complexes in non-traditional sites which possess adequate reserves of bauxite as well as cheap and abundant power.

British Aluminium has had to close its ten year old smelter at Invergordon because of a reported power price of 32.3 mills/kwh[2]. In the meantime, ALCAN (in Northumberland), and Rio Tinto Zinc/KAISER consortium (in Anglesey) are reported to be paying between 19.0 - 24.7 mills/kwh[3]. Japanese smelters are also being closed down because of power prices which range between 53-58 mills/kwh[4]. To lure the aluminium producers to Australia, the state of New South Wales is reported to have offered ALUMAX a power rate of 11.6 mills/kwh - a rate which was then two thirds that offered by the Australian state of Victoria[5]. But, at the end of 1980, the New South Wales government,

faced with the real cost of power generation of 39.4 mills/kwh, attempted to renegotiate the power rate upwards to 20.9 mills/kwh. ALUMAX responded by threatening to "re-examine" their aluminium investments[6].

With this background of increasing costs, it is not surprising that COMALCO's chairman is reported to have warned of the loss of competitiveness of Australian aluminium industry[7]. THE ECONOMIST (United Kingdom) has also commented recently that:

> "The industry's chief beneficiary of the 1970's oil crisis, Australia, has seen long-cherished investment curtailed, while Japan is hurriedly closing its uneconomic plants. Brazil will not necessarily take up the slack."[8]

This backdrop of decreasing competitiveness in the traditional locations for refineries and smelters is reflected by a report in THE GUARDIAN (United Kingdom) that the owners of the EEC's twelve aluminium producers have even asked for EEC protection in spite of the fact that the level of both imports and stocks are low. The main problem facing the European producers now is that while the LME spot aluminium prices are now £530 - £540 sterling per tonne (i.e. $954 - $972/tonne), the cost of producing a tonne of the metal in Europe is £700 (i.e. $1260/tonne)[9].

Against this general background, it is plausible for one to believe that VALCO's 200,000 tonne/year smelter - expanded twice at a cost of $87 million (Appendix A1-8) during the recession of the 70's - is, a fortiori, low-cost in its operations and would, barring further deterioration in the politico-economic situation, be sustained by its owners.

Besides power, the comparative delivery cost of alumina is the second most important criteria which influences the direction of investible capital flows. In the light of the wish, in Ghana, to integrate the industry backwards into mining and refining, the neutral

observer may very well ask whether alumina of Ghanaian origin is comparable to and competitive with Jamaican alumina - the principal source of current alumina imports? Only then could the aluminium producers, whose co-operation is crucial, be justified in their replacement of imports with local alumina (whatever the power price).

On the assumption of a specific alumina usage of 1.95 tonnes/tonne metal, Langton's hypothetical estimates for the delivered cost of alumina (Table 3-3 above) translate into the following costs (1980 U.S. dollars):

(i) U.S.A. ..... : $213 - $234 per tonne alumina;

(ii) Australia ..... : $197 - $216 per tonne alumina;

(iii) Caribbean ..... : $207 - $228 per tonne alumina.

Besides Langton's estimates, Robson and Frame (Table 3-4 below) also provide estimates of the cost elements for alumina production in a hypothetical greenfield Caribbean refinery. From these hypothetical estimates, alumina from new facilities in the Caribbean would cost $277/tonne (in 1980 U.S. dollars).

The estimates of Langton, Robson and Frame provide a hypothetical range of alumina cost of $197 - $277 per tonne for Australian and Caribbean supplies. These then form the barometer against which the competitiveness of Ghanaian alumina could be measured.

To assess the competitiveness of Ghanaian alumina relative to rival alumina supply from Australia and the Caribbean, three references need to be made. First, the conclusions of the most recent (April, 1977) feasibility study report on alumina production in Ghana, carried out by ALUTERV - FKI of Hungary need to be cited. Second, the KAISER-led feasibility study of mid-1975 has to be referred to. Thirdly, actual reported cost data for 1975 - 1977 for Jamaican alumina - the principal source of Ghanaian alumina imports - needs to be referred to because it offers a fair context in which to examine the KAISER-led conclusions of mid-1975.

TABLE 3-4: Bayer Alumina Production Costs - U.S. $ Per Tonne Alumina Undiscounted
(Caribbean Green Field Plant, 1980 Start-Up)

	Quantity	Price	Cost	% Total Cost
RAW MATERIALS				
. Bauxite (incl. levy)	2.3 tonnes	31.77	73.07	*26
. Caustic Soda	0.1 tonne	140.00	14.00	5
. Other			1.00	-
			88.07	32
UTILITIES				
. Fuel boiler	10 GJ	3.00	30.00	11
Calcination	4 GJ	3.00	12.00	4
. Other			2.00	-
			44.00	*16
MAINTENANCE SUPPLIES	1.5% capital investment		10.20	4
DIRECT LABOUR	1.5 man-hrs	6.0	9.00	3
SUPERVISION	20% direct labour		1.80	-
LABOUR OVERHEADS	33⅓% total labour		3.60	-
RATES & LOCAL TAXES	0.5% capital investment		3.40	-
DEPRECIATION	5% capital investment		34.00	12
RETURN ON CAPITAL	10% investment post-tax		68.00	*25
SELLING & ADMINISTRATION	5% selling price		15.00	5
			145.00	52
			277.07	100

See: R.J. Robson and P.K. Frame, "Criteria for Investment In Alumina Refining," IBA QUARTERLY REVIEW, Volume 5, Number 4, June 1980, Table 2, p.31.

Note: * Dominant cost elements are bauxite, energy and capital.

Table 3-5 below presents ALUTERV-FKI's estimates for the manufacturing and debt servicing costs and the rates of return on refineries of the following alumina capacity variants: 200,000 tonnes/year; 400,000 tonnes/year; 600,000 tonnes/year; 800,000 tonnes/year. As to be expected, the higher capacity variants of 800,000 and 600,000 tonne/year are the most profitable.

TABLE 3-5: Summary of Ghanaian Alumina Production Costs for Various Capacity Variants (Year of reaching rated Capacity 1984/1985)

Location of Plant ⟶	KIBI	TEMA	KIBI	TEMA
Debt-to-Equity Ratio ⟶	⟵ 80 : 20 ⟶		⟵ 75 : 25 ⟶	
1. MANUFACTURING COSTS (U.S.$)/ TONNE				
800,000 tonnes alumina/year	123.4	138.7	123.4	138.7
600,000 tonnes alumina/year	127.1	141.3	127.1	141.3
400,000 tonnes alumina/year	134.5	148.6	134.5	148.6
200,000 tonnes alumina/year	171.0	184.7	171.0	184.7
2. INTEREST AND DEBT REPAYMENT COSTS/TONNE (U.S. $/tonne)				
800,000 tonne alumina/year	96.7	92.4	89.8	85.8
600,000 tonnes alumina/year	108.1	103.0	100.5	95.8
400,000 tonnes alumina/year	113.2	106.7	105.4	99.3
200,000 tonnes alumina/year	163.7	152.3	152.6	142.0
3. ROE (%)				
800,000 tonnes alumina/year	15.9	12.5	15.5	12.3
600,000 tonnes alumina/year	12.3	8.7	12.1	8.8
400,000 tonnes alumina/year	7.0	4.1	7.2	4.4
200,000 tonnes alumina/year	-	-	-	-

The calculation of unit costs and subsequent compilation were based on data from the following source:

ALUTERV-FKI, "Report On The Feasibility of The Kibi Bauxite And Alumina Project," Budapest, April 1977.

Notes: The report assumed the following:

(i) Railways, rather than slurry transport, as the main mode of bulk cargo freight.

(ii) 1977 prices projected to date of project realisation (1982) and for the entire project life of 20 years.

(iii) Debt redeemed by semi-annual instalments for 12 years.

To enable a comparison to be made with the KAISER-led study, the data relevant to the 600,000 tonne/year capacity variant, located at Tema and financed on a debt-to-equity ratio of 75 : 25 would have to be selected for review.

From Table 3-5 above, a 600,000 tonne/year refinery, located at Tema and financed on a 75 : 25 debt-to-equity ratio, would produce alumina at a projected cost of $237.1/tonne. This is made up of $141.3/tonne for manufacturing costs and $95.8/tonne for debt servicing.

To project 1977 prices, ALUTERV-FKI made a number of optimistic assumptions. For example, fuel oil prices were escalated at the following annual rates: 5.7% (1980-1985); 4.8% (1986-1990); 4.3% (1991-1995); 3.9% (1996-2000). Local costs were also assumed to increase by: 36% (1977); 24% (1978); 15% (1979); and 10% (1980 onwards).

To show why ALUTERV-FKI's projections of costs were optimistic, reference could be made to domestic and international inflation, energy costs, and the cost of capital.

First, the local inflation of over 100% for several years mean that local costs would increase much faster than assumed.

Secondly, prices have risen very fast in recent years for Arabian Light Crude Oil. Since the price structure of alternative fossil fuels tend to align themselves with that of Arabian Light Crude Oil, the projection of fuel oil prices by ALUTERV-FKI appear optimistic.

TABLE 3-6: Price of Arabian Light Crude Oil, 1969-1980 (US $/bbl)

1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980 (July)
1.8	1.8	2.3	2.5	5.0	10.5	11.5	11.5	12.7	18.0	23.5	28.0

Source: R.J. Robson, "The Energy Factor In The Bauxite/Alumina/Aluminium Industry", IBA QUARTERLY REVIEW, Volume 6, Number 3, January-March, Table II, p.42. Data quoted from OPEC Annual Statistical Bulletin, 1977 and OPEC Press Releases.

Table 3-6 above demonstrates that oil prices more than doubled in the 1977 - 1980 (July) period.

Thirdly, KAISER has estimated that the rate of international inflation was 12.8% (for 1970 - 1980) and would be about 12% for the 80's (See Figure 3.9). In the light of this, ALUTERV-FKI's assumption that the prices of imported materials would increase annually by only 4.7% (1980 - 1985) and 3.8% (1986 - 1990) would also appear optimistic.

Besides the underestimation of probable increases in the cost of production, recently the cost of capital has been high and few can be certain on the level of interest rates in the future.

Notwithstanding these reservations about the estimates of ALUTERV-FKI, those who accept it could argue that, compared with the estimates of Langton, Robson and Frame, Ghana-produced alumina is competitive with rival alumina from the traditional sources.

The KAISER-led consortium of Bauxite Alumina Study Company (BASCOL) on the other hand had, in mid-1975, concluded that a 600,000 tonne/year alumina refinery which is located at Tema would yield, over a ten year period of realisation, manufacturing costs averaging $77/tonne alumina and debt service expenditure averaging $65/tonne (constant mid-1975 U.S. dollars). Consequently, the total average alumina cost (constant mid-1975 dollars) would be $142/tonne.

Among other things discussed in Chapter 4, it is significant that the BASCOL Feasibility study selected a period of just 10 years to retire the entire debt while ALUTERV-FKI chose a time span of 12 years to retire the debt. Besides, while ALUTERV-FKI chose a twenty-year period of realisation, BASCOL used a short pay-back period of ten years for this long-term project. BASCOL's pessimistic assumptions merely reflected the higher degree of uncertainty which they chose to attach to the project. This assumption notwithstanding, the 1975 average constant dollar cost of Ghanaian alumina (as estimated by BASCOL) competes effectively with actually reported pro-

duction cost of alumina of Jamaican origin in the corresponding period from facilities which are largely amortised.

Quoting from the Jamaican Bauxite Institute, Mathurin indicates that the average cost of producing alumina in Jamaica for 1975 and 1976 were, respectively, US $150/long ton (i.e. US $147.6/tonne) and US $182/long ton (US $179/tonne)[10].

As a further corroboration of the fact that BASCOL's pessimistic valuation of Ghanaian alumina costs still competes with Jamaican alumina, the port-of-shipment values for Jamaican alumina exports, as recorded by the U.S. Bureau of Census, may also be cited. As Table 3-7 illustrates, the f.a.s. (free alongside ship or port-of-shipment) values for Jamaican alumina exports to the U.S. for 1976 (January - September) averaged U.S. $144.66/long ton (i.e. U.S. $142.38/tonne).

If the f.a.s. valuation of Jamaican alumina exports is chosen in preference to the data of the Jamaican Bauxite Institute, the cost of ocean freight and insurance for Jamaica-to-Ghana alumina cargoes has to be added to obtain the landed alumina cost.

According to the United States Bureau of Mines (USBM), in 1976, the f.a.s. and c.i.f. values for cargoes of Guinean bauxite exported to the U.S. were respectively, $18.90/long ton and $26.44/long ton. This implies a freight plus insurance cost of $7.54/long ton ($7.42/tonne) for Guinea-to-U.S. bauxite shipments[11].

On the assumption that the Jamaica-to-Ghana alumina cargo shipments would have freight and insurance rates similar to the Guinea-to-U.S. bauxite cargo rates, the c.i.f. rate for the Jamaica-to-Ghana alumina exports would, on the basis of the f.a.s. valuation, approximate to $149.8/tonne (that is, $142.38/tonne plus $7.42/tonne).

Again, the competitiveness of the average cost of Ghanaian alumina (vis-à-vis imports from Jamaica) is confirmed.

TABLE 3-7: The Bauxite/Alumina Imports Of The U.S.A. From Jamaica (General Imports[1])

COMMODITY	Year Jan.-Sept. (a)	Gross Weight (Long tons) (b)	Customs Value[2] U.S. $ (c)	F.A.S. Value[3] U.S. $ (d)	F.A.S. Value Per Long Ton (e)	C.I.F. Value[4] U.S. $ (f)	C.I.F. Value per long ton (g)
A. BAUXITE	1976	7,052,738	182,291,318	182,301,268	$25.84	201,277,638	$28.54
	1977	5,410,467	151,201,461	151,211,461	$27.95	166,457,866	$30.77
B. ALUMINA	1976	549,747	79,525,645	79,525,285	$144.66	83,370,017	$151.65
	1977	389,453	64,140,041	64,140,041	$164.69	68,260,892	$175.27

Source: David Mathurin, "A Study of the Components and The Determinants of (Unit) Prices Costs and Revenues in Jamaica's Bauxite and Alumina Industry", Mimeograph, Institute of Social and Economic Research, University of the West Indies, Kingston, Jamaica, April 1978.

Notes: (1) "General Imports" are imports for immediate consumption plus those destined for the warehouses. In other words, it is the total arrival of the particular commodity at the U.S. ports of entry.

(2) "Customs Value" represents the value of the imported commodity in the foreign country. This value excludes U.S. tariffs, freight insurance and other fiscal charges associated with the shipment to the U.S.A. This is used in the assessment of import duties and generally differs from the actual transaction value.

(3) The "F.A.S. Value" or free alongside ship represents the transaction value of the commodity at the foreign port of exportation. Generally, it involves the procurement costs plus those costs associated with the delivery of the commodity alongside the ship at the foreign port from where the goods are to be exported to the U.S.

(4) "C.I.F. Value" in full is the cost of the commodity, insurance of the freight plus all other charges associated with the placement of the merchandise alongside the ship at the port of entry in the U.S. It excludes U.S. import duties.

The impact of transport costs on the competitiveness of bauxite and alumina from the alternative sources are very well illustrated by Appendix A3-9. Cargo rates peaked in 1974 with Jamaica/U.S. rates at $3.75 - $5.50/tonne; Australian rates within $16.40 - $18.75/tonne; and Guinean rates within $6.00 - $7.25/tonne. Although these rates have come down considerably since then, Australian delivery costs for bauxite/alumina exported to the U.S. and European markets are still 100% more than the similar cargo rates for Guinea-to-U.S.A. and Jamaica-to-U.S.A.

Appendix A3-10 also shows the relative proximities of traditional suppliers to the main consuming areas. Jamaica is closer to the U.S. market. Asian markets are within easy reach of Australia. West African sources are nearest the EEC market. Naturally one would expect the proximity of the various suppliers to influence the comparative economics of supply vis-à-vis each of these markets. As such, any excess output from Ghana can be most advantageously marketed in the European market.

Notwithstanding the apparent competitiveness of aluminium production in Ghana, arising from its cheap power, reasonable manufacturing cost for alumina, and proximity to the European market, KAISER and REYNOLDS may not necessarily be wholly convinced of the efficacy of investing in mine/refinery facilities to complete the mine-to-metal complex. Not least of their reasons for hesitation would be marginal cost considerations and whether or not any excess output which would be necessitated by economies of scale would be marketable.

The decision of the aluminium producers, whether or not, to increase capacity and/or supply of bauxite/alumina/aluminium at various price levels depends primarily on marginal costs. To the producers, it is simply a question of whether to utilize idle and largely amortized plant capacity to obtain the additional tonnage required or whether to supply the same quantity of the commodity from new greenfield facilities yet-to-be established in Ghana.

Besides the uncertainty over the politico-economic situation in Ghana, there could be genuine concern about the long 4-5 year pre-production period necessary to construct the facilities. During this long construction period, the market for the commodity could very well alter drastically.

Also, since installation costs are already sunk in Jamaica and Australia, the producers would be unwilling to invest a capital of $1,000/tonne of alumina capacity when idle plant elsewhere could be mobilized rapidly to produce the same requirement at less risk. All that would be required would be the addition of more labour and raw materials in Jamaica and Australia.

As Appendix A3-2 demonstrates, in 1979 KAISER and REYNOLDS each had smelter capacities of 1.1 million tonnes. At the conversion ratio of 1.95 tonnes alumina/tonne metal produced, the alumina requirements for each of the companies were 2.1 million tonnes. However, Appendix A3-16 reveals that KAISER owned refinery capacity amounting to 3.1 million tonnes while REYNOLDS owned 2.7 million tonnes in 1979. Clearly, the development of additional alumina capacity is superfluous under present market conditions.

Therefore, if the growth in the alumina/aluminium market remains unchanged from present levels, the debate as to whether VALCO's owners should integrate backwards is, in effect, confined to replacement. By this, one is implying that the choice is whether or not the companies can be persuaded to phase out production in Jamaica and Australia in favour of new production from Ghana. It is obvious why the producers would prefer to maintain capacity in Jamaica and Australia. What is, however, not obvious is what Ghana can now or in the future afford to do in order to justify the production switch and thereby attract the requisite alumina investment.

The inclusion of Article 17B of the Master Agreement - as the penalty for the continued use of non-indigenous alumina after 1977 - indicates that both parties (Ghana Government and the KAISER-

REYNOLDS consortium) foresaw the present scenario whereby the VALCO still produces aluminium from imported alumina.

Since the case for the perpetuation of the status quo depends also to a large extent on the market for alumina and aluminium, Chapter 3.5 discusses the nature of the market for these commodities.

Chapter 3.5: Market Considerations

In Chapter 3.4, it was argued that Ghana's power price is highly competitive. On this basis, the continuation of VALCO's "tolling" operations at Tema is justified economically. Also, recent estimates of the average cost of Ghanaian alumina appears comparable to the cost of rival alumina from the traditional locations.

Notwithstanding the apparent comparability of average costs, it was argued that one of the critical determinants of where to obtain the additional alumina requirement is the marginal cost of the commodity in each of the alternative locations. If the growth in alumina/aluminium demand were substantially higher than supply, and if KAISER and REYNOLDS did not have excess alumina capacity, then, the question of increasing alumina capacity would simply be a matter of ranking the viability of a number of greenfield proposals in alternative locations - including Ghana. In such circumstances, Ghana's problem would simply be one of assembling a competitive package of inducements to attract the requisite investments for a bauxite-to-alumina complex.

Since VALCO's owners have excess alumina capacity, the cost to them of the supply of the additional tonne of alumina would be higher if the companies were to choose the prospective alumina plant in Ghana as the source. In Jamaica and Australia, the producers only need to add more inputs into idle plants which are largely amortized in order to obtain the additional alumina. By contrast, the producers would be faced with the additional cost of installing the alumina plant in Ghana. Consequently, the lack of interest of the aluminium producers in Ghana's proposals for backward integration into mining and refining is partly traceable to and explicable by marginal cost factors.

Besides marginal costs, there are problems of economies of scale. Because of economies of scale, viable alumina plants in Ghana need to be 600,000 tonne/year or more. The BASCOL and ALUTERV-FKI

feasibility studies into alumina production in Ghana in 1975 and 1977 confirmed as much.

If it is assumed that VALCO's 200,000 tonne/year smelter at Tema cannot be expanded (because of financial and power constraints) so as to absorb all the alumina produced from such a large greenfield plant, then effort must be directed into securing an export market for the excess output. To assess the excess output, it is assumed that the Tema smelter would operate at its full installed capacity, consuming for each tonne of metal produced 1.95 tonnes of alumina. On this basis, the inferred alumina usage by the 200,000 tonne smelter is 390,000 tonnes each year. Consequently, a prospective alumina plant with an annual capacity of 400,000 tonnes would match exactly the requirements of the smelter.

However, even ALUTERV-FKI's optimistic study showed that a 400,000 tonne/year alumina plant would be uneconomic to install and operate. Capital cost/tonne increases sharply with lower plant capacities. As Table 3-13 demonstrates, the capital costs per tonne of installed capacity, financed on a debt-to-equity ratio of 75 : 25 are: $682.3 (800,000 tonne/year), $737.5 (600,000 tonne/year), $792.5 (400,000 tonne/year), $1,102.3 (200,000 tonne/year). Table 3-5 also demonstrates that the return for capacities less than 600,000 tonne is not adequate and production costs per tonne increases substantially with lower capacities. The production costs per tonne of alumina increases as follows: $224.5 (for 800,000 tonne/year alumina plant at Tema); $237.1 (for 600,000 tonne/year alumina plant at Tema); $247.9 (for 400,000 tonne/year alumina plant at Tema); $326.7 (for 200,000 tonne/year alumina plant at Tema).

If, on the basis of economies of scale, the capacity of the prospective alumina plant is taken to be 600,000 tonnes/year, there would be a need to find an export market for 210,000 tonnes of alumina each year.

Historically, however, the international trade in bauxite,

alumina (and, until recently, aluminium) is restricted. Captive mines and refineries have always sold their output on long-term contracts to specific smelters, either already installed or planned.

From this, it is not obvious that a market would be found for any excess Ghanaian output of alumina at profitable price levels. As such, a quantitative review of the demand/supply/capacity balances and price trends for both aluminium and alumina are in order.

The consumption of bauxite and alumina are "derived" from the established demand for primary aluminium. From the established demand for primary (or virgin) metal, the "derived" demand for bauxite and alumina are inferred from the transformation ratio: 6-4 tonnes bauxite : 1.92-1.96 tonnes alumina : 1 tonne virgin metal.

Like all mineral commodities, the demand for aluminium is susceptible to cyclical variations. In the long-term, however, there are a number of indications which portend relatively buoyant demand and prices for the metal.

The annual growth rate of aluminium demand since the Second World War has been 8.2% while the rate of growth for aluminium's substitutable rivals have been : copper (4.4%); nickel (4.9%); zinc (3.1%); and tin (0.5%)[1].

The growth rate of the demand for aluminium can be said to have even outperformed several leading economies. Yotopoulos and Nugent have reported that the average unweighted annual growth rates of the GDP at constant prices was 4.7% (1950-1959) and 5.2% (1960-1969) for the developed countries as a whole[2]. The World Bank has also estimated that the average annual growth rate of the GDP of the industrialized countries was 5.1% (for 1960-1970) and 3.2% (for 1970-1978)[3]. Of the developed countries, Japan is among the few countries whose growth has consistently outperformed the growth rate in the demand for aluminium.

Some subscribe to the rule of thumb that the growth rate of the demand for primary aluminium is twice the GNP growth of the economies of the OECD countries[4]. Needless to argue, the predictive power of this rule of thumb is problematic.

Others hold the view that the consumption of a mineral per unit of GNP, defined as the "intensity of use", follows an inverted "U" pattern. That is to say that the demand of the mineral commodity per unit of GNP will rise and fall as the GNP per capita increases. The reasons assigned for this apparent phenomenon are the increases in the per capita income which bring about changes in taste, substitution of one product for the other, and the increasingly efficient use of the mineral commodity. These views are ascribed to Malenbaum[5].

Vogely, however, has taken the view that a conclusive case has not yet been made for the applicability of Malenbaum's proposition to the behaviour of aluminium demand[6]. What is applicable to aluminium demand, in Vogely's view, is a substitution process where there is increasing intensity of use as GNP per capita increases[7].

Vedavalli has also shown that the GNP growth rate of the developed countries (who account for about 90% of the global consumption of the metal) is a significant determinant of aluminium demand[8]. As Table 3-8 shows, the elasticity of primary aluminium demand with respect to the GNP of the OECD economies is large - 1.7 - 1.8. This means that large variations in the demand for aluminium are likely to take place in response to small changes in the GNP of the OECD economies.

TABLE 3-8: GNP Growth Rate of Developed Countries and the Demand For Aluminium

	1961-1974 %	1977-1980 Per Annum	1981-1985
GNP Growth Rate	4.8	4.6	4.5
Growth of Aluminium Consumption	9.0	7.6	7.6
Elasticity of Primary Aluminium with respect to GNP	1.8	1.7	1.7

Source: Vedavalli, op. cit., p.5.

Since the discovery of aluminium a mere 150 years ago and the advent of the Bayer/Hall-Heroult technologies almost a century ago, all branches of industry have and continue to use the metal in a variety of applications. The rapid growth in demand owes much to its versatility, lightweight, strength, malleability, ductility, conductivity, non-toxicity and aesthetic qualities. Appendix A3-11 shows that the increases in demand in all branches of industry is considerable.

However, on account of the slower growth rates being experienced in the developed economies, several authoritative sources forecast some tapering off in the demand. Besides the slower growth rates of GNP, it is natural for the demand for the metal to taper off as the metal advances along its life curve towards maturity. The view from KAISER is that, although the underlying demand for the rest of the decade will taper off to between 4% and 6%,

> "..... aluminium growth could, at times, be "supply-limited" - that is, demand will be greater than the industry's supply capacity - for much of the decade."[9]

The various authoritative forecasts for aluminium demand are presented in Table 3-9 below.

TABLE 3-9: Various Forecasts for Aluminium Demand

	Forecast Period	Predicted Growth Rate (%)	1990 Consumption (million tonnes)
Malenbaum	1971/75-2000	3.0	20.9
Leontieff	1970 - 2000	4.8	26.1
U.S. Bureau of Mines	1974 - 2000	5.5	28.5
Commodity Research	1975 - 1985	7.7	37.3
IBRD	1975 - 1985	8.4	40.5

Source: Marian Radetzki and Stephen Zorn, "Financing Mining Projects In Developing Countries", MINING JOURNAL BOOKS (London), 1979, Table 5, p.16.

Given the fact that mine/refinery facilities are always purpose-built, it is reasonable to assume that the aluminium producers, who have the ability to underproduce during periods of sluggish growth and thereafter expand output to meet increasing demand, would add enough refinery capacity to meet any anticipated increase in aluminium demand.

Figure 3.4 clearly illustrates that, for the non-Communist world, the demand for primary aluminium has outpaced the supply of primary aluninium for most of the 70's. The exception was the recession of 1975 period when primary aluminium inventories rose to 36% of consumption. As Figures 3.5 and 3.6 respectively show, the capacity utilisation of aluminium smelters in the Western World has varied between 80% - 92% while the stocks of primary aluminium have, on the whole, remained between 10% - 20% of consumption levels.

In spite of the probability that recycled aluminium could depress the demand for primary aluminium, there are a number of technical drawbacks which could temper the overall impact of secondary aluminium. Contaminants such as stainless steel, zinc and magnesium in aluminium scrap (whether free or alloyed) are generally difficult to detect and remove completely. Non-metallic contaminants, such as, paints, oil, insulation, rubber plastics also introduce pollution problems[10]. Thus, the problems of collection and assembling suitable stocks of processible aluminium-bearing scrap could also be costly. Therefore, on account of the cost and technical problems of reclamation, it is plausible to assume that secondary aluminium will have only a minor impact on the demand for the metal.

This means that the tight demand/supply balances for primary aluminium which are anticipated for the 80's is unlikely to be influenced significantly by the secondary aluminium industry.

The tight demand/supply balances for primary aluminium have led, a fortiori, to generally firm aluminium prices (See Figure 3.3). Although a rapid rate of increase in the prices of mineral

Figure 3·3 The prices of primary aluminium (US $ / tonne) – The American metal market

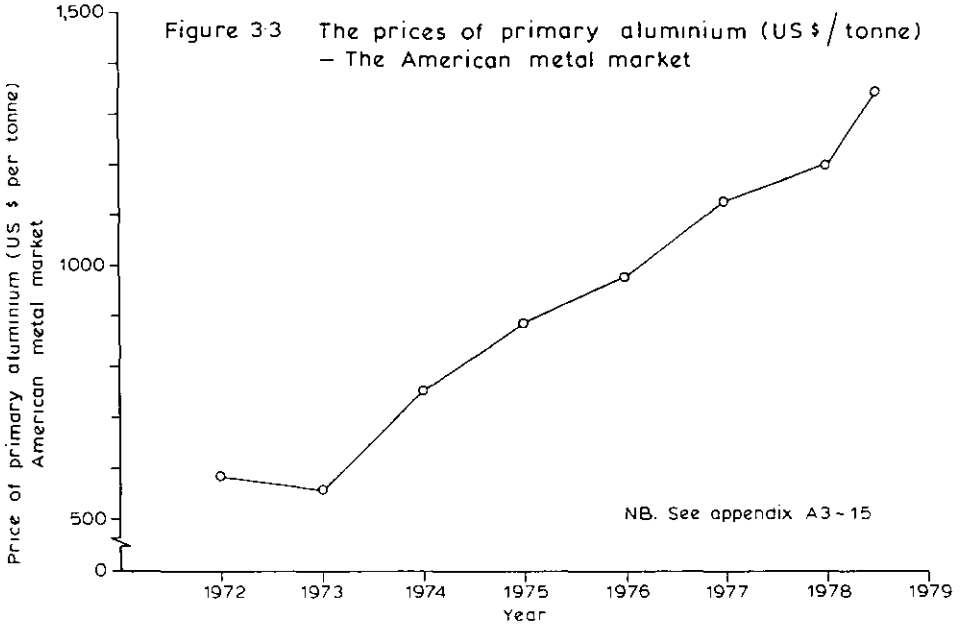


Figure 3·4 Production and consumption of aluminium in the western world

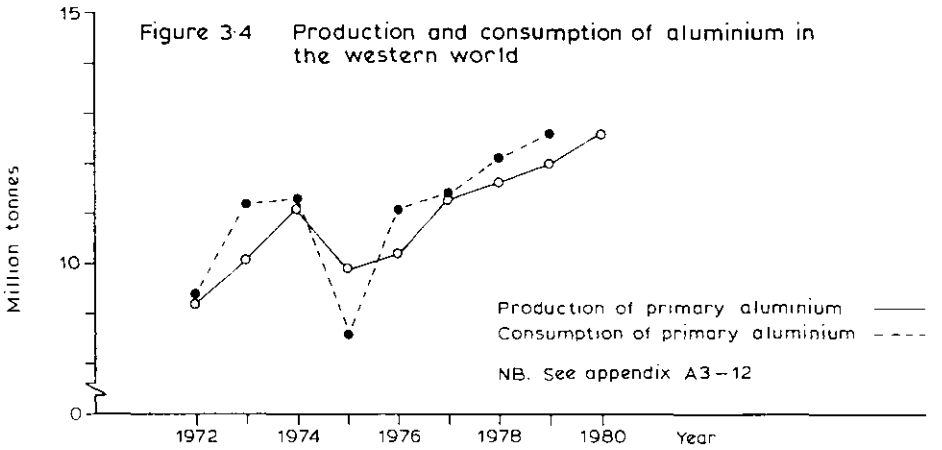


Figure 3·5 CAPACITY UTILISATION in the western world

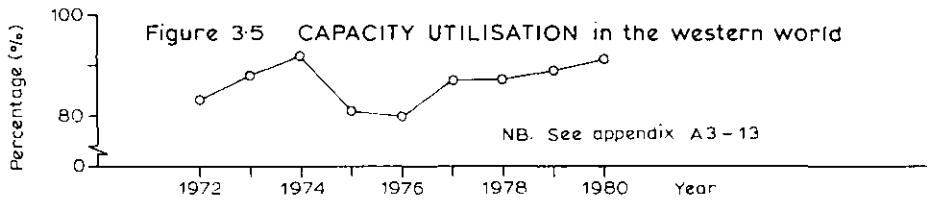
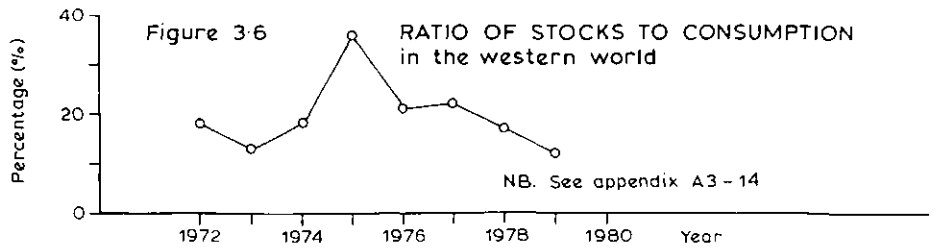


Figure 3·6 RATIO OF STOCKS TO CONSUMPTION in the western world



commodities could ultimately lead to their being priced out of the market, a close review of aluminium's price behaviour reveals that aluminium is relatively free from this kind of threat.

As Table 3-10 below evidently illustrates, the price movement of aluminium has clearly lagged those its rival metals. This price lag implies that aluminium is, by far, less susceptible to substitution (on account of its price) than its rival metals.

TABLE 3-10: Growth Rates of The Prices of Aluminium, Copper, Tin, Zinc, Steel and Lead (1964 - 1979)

Metal	Average Annual Increase (%)
Primary Aluminium	6.5
Refined Copper	7.8
Tin	11.1
Zinc	6.9
Steel-bars	7.9
Lead-pig	9.0

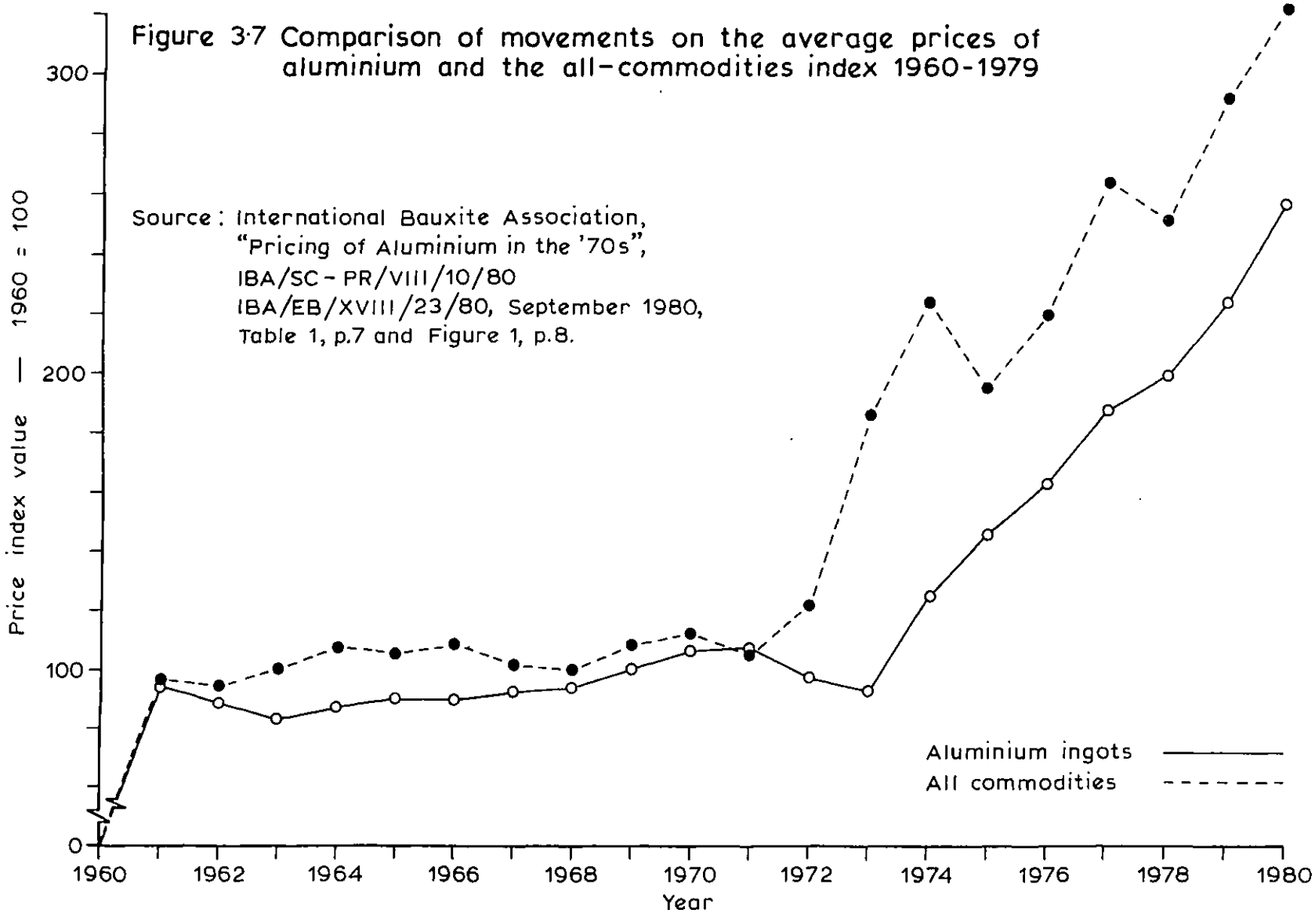
Source: International Bauxite Association (IBA), "Pricing of Aluminium In The '70's", IBA/SC - PR/V111/10/80, IBA/EB/XV111/23/80, September 1980, Table 4, p.14.

Furthermore, aluminium's competitiveness is enhanced by the fact that the price movements for aluminium lags the index for the fifty-five commodities traded internationally (See Figure 3.7). This is significant because inroads could be made into the demand for aluminium, not only by the substitutable metals mentioned above, but also by such non-metallic commodities such as wood (in the large but competitive building and construction industry), plastics, glass and paper (in the container and packaging industries).

On the basis of these indications, it is plausible to anticipate the underlying strength of demand and prices for primary aluminium to remain firm for the 80's at least.

In spite of these favourable indications for the growth of

Figure 3·7 Comparison of movements on the average prices of aluminium and the all-commodities index 1960-1979



aluminium demand and prices, there are uncertainties which cannot be ignored. As a result of the present recession, several aluminium producers are cutting back production. KAISER is now operating at 62% of its installed capacity and is expected to make an overall loss for 1982 (VALCO information).

The problem, given the depth of the current recession, is that there is nothing to suggest that, in the expected recovery, the supply/demand pattern for alumina/aluminium will revert to pre-recession levels. This uncertainty could reinforce the unwillingness of the producers to promote the proposed alumina investment in Ghana.

Even if one were to assume pre-recession buoyancy in aluminium demand and price, the proliferation of alumina/aluminium producers has significantly reduced the dominating hold once held by the six-member oligopoly in relation to the supply and pricing of alumina and aluminium. Consequently, there is increased uncertainty in the market which will influence investment appraisal.

Besides the impact of increased number of producers on the alumina/aluminium market, the price behaviour of aluminium cannot be considered as automatically translatable into similar trends for alumina prices.

On account of the vertically-integrated structure of the industry and the probable existence of excess alumina capacity, shortfalls in supply could be met by intra - and inter-company co-operation, using the "barter", "toll-processing" or "swapping" mechanisms. So, rather than add new alumina capacity, companies could very well secure their alumina requirements outside the framework of arms length trading in the open market and, thereby, effectively weaken the relationship that ought to exist between the supply/demand pressures and alumina price levels.

If one allows for a reasonable margin of error due to the difficulty of getting data relating to the Eastern block countries,

and also estimate non-metallurgical alumina usage at 8% of alumina demand, the world alumina capacity/demand/supply balances (Table 3-11) could be said to show that alumina supply and demand has been tightly matched so far. On the basis of this 1980 forecast, one could continue to expect the balance to be tightly matched for the near future as well.

This is not entirely surprising as most refinery plants are captive to established smelters. Table 3-11 also demonstrates that, although alumina demand is expected to rise from 31.4 million tonnes in 1978 to a level of 45.1 million tonnes in 1989, alumina capacity can be expected to rise to 48.8 million tonnes - enough to cope with demand and provide reserve capacity.

In spite of the expected expansions in global alumina capacity, the uncertainty on future demand and the surplus alumina/aluminium capacities of KAISER and REYNOLDS mean that, the shareholders of these companies would probably see the development of the Ghanaian alumina venture, at the present time, as superfluous.

Alumina demand/capacity balances apart, there is the problem of settling the price of alumina for any mine/refinery venture in Ghana. Although alumina, in general, follows the fortunes of the metal, its price tends to be settled secretly between the seller and buyer on long-term contracts. To ascertain these contract prices is extremely difficult because of the extensive intra-company transfers of the commodity which are subject to the accounting and financial objectives which embrace the globally dispersed mines, refineries and smelters. Consequently, the prices assigned to alumina are more often a reflection of where the companies wish to show their profits than the valuation of the commodity based on their true costs of production and supply/demand pressures.

An alternative to fixed contract prices for alumina are formulae which attempts to link alumina price to that of primary ingot aluminium. The BASCOL study, for example, proposed the following

TABLE 3-11: World Alumina Capacity/Demand/Supply Balances

	1971	1972	1973	1974	1975	1976	1977	1978	←FORECAST→ 1983	1989
Year-End World Alumina Capacity[1]	25.2	28.4	31.7	32.4	34.3	34.9	34.3	34.8	38.6	48.8
World Alumina Production (TOTAL SUPPLY)[2]	22.3	23.6	26.4	28.6	26.1	26.9	30.1	30.8	32.8	41.5
Primary Aluminium Production[3]	11.0	11.7	12.8	14.0	12.8	13.2	14.3	14.8	16.8	21.3
Metal-Grade Alumina Demand @ 1.95[4]	21.5	22.8	25.0	27.3	25.0	25.7	27.9	28.9	32.8	41.5
Non-metallurgical Alumina Usage : 8% Alumina Demand	1.9	2.0	2.2	2.4	2.2	2.2	2.4	2.5	2.9	3.6
SUB-TOTAL	23.4	24.8	27.2	29.7	27.2	27.9	30.3	31.4	35.7	45.1
Growth of inventory required to sustain higher levels of consumption @ 0%	-	-	-	-	-	-	-	-	-	-
TOTAL DEMAND	23.4	24.8	27.2	29.7	27.2	27.9	30.3	31.4	35.7	45.1
SUPPLY/DEMAND SURPLUS (DEFICIT)	(1.1)	(1.2)	(0.8)	(1.1)	(1.1)	(1.0)	(0.2)	(0.6)	(2.9)	(3.6)

SOURCES AND NOTES

1. Year-End Alumina Capacity for the world is obtained from Appendix A3-17. 1971-1978 represent actual capacities. 1983 and 1989 capacities are forecasted as per: $\frac{100}{85}$ x Forecast of Alumina Production (Note 2 below). This forecast assumes that alumina capacity utilisation is 85%.

2. World Production (Supply) of Alumina is obtained from Appendix A3-17. 1971-1978 represent actual production. The production for 1983 and 1989 are forecasted as being equal to alumina demand (See Note 4 below).

3. Primary aluminium production (1971-1978) obtained from Metallgeselschaft Aktiengeselschaft. Forecasts for 1983 and 1989 are written up as 0.85 x Kaiser's Forecast For Primary Aluminium Capacity (Appendix A3-18). This forecast also assumes smelter capacity utilisation of 85%.

4. Metal-grade alumina demand was calculated as: 1.95 x Primary Aluminium Production.

5. As Belle points out 92% of the alumina refined in the world is used as feedstock in smelters to produce aluminium. The remaining 8% is used for non-metallurgical purposes.

   See: P. Belle, "History and Analysis of Marketing Activities in The Field of Bauxite and Alumina (Case Study of Hungarian Experience)", UNIDO, ID/WG, 273/6, 10th July, 1978, p.24.

   ∴ Non-metallurgical alumina usage = $\frac{8}{92}$ x metal grade alumina demand.

   Actual figures for the non-metallurgical alumina usage in the Western World are obtainable in: IPAI, Statistical Summaries.

6. Industry normally allows for growth in alumina stocks to cater for unexpected increases in smelter demand, processing and manufacturing losses and start-up inventories for greenfield smelters. In the BASCOL study, the 16% growth in inventories were allowed for. Since the size of stocks are only a small fraction of alumina demand and are within margins for error, no allowances are made here.

formula:

$$\text{Alumina Price} = \frac{\text{Primary Aluminium Price (\$/tonne) x 0.304}}{\text{1.95 tonnes alumina/tonne metal}}$$

In the light of the underlying strength of aluminium prices (Figure 3.3), the determination of alumina price as a fixed percentage of ingot prices is significantly better than the fixed long-term contract prices. Notwithstanding this, this sort of pricing formula is disadvantageous to the producer country because it implies that the value of alumina should, for all time, be a fixed proportion (30.4% for every 1.95 tonnes in Ghana's case) of the value of the metal. Relle points out two reasons why this fixed percentage formula could be disadvantageous[10].

First, Relle cites the example of petrol and crude oil. He points out that their price movements have not always been in consonance. Why then should alumina price be rigidly tied to that of aluminium?

Secondly, Relle points out that the cost of producing aluminium (hence, the listed producer pricing mechanism) is now increasingly dependent on electricity prices while alumina costs are determined principally by the cost of bauxite, energy derived largely from fossil fuel, and the fiscal regime of the host country such as it affects depreciation and return on capital. It may, therefore, be argued that there are no justifiable economic grounds on which to rigidify the linkage between alumina and aluminium prices.

On these grounds, the method of pricing alumina for the re-assessment of the viability of alumina production in Ghana (Chapter 4) would be based on the prices imputable (by means of Articles 17 and 18 of the 1962 Agreements) to the alumina imported by VALCO's owners for conversion at the Tema smelter.

Since Ghana would ultimately have to offer inducements to the KAISER-REYNOLDS consortium to pave the way for their assistance in the

development of mining/refinery facilities in addition to its smelting operations, there is a need to assess the financial requirements and the extent to which inflation influences the feasibility of the project. The more costly the project, the greater the extent of inducements and assurances required of the Government. This assumes that the Ghana Government sees its options as limited to pressing ahead with the development of a local alumina plant.

Chapter 3.6: Investment Requirements For The Prospective Mine/Refinery Facilities In Ghana

The foregoing exposition showed among other things, that the balances between the demand and supply for both aluminium and alumina have been very tight and that shortfalls in supply could probably develop in the 80's. With the relatively favourable growth in prices, the overall market situation for aluminium augurs well for fresh investment to increase capacity. The major producers are aware of this and are willing to invest substantial sums of risk capital. As CHEMICAL WEEK recently reported, the producers are investing $10 billion dollars in twenty two smelter-expansion projects which will, together, increase the non-Communist-world's primary aluminium capacity by 2.3 million tonnes/year[1] (Appendix A3-18). It is notable that such a massive commitment of risk capital is being undertaken while capital, energy and raw material costs are rapidly increasing due to inflation and host government decisions to increase their resource rents.

To complement the additions to smelter capacity, substantial additions to alumina capacities were planned before the current downturn in demand. Table 3-12 and Figure 3.8 below demonstrate the geographical distribution of these investments. These projects are committed projects as opposed to planned investments.

The ultimate problem for the Ghanaian Government is why Ghana is being bypassed in favour of countries such as Ireland and Spain which do not even have the resources of bauxite to support the prospective refinery expansions.

The answer partly lies in the fact that the industry is hugely capital-intensive. Consequently, the investor requires not only politico-economic stability and markets but also fiscal inducements to facilitate the servicing of debt capital and to ensure an adequate return on the investment. The aluminium producers are not convinced that Ghana's politico-economic environment, at present and for the

TABLE 3-12: The Geographical Distribution Of Prospective Expansions of 200,000 tonnes/year Or More In Alumina Capacity

Country	Capacity Expansion** in period 1978-1985 (tonnes x 10^6)	1978 Capacity (tonnes x 10^6)	1985 Capacity (tonnes x 10^6)
Australia*	1.8	6.8	6.8 + 1.8 = 8.6
Venezuela	1.0	-	1.0 + 0.0 = 1.0
Brazil	0.8	0.4	0.8 + 0.4 = 1.2
Yugoslavia*	0.9	1.0	0.9 + 1.0 = 1.9
Ireland	0.8	-	0.8 + 0.0 = 0.8
Spain	0.8	0.1	0.8 + 0.1 = 0.9
Guinea*	0.6	0.7	0.6 + 0.7 = 1.3
Greece	0.4	0.5	0.4 + 0.5 = 0.9
India	0.4	0.7	0.4 + 0.7 = 1.1
Turkey	0.2	0.2	0.2 + 0.2 = 0.4
TOTAL	7.7	10.4	7.7 +10.4 =18.1

Source: R.J. Robson and P.K. Frame, "Criteria For Investment In Alumina Refining", IBA QUARTERLY REVIEW, Volume 5, Number 4, June 1980, Table 1, p.30.

Notes: * Members of the IBA.

** The expansion projects referred to in Table 3-12 above were committed projects as opposed to potential expansions.

foreseeable future, will be conducive to the inflow of capital on a massive scale.

The total amount of investment required for any project are determined by the supportive infrastructural developments, the scale of the project and, finally, the behaviour of domestic and international inflation during and after the pre-production phase.

It is now the accepted practice for the host government to develop, at its cost, the necessary infrastructure such as power supply, port facilities, access routes, townships and other utilities. The underlying reason for the increasing tendency of host governments to

Figure 3·8 Expansions of Western World Alumina Refining Capacity, 1978-1985

NOTE. Unit within the symbols are measured in millions of metric tonnes

Source : R.J.Robson and P.K.Frame, "Criteria For Investment In Alumina Refining", IBA QUARTERLY REVIEW, Volume 5, Number 4, June 1980, Figure 1, p.39.

accept the responsibility for infrastructural developments is that they have the wider aim of stimulating overall economic development. As such, the subsequent owners of the production complex merely pay to the government a price (which is often subsidised) for using the facilities. Another reason is that softer loans could be more easily arranged from the World Bank and other institutions to finance the supportive infrastructure.

The influence of the size of the project on the capital requirements are illustrated by two recent studies on alumina production in Ghana by ALUTERV-FKI and BASCOL. The estimates of ALUTERV-FKI's for the capital required for various capacity variants are set out in Table 3-13. Clearly, they illustrate that capital costs/tonne of alumina capacity decreases significantly with larger plants.

By assuming that the existing railway network in Ghana could be up-graded and slightly extended by the Government to provide the means of conveying raw materials to and from the plant, ALUTERV-FKI concluded that investment requirements could be $442 - $468 million for a 600,000 tonne/year plant which comes on stream in 1982.

In contrast to the ALUTERV-FKI study, BASCOL confined itself to the study of a 600,000 tonne/year refinery. BASCOL recommended that the bauxite should be transported to the refinery via a slurry pipeline which is not only restrictive in use but also capital intensive in its installation as well. The advantage of the slurry pipeline is the subsequent lower maintenance costs which would be incurred during the project life. BASCOL concluded that total project cost would be $340 million in constant mid-1975 dollars (that is $500 - $800 million in current dollars).

These estimates are also in line with recent estimates by KAISER for a 300,000 tonne primary aluminium greenfield complex. Figure 3.10 demonstrates that the investment requirements for each phase escalates rapidly with more advanced stages of production. For a 300,000 tonne/year primary aluminium complex, the investment costs

TABLE 3-13: Summary Of The Capital Cost Requirements As Per ALUTERV-FKI's Feasibility of Alumina Production In Ghana (Start-up 1982)

Location of Alumina Plant ⟶	KIBI	TEMA	KIBI	TEMA
Debt to Equity Ratio ⟶	80 : 20		75: 25	
1. CAPITAL COSTS (million U.S.$)				
800,000 tonnes alumina/year	576.6	551.2	570.9	545.8
600,000 tonnes alumina/year	468.0	446.3	464.1	442.6
400,000 tonnes alumina/year	338.1	319.2	335.8	317.0
200,000 tonnes alumina/year	237.5	221.7	236.1	220.5
2. CAPITAL COST/TONNE (U.S.$/tonne)				
800,000 tonnes alumina/year	720.7	689.0	713.7	682.3
600,000 tonnes alumina/year	780.0	743.0	773.5	737.5
400,000 tonnes alumina/year	845.2	798.0	839.4	792.5
200,000 tonnes alumina/year	1,187.5	1,108.6	1,180.7	1,102.3

Unit costs were calculated and compiled from: ALUTERV-FKI, "Report on the Feasibility of the Kibi Bauxite and Alumina Project,"Budapest, April 1977.

would be of the order:

(a) $100/tonne of bauxite capacity;

(b) $1,000/tonne of alumina capacity;

(c) $3,500/tonne of smelter capacity;

(d) $1,875/tonne of capacity for fabrication.

Figure 3.9 illustrates that international inflation in the 80's could be about 12% annually. This would mean that if an integrated project is delayed, the total capital requirements on a per-tonne basis, could escalate from $7,400/tonne of smelter capacity in 1980 to $20,500/tonne smelter capacity in 1989. For alumina capacity, costs would escalate from $1,000/tonne in 1980 to $2,773/tonne in 1989.

Domestic inflationary spiral also acts as a disincentive to

investors partly because it results in the actual incurred costs overshooting budgeted costs during the pre-production phase. It also results in unplanned increases in operating costs after start-up, and hence reduces company profits. If the official exchange rate remains pegged at unrealistic levels, competitiveness is also lost. In Ghana, very high rates of inflation coupled with unrealistic exchange rate policies have reduced the country's competitiveness for investible capital. However, these are not the only factors which account for the reluctance of the producers to invest in the bauxite-to-alumina venture (See Chapter 5).

Before discussing the other explanatory factors, it as well to point out that the longer the alumina venture is deferred, the less competitive it is likely to become. Indeed as pointed out earlier, the threat of non-bauxitic ores as an alternative source of alumina also means that, in the near future, KAISER and REYNOLDS could have even less reason to continue with the Jamaican production (let alone Ghana's).

KAISER has estimated that, on a global basis, the capital funds required to meet the expansions would amount to $100 billion for new capacity and $40 billion for the modernization and cost reductions in existing plants (Figure 3.12). Significantly, KAISER expects internally generated funds within the industry to account for 75% of the requirements. By this, it is confirmed that the main channel for investible capital for the industry remains to be the producers themselves. As such, if it should still be the policy of the Ghanaian Government to pursue integration, it may have to court the producers. As argued throughout, it is not certain that Ghana would be successful even in this approach.

Other estimates of the investible capital outlays needed to cope with future increases in demand also confirm that, the sums involved are substantial. Radetzki et al have estimated the capital requirements for the bauxite/alumina/aluminium industry under three scenarios of pessimistic, probable and optimistic demand. According

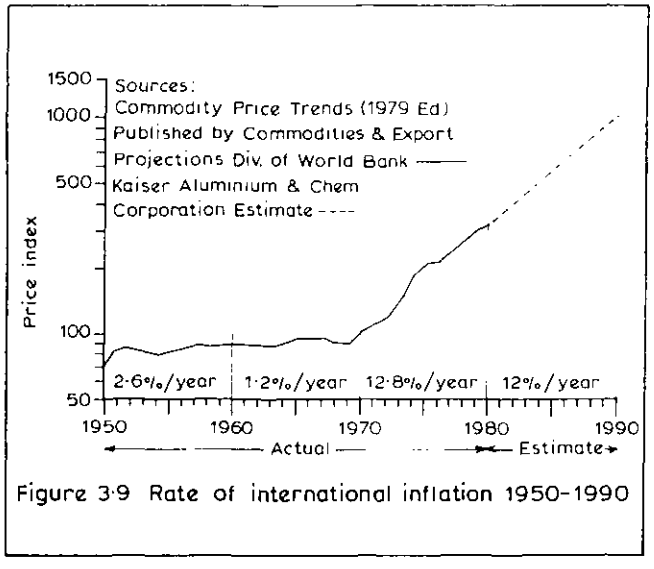


Figure 3·9 Rate of international inflation 1950–1990

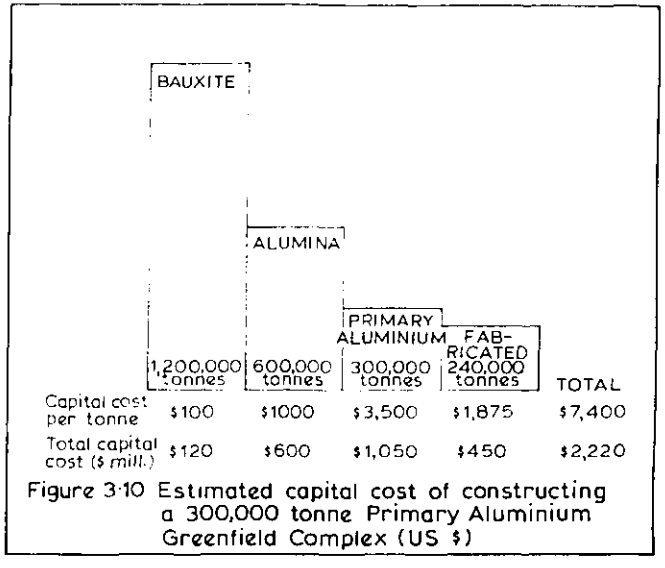


Figure 3·10 Estimated capital cost of constructing a 300,000 tonne Primary Aluminium Greenfield Complex (US $)

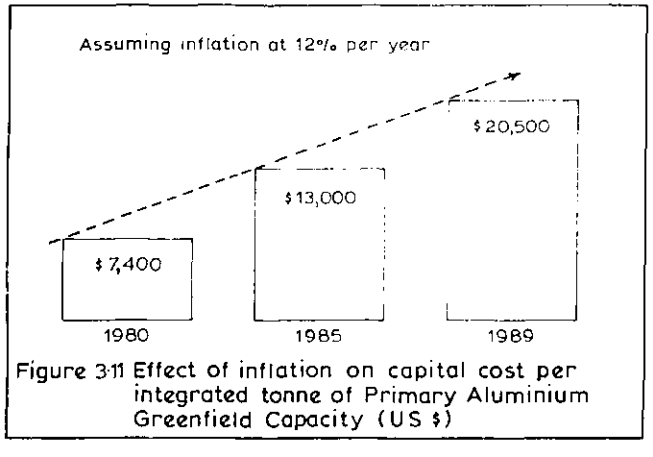


Figure 3·11 Effect of inflation on capital cost per integrated tonne of Primary Aluminium Greenfield Capacity (US $)

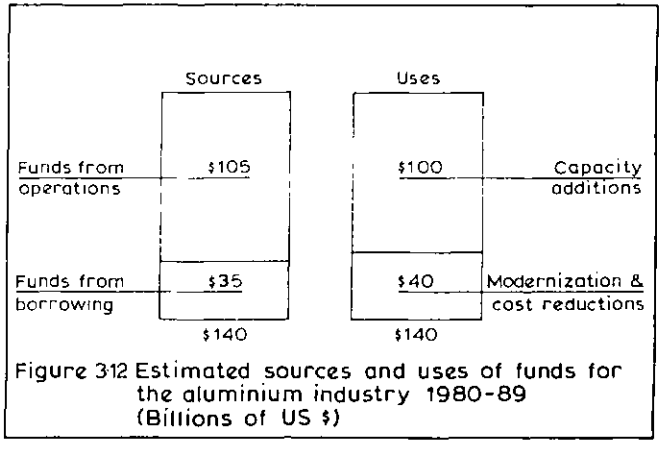


Figure 3·12 Estimated sources and uses of funds for the aluminium industry 1980–89 (Billions of US $)

Sources for figures 3·9, 3·10, 3·11, 3·12 William Hobbs (Vice President and Chief Financial Officer), Kaiser Aluminium and Chemical Corporation, "Financing the Aluminium Industry in the 1980's", paper delivered at FIRST INTERNATIONAL ALUMINIUM CONFERENCE, Madrid, Spain, September 29, 1980, to be published in Proceedings of... by METAL BULLETIN.

TABLE 3-14: Estimated Cost of Mining and Processing Plants 1978-90 (Millions of 1977 U.S. Dollars)

	Consumption Growth Estimates		
	Low	Probable	High
Bauxite	3,367	4,743	6,294
Alumina	13,378	16,968	20,990
Aluminium	22,431	26,610	37,652
TOTAL	39,176	48,321	64,936

Source: Radetzki and Zorn, "Financing Mining Projects in Developing Countries", MINING JOURNAL BOOKS, 1979 p.29, Table 18.

to their estimates for the industry as a whole (Table 3-14), the cost of investment could be in the range $39 - $65 billion for the period 1978 - 1990. For alumina investment requirements in particular in the same period, capital requirements would be in the range $13 - $21 billion (1977 U.S. dollars).

On the assumption that 65% of the bauxite investments, 25% of alumina investments and 23% of aluminium investments would go to developing countries, Radetzki et al estimate that developing countries' likely share of projected investments for the aluminium industry are as outlined in Table 3-15. They estimate that between $3.3 billion and $5.2 billion (1977 U.S. dollars) is likely to be earmarked for alumina investment in developing countries. On the basis of current costs for economic-size alumina plants, Radetzki's estimates imply only about 6-10 alumina plants for the 1977-1990 period. For the number of countries competing for alumina investments, this number of plants is very small. It is not obvious that Ghana would be either justified in competing for these few projects, or indeed if it entered the competition, it could afford the requisite inducements which would succeed in attracting the producers.

Mikesell has also estimated that if aluminium demand grows at

an annual rate of 6% between 1977 - 1990 and 5% between 1990 and 2000, then the aggregate investment required to meet the cost of the additional capacity would be $22 billion (1975 dollars) for alumina plants and $69 billion (1975 U.S. dollars) for aluminium smelters in the entire period of 1977 - 2000. If developing countries attract 25% of the alumina investments, then Ghana ought to be competing for $5.5 billion worth of alumina investments in the 1977 - 2000 period[2]. On the estimates of Mikesell and BASCOL, the capital requirement for the alumina project in Ghana is 6% of the total funds likely to be invested in the developing countries in the 1977 - 2000 period.

TABLE 3-15: Developing Countries' Likely Share of Projected Investments For The Bauxite/Alumina/Aluminium Industry, 1978 - 1990 (Millions of 1977 U.S. Dollars)

	Consumption Growth Estimate		
	Low	Probable	High
Bauxite	2,189	3,083	4,091
Alumina	3,344	4,242	5,248
Aluminium	5,159	6,120	8,660
TOTALS	10,692	13,445	17,999

Source: Marian Radetzki and Stephen Zorn, "Financing Mining Projects in Developing Countries,"MINING JOURNAL BOOKS (LONDON), 1979, Table 20, p.30.

The import of Chapter 3.6 is that greenfield bauxite/alumina/aluminium plants require substantial sums of capital expenditure. Consequently, only very large plants are economic. In Ghana's case, only alumina plant capacities of 600,000 tonnes/year or more are viable. In 1980 dollars, it would require an investment of $1,000/tonne. Besides the prohibitive cost of installation, the domestic inflationary spiral (estimated at over 100%) as well as high international inflation (estimated at 12% for the 1980's) will have the combined effect of increasing costs during and after a 4-5 year gestation period. After this pre-production phase of up to 5 years, there is no certainty that pre-installation market conditions would

still prevail.

Coupled with the high cost of installation, the impact of inflation, and market uncertainty, there is the permanent danger of the substitution of non-bauxitic ores as the viable and alternative source of soluble alumina. In that event, the producers may even have less reason to develop an alumina plant in Ghana. Consequently, by deferring the alumina venture, the project is likely to prove increasingly uncompetitive, and hence, less likely ever to be launched.

Besides, the estimates for alumina investments in the developing countries as a whole for 1977-2000 is likely to amount to no more than $5.5 billion (1975 dollars). On this scale, the number of alumina plants that may be built in the developing countries as a whole may number only 10-20. Given the domestic problems, the constraints of the 1962 agreements, the modus operandi of the international aluminium industry and the overall market uncertainties, it is quite obvious that there is very little prospects of Ghana succeeding in hosting one of these large scale alumina projects. There is nothing identifiable that Ghana can do or afford to offer the producers to attract the scale of investment required.

Notwithstanding the apparently gloomy prospects for the inflow of the requisite alumina investments, it is necessary to get the record straight. It has to be demonstrated that, contrary to the KAISER-led verdict of the BASCOL study in 1975, the bauxite-to-alumina venture is profitable on the basis of the BASCOL estimates at the time. Its non-development is, however, traceable to and explicable by the high politico-economic risks attached to the project rather than the economics of production or unprofitability per se. The aim of Chapter 4 is to prove this point.

The establishment of this fundamental situation is an important pre-requisite of a survey of the range of feasible policy options open to the Ghana Government. If it is established that the continued fragmentation of the industry is largely due to the high

risks associated with integration, it might explain the logic of the recommendation in Chapter 6 that the pursuit of integration as a central policy goal should be abandoned. If KAISER argues that the Ghanaian alumina venture is uneconomic, it is doing so merely because the company wishes to contain politely the mounting domestic pressure for an investment which, in the view of the company, is not only high-risk but superfluous for its own immediate and foreseeable requirements.

CHAPTER 4: THE CASE FOR INTEGRATION

Chapter 4.1 Overview

The neutral observer of the fragmentation in Ghana's aluminium industry would naturally wish to know whether the backward integration of VALCO's tolling operations into mining and refining is, economically, a viable proposition, in the first place.

Secondly, the neutral observer may wish to know why VALCO's owners do not wish to produce alumina in Ghana - if the proposed alumina venture, as argued in this Chapter, is profitable.

Thirdly, one may wish to know why the KAISER-led study used lower prices and adopted a generally pessimistic approach to the investment appraisal - particularly as it is being argued that there is much to be gained from the competitive price of the locally available inputs as well as from the savings inherent in the localization of the various stages of production in Ghana?

The answer to the first question is in the affirmative. That is to say that, on the basis of BASCOL's estimates in 1975 and the estimates of the actual alumina prices earned by KAISER and REYNOLDS, a bauxite-to-alumina venture is profitable. This must be seen as the logical extension of the case advanced earlier in Chapter 3 that, Ghanaian power and alumina (two of the most critical input and expense items in the commercial production of aluminium) are competitive in price when compared to rival supplies from the traditional sources in the Caribbean, Australia and the U.S.A.

However, it has to be recalled from the exposition in Chapters 1 and 2 that the worsening politico-economic situation in Ghana coupled with the favourable tax advantages negotiated in 1962 have introduced serious obstacles for the further development of the aluminium industry. One of the obstacles is the uncertainty of VALCO's owners about the retention of the same tax incentives or securing a better package in the re-negotiations which would be prompted by the

implementation of the bauxite-to-alumina venture. Another problem which transpired from Chapter 1 was that, given the recent record of nationalisations in Ghana, VALCO's owners are naturally hesitant to promote such a costly project. To KAISER and REYNOLDS, the implementation of the alumina venture would jeopardize the lucrative "tolling" operation at Tema and make the resultant bauxite-to-aluminium complex more easily nationalizable.

Additional obstacles emerged from the discussions in Chapter 3. It transpired that the high cost of the alumina project, inflation, supply/capacity/demand balances and trends as well as marginal cost considerations, together, do not justify (in the view of VALCO's owners) the development of a Ghanaian alumina plant. To KAISER and REYNOLDS, all the additional alumina required by them to meet current and anticipated demand for aluminium could be more easily supplied by utilizing idle capacity in Jamaica and Australia. More importantly, this supply can be secured at less marginal cost and at less risk.

Additional explanations for the lack of interest and pessimism of VALCO's owners towards integration are also argued in Chapter 5. Together, they explain why KAISER and REYNOLDS are not interested in a project that has been argued here to be viable.

The answers given above to the first two questions explain the third. That is, why VALCO's owners have (in the past) and probably will (in the foreseeable future) adopt a pessimistic attitude towards the investment appraisal. It could plausibly be argued that such an approach is merely a polite and convincing way to deflect or contain mounting pressure in Ghana on the company to invest in a project which could be considered with justification (if one looks at the problem solely from the perspective of VALCO's owners) to be unsafe, first in its own right, and secondly from the probability that the existing lucrative arrangements may be jeopardized. If the alumina project is shown to be uneconomic, what then is the case for the investment?

Chapter 3 also identified capital as one of the most critical expense items. Because of the significance of capital, the viability of bauxite/alumina/aluminium investments can very much depend on the way in which capital is treated in the project assessment. As such, the treatment of capital in the project appraisal turned out to be one of the means by which the alumina venture was shown to be uneconomic.

Besides the treatment of capital and the allocation of costs to other inputs, the prices assigned to the marketable output is also immensely significant. Because of the absence of arms length pricing mechanisms for bauxite, alumina (and until recently, aluminium), there is particular difficulty in arriving at a fair price for the bauxite and alumina. The prices assigned to alumina therefore became another effective avenue to demonstrate that the project is uneconomic and must, therefore, be shelved in the meantime.

As such, the KAISER-led BASCOL study in 1975 has been re-examined for two reasons. First, the price imputed to the alumina was unduly low. Secondly, on account of the high degree of uncertainty and risk attached to the prospective investment in Ghana, the financial structure assumed for the project analysis called for a short payback period for what ought to be a long-term project.

To argue out the case that the alumina price used by BASCOL for its 1975 study was unduly low, reference is made to the alumina prices being earned by KAISER and REYNOLDS for the supply of alumina to the Tema smelter in the 1967-1980 period. Reference is also made to other contract prices to enable a fair comparison to be made.

By using the prices being earned by KAISER and REYNOLDS for the alumina supplied to the Tema smelter, the re-evaluated cash flow turns out to be highly profitable.

Against this backdrop, Chapter 4 is confined to showing that the alumina project is profitable. But as profitability per se has

not and cannot be expected to generate the requisite interest of VALCO's owners in the project, Chapter 5 examines the problems of implementation on the assumption that the Ghana Government still considers the integration of the aluminium industry as the cornerstone of its development strategy.

There are, however, feasible options other than the relentless pursuit of a mine-to-metal complex. These other options are explored in Chapter 5 and 6.

Chapter 4.2: The Economic Justification For Integration

The main conclusions of the BASCOL report which is to be re-assessed were as follows:

(i) The Kibi bauxite is not only processible but also, the reserves are adequate. The measured (or proven) ore reserves were estimated to be 132.3 million short dry tons - that is, 120 million tonnes. (This deposit is one of three major deposits of bauxite in Ghana).

(ii) With a specific bauxite usage of 2.624 tonnes/tonne alumina, and consequently, an annual usage of 1.574 million tonnes for the proposed 600,000 tonne refinery, a life of 76 years can therefore be guaranteed for a mine-to-metal complex dependent only on the Kibi bauxite.

(iii) Although restrictive in use and capital-intensive in its installation, it was recommended that the bauxite should be conveyed to the 600,000 tonne/year refinery (located next door to the 200,000 tonne/year smelter at Tema) via a slurry pipeline rather than by railway carts. The advantages of the slurry transport of the bauxite were identified as lower maintenance costs of the transport system and the reduction of the water bills at the alumina plant site because of the possibility of re-cycling the water used in slurrying.

(iv) In constant 1975 dollars, the capital cost of the mine-refinery complex was estimated at $340 million. The breakdown of the capital cost estimate are as follows:

Fixed Assets	$304,927,000	
Working Capital	19,525,000	
SUB-TOTAL		$324,452,000
Less Permanent Housing and Support Facilities paid for by the Ghana Government		(24,485,000)
Financing Cost and Interest Charges		40,000,000
TOTAL CAPITALISATION:		$ 339,967,000 i.e. $340 million

(v) Of the capital cost amounting to $340 million (constant mid-1975 dollars), 75% ($255 million) would be borrowed and 25% ($85 million) would be equity subscriptions.

(vi) The debt capital would be retired completely by 20 equal, and semi-annual instalments - that is, at the rate of $25.5 million/year (constant mid-1975 dollars).

(vii) On the basis of a ten year period of realisation, total manufacturing cost would average $142/tonne alumina (constant mid-1975 dollars) - that is, $77/tonne for the cost of production and $65/tonne to cover debt servicing (see Table 4-3, Notes 12 and 13).

(viii) For the cash flow analysis, BASCOL settled the price for Ghanaian alumina as $131/tonne. A price of $0.39/pound of metal was assumed and the formula used was as follows:

$$\text{Alumina Price (\$/tonne)} = \frac{\text{Aluminium Price (\$/tonne) x 0.304}}{\text{2 tonnes alumina/tonne metal}}$$

On the basis of the foregoing, BASCOL concluded that for the ten year period of realisation, a mine/refinery complex would incur a cash deficit of $95.5 million (constant mid-1975 dollars) for the first seven years and $80 million (constant mid-1975 dollars) for the ten year time span (Appendices A4-1 and A4-2).

Even if BASCOL's pessimistic assumptions regarding the capital structure and risk are accepted, a reassessment of the cash flow is warranted because of the low price of $131/tonne imputed to the Ghanaian alumina. Specifically, because there is no arm's length alumina pricing mechanisms and also because at least 65% of the projected alumina output from the 600,000 tonne/year refinery would be expected to be processed by the Tema smelter, it is fair to suggest that existing arrangements covering the alumina which is supplied by KAISER and REYNOLDS should also apply to any alumina to be supplied from Ghana. After all, the local alumina would be comparable (in quality) to the alumina being imported into Ghana from Jamaica and elsewhere.

The Long Term Tolling Agreement and the Master Agreement together sanctioned that KAISER and REYNOLDS, in proportion to their equity holdings in VALCO's smelter at Tema, could supply imported alumina to the smelter for conversion from 1967 to 1977. After this period, the continued use of imported alumina was to be subject to a penalty.

The two key provisions which deal with the supply of alumina are Articles 17 and 18 of the Master Agreement.

The upshot of Article 17 is that for the 1967-1977 period, VALCO's revenues (i.e. the fees chargeable by the smelter for "tolling" or converting the alumina which is supplied to it by others into aluminium metal) would be established as 56% of the lesser of the aluminium prices (as published in the METAL BULLETIN and THE AMERICAN METAL MARKET), less any import duties applicable to the aluminium produced in Ghana.

As a corollary, for the 1967-1977 period, 44% of the ingot prices less the tariffs applicable to the aluminium produced in Ghana would be allocated to the parties which supplied the alumina for conversion at the smelter at Tema.

The penalty for the continued use of imported alumina was that, after 1967, VALCO's income was to be raised from 56% to 60% of the published aluminium prices less the relevant tariffs. The reasoning behind this penalty was that VALCO's income would increase, and therefore, become liable to higher tax payments to the Ghana Government[1].

The implication of the tolling agreement and Article 17 of the Master Agreement is that VALCO-produced aluminium does not belong to VALCO (the company registered in Ghana to smelt alumina and produce aluminium) but to the parties which delivered the alumina to VALCO to be converted. VALCO itself has described the "tolling" operation thus:

> "VALCO is a tolling operation with the shareholders supplying alumina delivered f.o.b. vessel Tema and VALCO converting the alumina into aluminium likewise delivered f.o.b. vessel Tema" (VALCO information).

Therefore, it follows that the fees charged by the parties which supply the alumina feedstocks to VALCO's Tema smelter to be converted represent the following cost elements: the cost of acquiring the alumina; the cost of delivering the alumina f.o.b. vessel Tema; the profit margin for the parties which supplied the Tema smelter with its alumina feedstock; the freight of the ingot and the costs associated with the marketing of the aluminium ingot overseas.

Therefore, in order to obtain the landed (c.i.f.) cost of the alumina being supplied to the smelter at Tema by KAISER and REYNOLDS, Article 18 of the Master Agreement has to be invoked. Article 18B specifies that:

> "The Government agrees that if VALCO produces aluminium from Ghanaian bauxite and the Government requires VALCO to charge, or imputes to VALCO, a minimum price for aluminium so produced and sold by VALCO, such price will take into account not only direct costs of production and interest, depreciation and all other overhead costs borne by VALCO but also the extent to which the cost of selling, tariffs, freight, and reasonable allowances for the cost of market development and general administrative costs will not be borne by VALCO. VALCO represents that at the time of execution of this Agreement approximately fifteen per cent of the fair market value of aluminium is represented by the cost of selling, tariffs, freight, reasonable allowance for market development and general administrative costs."

The import of Article 18B is that approximately 15% of aluminium price is attributable to selling, tariffs, freight, reasonable allowances for market development and general administrative costs.

This then leaves 85% of the aluminium price to cover: the processing (or tolling) fees chargeable by VALCO; cost of procuring and delivering alumina for the conversion; and the margin of profit for the supplier of the alumina.

But since Article 17 of the Master Agreement, as indicated above, stipulates that 56% - 60% of the aluminium sales income must be allocated to cover the "tolling" (or processing) fees charged by the smelter, it follows that the landed cost of imported alumina plus the profit margins is equal to:

(i) $\frac{44}{100}$ (85% of the aluminium price) - for 1967-1977; and

(ii) $\frac{40}{100}$ (85% of the aluminium price) - for 1977 onwards.

But the publicly declared incomes of VALCO (from which the alumina and aluminium prices applied to the Ghanaian operations can be inferred) represents 56-60% of the gross sales income less the tariffs applicable to aluminium produced in Ghana.

Therefore, to avoid double counting of the tariffs in the estimation of alumina price using Articles 17 and 18 of the Master Agreement, it is necessary to add the estimates of tariff payments to the sales income (as inferred from VALCO's declared revenues) before applying the provisions of Articles 17 and 18.

On this reasoning, and on the assumption that the tariffs are levied conservatively on Ghanaian aluminium exports at the rate of 4% of their value[2], Appendix A4-3 provides very conservative estimates of the prices which have, over the years been assigned by KAISER and REYNOLDS to the alumina which they have supplied to their smelter at Tema. Table 4-1 below provides a summary of the conservative estimates of the alumina prices earned by KAISER and REYNOLDS for the alumina which they have been supplying to their smelter at Tema in the 1967 - 1980 period.

At this juncture, it is as well to refer to World Bank es-

timates of the price of alumina supplied to newly constructed smelters in Venezuela and the Middle East. Vedavalli estimated that, in 1976 U.S. dollars, the f.o.b. and c.i.f. prices for the alumina delivered to these smelters are respectively $175/tonne and $180/tonne[3].

It is interesting to note that Vedavalli's c.i.f. valuation of $180/tonne (1976 dollars) confirms that the estimates of $170.7/tonne (1975) and $168.3/tonne (1976), as indicated in Table 4-1 below, represent fairly the values imputable to the alumina which is delivered to Ghana by KAISER and REYNOLDS.

Also of topical interest is the report in the MINING JOURNAL of July 31st, 1981 (p.76) which states that:

> "It appears that Jamaica is having second thoughts over its contract with the Soviet Union, signed in 1969, under which it agreed to supply some 50,000 t/y of alumina during the 1979-'83 period, and 250,000 tonne/year thereafter until the end of the decade. It is understood that Jamaica has lost more than $5 million on the contract to date even though the original contract rate of $180/tonne has been increased to $245/tonne. Losses of about $30/tonne are still being incurred at this price level because of high shipping charges. Nevertheless, it appears that Jamaica will fulfil its obligations under the present agreement until 1983 but will cancel the proposed extension to 1990."

On the date of the above report, the free market price was reported by the journal as $1,220 - $1,250/tonne c.i.f. On this price range, the KAISER Alumina Pricing Formula would have suggested an alumina price of about $185.4/tonne $\left(\text{i.e. } \frac{\$1{,}220 \times 0.304}{2}\right)$ to $190/tonne $\left(\text{i.e. } \frac{\$1250 \times 0.304}{2}\right)$. The difference between the re-negotiated price of $245/tonne for Jamaican alumina exports to the Soviet Union and that suggested by the KAISER Alumina Price Formula

TABLE 4.1: Estimates Of The Landed Price Assigned To The Alumina Supplied By KAISER and REYNOLDS To The Tema Smelter

Year	Estimated Price of Alumina (U.S. $/tonne alumina)
1967	75.8
1968	103.3
1969	116.3
1970	119.5
1971	119.3
1972	122.0
1973	105.4
1974	141.4
1975	170.7*
1976	168.3
1977	202.3
1978	245.5
1979	238.2
1980	253.6

Note: See Appendix A4-3, column (h). Calculations were based on information from VALCO and VALCO Annual Reports. The U.S. aluminium tariff of 4% was assumed, although VALCO-produced aluminium is also exported to Europe and Japan where higher tariffs are levied.

* This figure used in the cash flow analysis.

is in the range of $55-$60/tonne as of July 31st, 1981.

Equally interesting is the comparability of the estimate of $253.6/tonne for the alumina supplied to the Tema smelter in 1980 by KAISER and REYNOLDS (Table 4.1 above) and the re-negotiated price of $245/tonne for the alumina supplied by Jamaica to the Soviet Union as reported by the MINING JOURNAL above. It is notable that Jamaica is still unhappy about this new price.

It is therefore plausible to accept the estimates of alumina prices as per Table 4-1 above as representing the "fair" values of

the commodity. On this reasoning, the price of $170.7/tonne alumina for 1975 (as per Table 4-1 above) would form the basis of the re-assessment of the cash flow for the project.

But before assessing the full impact on profitability introduced by the modifications to the revenues to be assigned to the mine-refinery project, the BASCOL assumptions for the "financial structure"[4] of the project have to be re-examined.

BASCOL assumed a high debt to equity ratio. For the total capital cost of $340 million (1975 dollars), it was assumed that 75% ($255 million) would be borrowed and 25% ($85 million) would be equity subscriptions. High debt to equity ratios are not uncommon in the aluminium industry. For example, as Appendix A4-4 shows, out of a total capitalisation of $224.5 million for the Boké Bauxite Project in 1972, only $17 million came from equity subscriptions. What is questionable are the sources and the terms of financing proposed by BASCOL.

BASCOL proposed the following:

TABLE 4-2: Sources and Terms of Financing/Kibi Alumina Project

LENDER	Amount ($ millions	Interest Rate	Repayment
U.S. Export-Import Bank	$73	8½%	10 years
Commercial Banks (with/EXIM guarantee)	$83	10%	10 years
Commercial Banks (with/OPIC guarantee)	$62	12%	10 years
Commercial Ghanaian Banks	$37	9%	10 years
TOTAL	$255		

Source: BASCOL Report, op. cit.

A number of topical comments could be made on these pessimistic BASCOL assumptions relating to the lending and debt repayments.

First, the point must be made that it is indeed possible to raise long-term debt capital at reasonable interest rates and with much longer repayment periods. As an example, the European Investment Bank is reported to have loaned about $17 million to Gabon for 15 years at 8% interest in 1981[5]. This loan was to be used to modernise and expand a uranium mine and refinery.

Secondly, the Ghanaian content of the proposed borrowing (i.e. $37 million or 14.5% of the debt capital) could have been arranged for a much longer period of repayment. The Government could even encourage the Banks to increase their share of the lending and extend the repayment schedule.

Thirdly, as the financial structure of Guinea's Boké Bauxite Project (Appendix A4-4) demonstrates, U.S. capital markets are by no means the exclusive source of debt capital for major long-term projects in the aluminium industry. Non-U.S. sources, such as the Eurodollar and Asiadollar capital markets and Japanese or European government-backed suppliers credits are also competitive sources of reasonably priced capital with reasonable repayment periods. The international lending agencies, OPEC sources, OPEC-funded institutions such as the Arab Bank For Economic Development in Africa are also competitive alternative sources of finance. Also the African Development Bank with special interest in the economic development of Africa is a potential source of funding. If the case for the project is properly prepared, more favourable lending can be secured for its implementation. Therefore, it is by no means obvious that BASCOL's proposals as shown in Table 4-2 above are necessarily the most favourable or indeed the best obtainable.

All along, it is assumed that problems of Ghana's politico-economic instability can be resolved. On this assumption, the long-term favourable outlook for aluminium when compared to substitutable metals also ought to augur well for the necessary extensive borrowing. This must be so because the prospective internal generation of cash can be shown to be high for the industry and this can ensure the

rapid redemption of any debts incurred. The value of VALCO to its owners so far justifies this view.

Fourthly, a larger consortium could be sought. The participants need not necessarily be in the aluminium industry. Companies such as Lonhro which are well established in Ghana's gold industry could be canvassed. This would increase equity and reduce debt and interest repayments.

Notwithstanding the foregoing, even if one were to adopt the particular scenario for the capital structure advanced by BASCOL, the modifications in the income stream as suggested above are sufficient to render the project highly profitable. Under these circumstances, the rapid internal generation of cash will significantly supplement the project's capitalisation just as VALCO has done for its owners since its inception.

In re-calculating the impact of the changes in the value (or price) assignable to Ghanaian alumina on the overall cash flow, the following assumptions were made:

(i) BASCOL's estimates for capital costs, manufacturing costs, depreciation, interest charges, capital spending after start-up, and the schedule for debt retirement were accepted without modification. This is in spite of the view that more favourable borrowing could be arranged.

(ii) For Ghanaian Income Tax, it was assumed that the rate levied would be 50% of net taxable income and it would be applicable after a 5 year tax holiday. The tax holiday would be effective from the second year of operation in line with general Ghana Government policy on the subject. Taxation, nevertheless, is negotiable.

(iii) The cash flow analysis would be in constant mid-1975 dollars. This assumes that, in the long term, production costs and sales revenues will maintain approximately the same relationship.

(iv) The price of alumina for the cash flow analysis, as argued above would be taken as $170.7/tonne.

On the basis of these assumptions, it can be shown that apart from a cash deficit of $6.7 million (constant mid-1975) in the first year of operation, the project consistently yields a cash surplus for each subsequent year of operation. The cumulative cash surplus for the first ten years of operations is estimated at $72.9 million (constant mid-1975) - See Table 4-3, Column (n). It is as well also to point out that this cash surplus is accruable in spite of the complete retirement of the debt capital amounting to $255 million in the same period.

The upshot of the foregoing is that, given the 200,000 tonne/year smelter at Tema, the integration of Ghana's aluminium industry backwards into mining and alumina refinery is a patently viable economic proposition. This contradicts the BASCOL verdict.

Notwithstanding the viability of backward integration, KAISER and REYNOLDS do have perfectly understandable reasons to hesitate in the commitment of further investment capital. Some of the main reasons for hesitation are as follows:

First, as outlined in Chapter 3, both KAISER and REYNOLDS are oversupplied with alumina. As such, special and obviously unaffordable inducements would be required to justify the phasing out of their alumina capacity elsewhere to make room for the excess output from Ghana which would be necessitated by economies of scale. For as Mr. Lennon McAdams, VALCO's local director told NEW AFRICAN (June 1980):

> "it (i.e. the mine/refinery project) is marginal for us. The Japanese and Reynolds have fallen out. We cannot raise the $500 million on our own. We are over-supplied with alumina."

TABLE 4-3: The Estimated Production Cash Flows ($ millions)
For 600,000 tonne/year alumina plant (Equity)

YEARS (a)	Alumina Production ('000 tonnes) per year (b)	Revenue ($ millions) (c)	Manufacturing Costs ($ millions) (d)	Gross Profit ($ millions) (e)	Depreciation $ millions) (f)	Interest ($ millions) (g)	Net Income Before Tax ($ millions) (h)	Income Tax @ 50% ($ millions) (i)	Net Income after Tax ($ millions) (j)	Debt Repayment ($ millions) (k)	Replacements of property, plant and equipment after start-up ($ millions) (l)	Depreciation ($ millions) (m)	CASH FLOW ($ millions) (n)
1	550	93.9	49.0	44.9	12.8	24.6	7.5	-	7.5	25.5	1.5	12.8	- 6.7
2	600	102.4	50.2	52.2	12.8	22.1	17.3	-	17.3	25.5	1.5	12.8	8.1
3	600	102.4	50.2	52.2	12.8	19.6	19.8	-	19.8	25.5	1.5	12.8	5.6
4	600	102.4	48.1	54.3	12.8	17.1	24.4	-	24.4	25.5	1.5	12.8	10.2
5	600	102.4	46.1	56.3	12.8	14.5	29.0	-	29.0	25.5	1.5	12.8	14.8
6	600	102.4	43.7	58.7	12.8	12.0	33.9	-	33.9	25.5	1.5	12.8	19.7
7	600	102.4	43.5	58.9	12.8	9.5	36.6	18.3	18.3	25.5	1.5	12.8	4.1
8	600	102.4	42.0	60.4	12.8	7.0	40.6	20.3	20.3	25.5	1.5	12.8	6.1
9	600	102.4	42.0	60.4	12.8	4.4	43.2	21.6	21.6	25.5	1.5	12.8	7.4
10	600	102.4	42.0	60.4	12.8	1.9	45.7	22.9	22.8	25.5	1.5	12.8	8.6
TOTALS	5950	1015.5	456.8	558.7	128.0	132.7	298.0	83.1	214.9	255.0	15	128	72.9

Notes: The following assumptions were made in the calculations above:

1. Rather than project alumina prices and capital and operating costs into the future, an exercise which is by no means easy BASCOL assumed that over the long run, the increases in alumina price and manufacturing costs would maintain the same relationship.
2. Revenues (Column (c)) = Alumina Production (Column (a)) x Alumina Price ($170.7/tonne)
3. Gross Profit (Column (e)) = Column (c) - Column (d)
4. Depreciation (Column (f)) as per BASCOL estimates
5. Interest Expense (g) as per BASCOL estimates
6. Net Income Before Tax (Column (h)) = Column (e) - Column (f) - Column (g)
7. A 5-year tax holiday, effective from the second year of operation, is assumed. Thereafter, tax is deductible @ 50% of taxable income. Therefore, when tax becomes due:

   Income tax payments = 0.5 x Column (h)
8. Net Income After Tax (Column (j)) = Column (h) - Column (i)
9. As per the BASCOL study, the debt capital of $255 million (i.e. 75% of the total capital cost) would be retired by 20 equal, semi-annual instalments - that is, @ $25.5 million/year as per column (k) above.
10. Column (l) reflects capital spending after start-up. It involves the costs associated with the replacement of plant, equipment and property. In general, this cost element increases with time. BASCOL's report spread this cost uniformly @ $1.5/year.
11. Cash Flow (Column (n)) = Column (j) - Column (k) - Column (l) + Column (n).
12. Average Manufacturing cost for the 10 years = $\frac{\$456.8 \times 10^6}{5,950,000 \text{ tonnes}} = \$77/\text{tonne}$.
13. Average Interest and debt repayment costs for the 10 years = $\frac{\$132.7 \times 10^6}{5,950,000 \text{ tonnes}} = \$65/\text{tonne}$

Notwithstanding this official position of VALCO, the rider to this observation is that, on the global scale, alumina shortages are also foreseeable. Therefore, if KAISER and REYNOLDS were to be really interested, they could use their enormous influence in the industry to secure markets for the excess alumina output.

Secondly, although in 1980, the Managing Director of VALCO commented that:

> "Ultimately, there will be an alumina plant in Ghana which utilizes Ghanaian bauxite and supplies the Tema smelter with local alumina"[6];

Mr. Lennon McAdams (VALCO's local director) has also expressed the view that:

> "We are worried about the stability of the government and the problems of inflation".[7]

Notwithstanding the fact that the viability of the project itself augurs well for the inflow of investible capital, the politico-economic uncertainties make such investible capital inflows unlikely. For as a U.S. Embassy official is reported to have said:

> "Who'd put a nickel in this place?"[8]

Thirdly, there is the fear of expropriation if the industry is integrated completely.

Therefore, for these reasons as well as others discussed in later chapters, the aspirations of Ghanaians for an integrated aluminium industry remains a hostage to uncorrected and perceived internal problems. Lack of progress on integrating the industry is certainly not attributable to the unviability of the proposed project. Should it remain Ghana's desire to pursue the aim to integrate the industry, enormous problems have to be overcome. - Hence Chapter 5.

CHAPTER 5: THE PROBLEMS OF IMPLEMENTATION

Chapter 5.1 The Problems Stated

From the conclusions of Chapter 4, it is clear that the bauxite-to-alumina venture can be shown to be profitable, contrary to the conclusions of the BASCOL study. However, VALCO's owners are unlikely to find the project attractive. The attitude of the companies are explicable, in part, by the uncertainty over the politico-economic situation, the probable loss of the tax advantages as agreed in 1962, and a desire to forestall nationalization.

An additional explanation which has not yet been discussed fully is the opportunity cost (to the aluminium producers) of replacing imported alumina with indigenous alumina. It would be natural for the producers to seek assurances that, by their involvement in the proposed alumina project, there will not be a diminution in the current and future profits which are derived from existing "tolling" arrangements. A close look at the modus operandi of VALCO suggests that what is at stake is so great that Ghana cannot give these assurances.

Together with the market considerations discussed in Chapter 3, these factors explain the lack of interest of VALCO's owners in integrating their current operations backwards into mining and refining. Although KAISER and REYNOLDS are unenthusiastic about the proposed alumina venture, they are the parties best placed to mobilize vital capital, identify and develop the requisite markets, and transfer technology and managerial know-how. Hence, their support (which is unlikely to be forth-coming) is the pre-requisite of the successful integration of the aluminium industry in Ghana. This is the crux of the problem facing the Ghanaian Government.

Even if all the excess alumina output from the proposed project could be marketed at profitable prices, the producers would still require assurances that their interests would not be jeopardized by the alumina project. Until this happens, they are likely to adopt

pessimistic parameters in the assessment of the venture so as to reach the verdict that the projected cash flows do not justify independently the necessary capital outlay.

Taking cognizance of the position of the producers and the fact that Ghana may not be able to satisfy them,it is logical to explore the range of alternative options open to the Ghana Government.

Broadly, the following courses of action are open to the Ghana Government in its attempts to deal with the problems of fragmentation. It can

Either:(i) Adopt a laissez-faire attitude, in the hope that some day, the convergence of economic interest of the producers and Ghana would lead to the requisite investments being made;

OR (ii) Threaten KAISER, REYNOLDS and BACO with nationalization, in the hope that, they would agree to integrate their Ghanaian operations fully;

OR (iii) To strive to win the confidence and interest of the producers so that the resultant mutual trust would facilitate further investment in the local production of alumina or indeed in other areas in the non-aluminium sector of the Ghanaian economy;

OR (iv) Abandon integration as its central objective and concentrate on the alternative strategies argued in Chapter 5.3.

Not least of the reasons for rejecting the second option are the facts that the GUYANA/ALCAN[1] and CHILE/KENNECOTT[2] nationalizations of the early 70's, together confirm the dangers of confrontation implied by such a policy.

And given the pressing problems now facing Ghana, the option of adopting a laissez-faire attitude would be as frustrating as it would be too slow to yield tangible results.

Superficially, the option of wooing KAISER and REYNOLDS appears attractive. A scrutiny, however, indicates that its success cannot be taken for granted. For it to be successful, the Government has to offer an improved package of the standard set of incentives to the producers in order to attract the requisite investible capital inflows.

The normal standard package of incentives (which this policy option suggests should be improved) covers taxation, investment grants, depreciation, exemptions or rebates from import and/or export duties, subsidised or free use of local facilities and services, preferential access to local capital, varying degrees of exemption from present and future exchange control regulations, preferential exchange rates etc.

Some observers have expressed doubts about the effectiveness of the improved incentives in channelling investible capital into the countries that offer them to the major companies[3]. The apparent ineffectiveness of improving incentives per se is explicable by two factors. First, many countries, developing and developed, offer them in the competition for investment. And given the few alumina projects (10-20) envisaged for 1977-2000 (See Chapter 3.6), it is unlikely Ghana can succeed in the competition. The second and more important reason, as far as Ghana's relationship with the aluminium producers is concerned, is that the geographical dispersal of the various stages of aluminium production (i.e. mining, refining, smelting and fabrication) serves a dual purpose for the companies. First, unintegrated facilities are less attractive to nationalize. And, secondly, the dispersal generates a significant volume of lucrative intra-company trade. This is corroborated by the record of the trade between: VALCO; the wholly owned KAISER subsidiary which provides management and technical services (KATSI); and the other off-shore alumina operations of KAISER. In Chapter 5.2, the profitability of VALCO's operations are discussed and these give a measure of the importance of intra-company trade.

Consequently, unless the concessions, inducements and guarantees

to be offered are perceived by the producers as making good the losses envisaged from the parent companies' reduced flexibility in intra-company pricing arrangements, VALCO's owners are unlikely to respond to any improvements in the standard package of incentives.

As such, it is unlikely that Ghana would succeed in wooing KAISER and REYNOLDS into promoting the alumina project. Chapter 5.2, therefore, details the scale of the financial interests at stake for the producers. In addition, the probable strategy of VALCO, in response to the mounting pressure for the industry to be integrated, is outlined. The knowledge of the probable response of the producers would help in formulating appropriate counter policies for the Ghana Government.

Chapter 5.2: The Probable Strategy Of VALCO's Owners

To KAISER and REYNOLDS, investment decisions regarding the location, the size of production facilities, the levels of production, and intra-company pricing arrangements are matters which are not determined by altruistic considerations for host country development. They have shareholders resident elsewhere whose criteria are - return, payback and growth. Consequently, VALCO was established in Ghana on the grounds that the Tema "tolling" operations would fulfil these criteria in two significant ways. First, the Tema smelter would prove lucrative in its own right. Secondly, the favourable fiscal regime negotiated in 1962 and the "tolling" status of VALCO, together with the granting of a free hand to conduct the complex operations would enable the parent companies to achieve, in a stroke, a significant volume of lucrative intra-company trade. This strategy has been very successful and it does represent the status quo.

VALCO's probable strategy in Ghana, given their success so far and the mounting pressure to integrate backwards, hinges on the company's perception of the equitability of the appropriation of the results of the VRP to date. From this standpoint, it would attempt to convince Ghanaians that:

(i) the economic progress made possible by the VRP has and will not be zero-sum;

(ii) the results of the investment has been equitably distributed;

(iii) the Ghana/VALCO relationship was, is, and will be mutually dependent as well as mutually beneficial. The status quo must, a fortiori, be preserved. In the event of failure, the companies' probable fall-back position is discussed later in the chapter.

The above-stated position of the companies is corroborated by the following catalogue of views that: "..... we enabled the dam to be built, and therefore to obtain electricity for Ghana ....."[1];

that before they decided to invest in the Tema smelter, the "Volta flowed into the sea"[2]; and that, "the arrangements so approved in 1962 were and are fair and reasonable and provide both the people of Ghana and the shareholders of VALCO with an equitable share of the result and provide an excellent example of proper and mutually beneficial international development"[3].
Overall, VALCO's Managing Director has commented that:

> "In my view - and I believe by any objective assessment - the Volta River Project is an excellent example of co-operation between host country and multi-national companies to achieve a mutually beneficial, productive enterprise"[4].

Significantly, VALCO implies that, Nkrumah, who executed the agreements in 1962 considered them fair and would probably hold the view that the appropriation of the surplus has been equally fair[5].

From the above catalogue of VALCO's views, VALCO's owners believe that they have done more than enough to honour their side of the 1962 bargain which required their operations to help diversify Ghana's single-crop economy. Seeing their contribution as more than adequate, KAISER and REYNOLDS do not feel obligated in any way to participate in the bauxite-to-alumina venture merely because VALCO's smelter at Tema has turned out to be an outstanding success.

Therefore, it must follow that, just as the status quo has produced "mutually beneficial" gains for Ghana and VALCO's owners, any extra investment beyond the status quo must be assessed separately and must also be justified by separate and tangible gains which take due account of the risks involved. To understand one of the main reasons why KAISER is unlikely to see the additional investment for the alumina plant as justifiable, one needs to examine what the status quo means to KAISER and REYNOLDS and the financial benefits that are being derived from it.

First, one needs to consider the profits derived from VALCO -

as a company registered in Ghana with the specific function to "toll-process" (i.e. convert) imported alumina into aluminium. By the Tolling Agreement, VALCO-produced aluminium is returned to the parties which supplied the alumina so that it can be marketed. The income (or fees chargeable by VALCO) is established as 56% - 60% of the aluminium sales income less the tariffs applicable. Since this income is denominated in foreign exchange, VALCO's owners transfer periodically just enough dollars to the Bank of Ghana at the current official exchange rate to pay for the company's financial obligations in Ghana. These transfers are used to pay for wages, salaries, supplies, materials, process chemicals, services obtained in Ghana power payments, company tax payments and the contributions to the VALCO Fund Payments.

The second source of profit for VALCO's owners is derived from the net income obtained from the supply of alumina to the Tema smelter and other related activities. By the Tolling Agreement, the owners, in proportion to their equity holdings in the VALCO smelter, procure and deliver alumina to be converted. The fees chargeable by the parties which supply the alumina has been established as 40% - 44% of the ingot revenue less the applicable tariffs. As explained in Chapter 2, this income is meant to cover the costs of alumina procurement, the delivery of the alumina, profit margins, and the costs associated with freight, the administration and the marketing of the aluminium ingots.

A measure of the profits gained is presented in Appendix A5-1. In column (e) of Appendix A5-1, it has been shown that in the period 1967-1977, the net income gained by the KAISER-REYNOLDS consortium from the supply of alumina to the Tema smelter amounted to $169.16 million.

In very sharp contrast, the net income gained by the KAISER-REYNOLDS consortium from the "tolling" operations of its VALCO plant at Tema amounted to $64.19 million for the same period (i.e. 1967-1977). In effect, the net income gained from VALCO's smelter, which

were declared to the Ghanaian authorities for tax purposes, was only 38% of the net income gained by supplying imported alumina to the smelter (See Column (b) of Appendix A5-1).

The upshot is that, the supply of non-indigenous alumina to VALCO's smelter at Tema for tolling (i.e. conversion) is, by far, more significant than the actual operations of VALCO. In a way, this demonstrates the significance of intra-company trading arrangements which are outside the scope of Ghanaian law.

If one considers the fact that the whole of the operational income resulting from aluminium sales are retained outside the country and that just enough funds are transferred into Ghana to meet VALCO's financial obligations in Ghana, then the enormity of what is at stake for VALCO's owners becomes evident. From 1967 to 1980, VALCO's owners transferred a total of $295.7 million into Ghana. These transfers were as follows: payments for power - $117.3 million; operating and construction expenditure - $152.5 million; direct taxes paid to the Ghana Government - $15.2 million; VALCO Fund contributions - $10.7 million (See Appendix A5-2). In contrast to these dollar transfers, VALCO's gross income less tariffs for the same period amounted to $1,628.7 million (See Appendix A5-3). Consequently, the total dollar transfers by the KAISER-REYNOLDS consortium to sustain its VALCO operations in Ghana represent a mere 18% of the gross income.

If KAISER and REYNOLDS were to replace imported alumina with indigenous alumina, it would mean that the whole of the income derivable from aluminium production as well as the costs involved would become liable to the administrative surveillance of the Ghana Government. The consequent loss of flexibility of existing intra-company pricing policies represents a change that is unlikely to be acceptable to any aluminium multinational. The unlikelihood of this being acceptable to KAISER, at this moment in time, is very well underlined by the considerable significance of the financial gains made from its Ghanaian investments when compared to the company's overall global performance.

Appendix A5-1 shows that, in the 1967-1977 period, the total profits earned by KAISER from both the supply of alumina and the "tolling" operations of VALCO accounted for 33.1% of the company's global net income. (See Appendix A5-1, column (i)). These profit contributions peaked in 1971 and 1972 when they accounted for 158% and 152.4% of the company's global net income[6]. No company would be willing to jeopardize such profit contributions, whether or not alternative sources of income have been developed in other sectors or in other locations.

The performance of VALCO in relation to the various other subsidiaries of KAISER is demonstrated by Appendix A5-4. This is the information submitted by the company itself on Form 10-K Reports to the U.S. Securities And Exchange Commission in 1980.

This report demonstrates, among other things, that out of a total investment of $545.5 million, the investment in VALCO was $91.5 million - that is, 17% of the total investment. Yet, out of a total equity income of $111.7 million, VALCO, on its own, contributed $24 million or 21.5%. Furthermore, out of a total income distribution of $34.6 million, VALCO's contributions accounted for $18.0 million or 52%. On the basis of these contributions, it is fair to suggest that VALCO's contributions plus the supplementary income from related activities have and can continue to play a key role in the success of KAISER's world-wide operations.

VALCO's contributions to the parent companies are not just limited to increasing the distributable incomes. Less obvious are the contributions to the capital structure of the company itself in an era of high interest rates.

The capital stock of VALCO, authorized and outstanding, is 4,285,720 shares without par value and it is valued at $12 million. From this initial investment, the success of VALCO's "tolling" operations has made possible the cumulative growth of retained (or undistributed) income from $71.575 million in 1978 to $126.277

million in 1981[7]. Such growth in VALCO's undistributed income implies a compounded annual growth rate of 20.8%. This rapid growth of internally generated funds improves the debt-to-equity ratio on the parent company's balance sheet. In an era of high interest rates, KAISER would not want to jeopardize this substantial contribution in any way.

For the owners of VALCO, the $12 million initial equity subscription has produced the underlisted results:

(i) A turnover of $1,628.7 million (for the 1967-1980 period) out of which only $295.7 million (or 18%) was required to be transferred to sustain their investments in Ghana;

(ii) An investment, which for its principal shareholder (KAISER) has contributed 33.1% of the total net income of the company's world-wide operations for the 1967-1977 period.

(iii) Besides the 1980 contributions of 21.5% of the equity income and 52% of KAISER's distributed income, VALCO's retained earnings could still manage a compounded annual growth rate of 20.8% for the 1978 - 1981 period;

(iv) An agreement which, not only maximises the parent companies' flexibility in intra-company pricing arrangements, but one which effectively grants the parent companies a virtual carte blanche in the conduct of all operations.

The foregoing assessment of the significance of VALCO to its parent companies provides the scale of what is at stake for the companies. Hence, any effort by the Ghana Government to develop bauxite-to-alumina facilities to replace Jamaican imports needs to guarantee, among other things, that none of these financial gains would be jeopardized by the proposed changes.

Besides the high financial stakes, any attempt by the Ghana Government to woo KAISER is also likely to be beset by the historical pattern of bauxite/alumina/aluminium investments in the world. Apart from Surinam, no other developing country has a fully integrated

aluminium industry. In Surinam, the development of the country's integrated aluminium industry was due largely to ALCOA and, to minor extent Billiton (a subsidiary of SHELL). As Moment recounts:

> "The company announced in 1959 that its reasons for building the aluminium smelter were the high quality bauxite, the available power, the exploration rights, the concessions in taxes and import duties, the right to withdraw earnings, and confidence in the stability of the government. The company also expected to sell the metal in Europe and to gain a competitive advantage if Surinam became an associate member of the Common Market"[8].

It is significant that ALCOA owns and operates, within this framework, the bauxite mines, the alumina refinery facilities, the aluminium smelters, and the hydro-electric power facilities. It is also significant that the relevant agreements were concluded well before Surinam became independent.

No other independent developing country has been able to achieve the localization of processing facilities such as in Surinam. Guinea has very large and high quality deposits of bauxite as well as enormous and low-cost hydro-electric power potential. Yet, Guinea has been successful in attracting investments only for bauxite mining and alumina refinery. Cameroon which also has very substantial deposits of bauxite has no mining and refinery facilities to speak of. Cameroon has a smelter which operates on the country's cheap power. As a general observation, it could be said that the prospects of local advantages (such as, savings in the cost of transporting bulk bauxite/alumina cargoes to overseasplants, the availability of larger blocks of cheaper and non-interruptible electrical power, lower salaries and wages to local manpower, plus other fiscal inducements readily offered by the host governments) have always been subordinated to company doubts about stability, expropriation, currency convertibility, and the degree of flexibility which the company can exercise in intra-company trading arrangements.

Against this backdrop, Ghana's problems appear not to be limited only to the financial interests which KAISER has a right to feel to be at stake, but also to the historical pattern of corporate investments in the bauxite/alumina/aluminium industry in the developing countries.

To KAISER, the status quo has and continue to provide very high profits at little or no risk (i.e. with the exception of marketing risks). Why then take the step of developing the bauxite/alumina complex which will merely make it more attractive for the Ghana Government to nationalize, at some future stage, the entire enterprise (i.e. from the bauxite mines to the smelter)? After all, Ghana has, in the recent past, nationalized partly other foreign-owned enterprises.

Also, KAISER may very well ask why it should promote the bauxite-to-alumina venture and thereby increase its own capacity (hence, supply) when the domestic and regional markets are too small to justify the investment, and even if they were, currency convertibility would still remain a problem?

KAISER consequently sees no commercial justification for the project at all - no matter how appealing it might appear to Ghanaians. Therefore, the sticking points as far as KAISER may be concerned may be summarised as follows.

First, Chapter 1 demonstrates that, the deterioration in the politico-economic situation with particular reference to stability, inflation and exchange rates, as well as the country's history of nationalization constitute very genuine worries for any investor.

Secondly, the concessions granted under the 1962 agreements were so wide-ranging and attractive that their re-negotiation (which would be necessitated by the bauxite-to-alumina venture) is unlikely to be welcomed.

Thirdly, although global alumina capacity/supply/demand balances have been tight and short falls could very well occur in the 80's, KAISER and REYNOLDS who own VALCO have excess alumina capacity. Consequently, marginal cost considerations mean that the companies would rather utilize idle capacity to obtain their additional alumina requirements than establish greenfield facilities at considerable cost and risk in Ghana to obtain the same quantity of the commodity.

Fourthly, the gradual dissolution of the dominating hold once held by the aluminium oligopoly on supply, marketing and prices (as producers have proliferated) means now that there is increased uncertainty in the market for alumina/aluminium. KAISER and REYNOLDS can be expected to be less enthusiastic about the venture unless a large and viable local market (probably protected) could be guaranteed.

Fifthly, as perceived by the companies, the risks involved in the alumina venture covers not only the $340 million mid-1975 constant dollar cost of the proposal, but also the huge turnover from the Tema investment.

As a result, the probable strategy of KAISER and REYNOLDS, in the face of mounting local pressure to integrate their VALCO operations backwards, is likely to be as follows.

First, VALCO would attempt to demonstrate publicly that the status quo is mutually beneficial and equitable, and hence, must be preserved.

Secondly, VALCO's owners are likely to adopt pessimistic scenarios in the assessments of the alumina project so as to arrive at the conclusion that the alumina project is uneconomic. If there is a public acceptance that the project is truly uneconomic, pressure for the massive investment in the alumina plant will abate.

However, in the event that the pressure on the company does not abate after the efforts outlined above, and the government resorts

to any action which can be interpreted as partial or whole nationalization, the Company will then lodge a complaint against Ghana at the International Chamber of Commerce (under Articles 38 and 41 of the Master Agreement) and seek to be immediately compensated on the basis of the going-concern value of its operations. The GUYANA/ALCAN and CHILE/KENNECOTT experiences (see Notes 1 and 2 of Chapter 5.1) are instructive of the probable cost to Ghana in such an event.

Set against the probable strategy of VALCO to the problem of fragmentation, Ghana has to evolve an appropriate counter-strategy. To do so requires the recognition that it is neither necessary to pursue integration as a central policy objective nor worth while to expropriate VALCO's assets in the event of failure of such a strategy.

Paradoxically, there is a good case for the Ghana Government to encourage the maintenance of the status quo. This recommendation is argued in Chapter 6. Although by its pursuit, Ghana would be working towards a common objective with the aluminium producers, their reasons for so doing differ markedly.

But since, the recommended strategy is not the only option, the alternatives are discussed in Chapter 5.3. Because all the strategies must be set against the benefits which Ghana has derived from the entire VRP, Chapter 5.3 also sets out those benefits and costs of the VRP which are identifiable.

Chapter 5.3: Counter-Strategies For Ghana

As pointed out in Chapter 1, Ghana chose to pursue the VRP in order to diversify the country's export income. The experience over the years had been that, irrespective of the volume of cocoa produced, export revenues fluctuated widely and thus made economic planning difficult. Besides the large fluctuations in the export income from cocoa, economic planners have had to contend with stagnating contributions from the mineral sector since the 30's. Under such circumstances, the VRP emerged as the centre-piece of the country's development strategy because if was seen as one of the few schemes whose pursuit offered a real opportunity for self-sustaining growth.

For, besides increasing and diversifying national output, broadening the tax base, improving the balance of payments, and raising standards of living through higher wages, additional benefits stood to be gained from the Volta Lake. Separately, the Volta Lake offered improved opportunities for large scale, irrigated and mechanized farming in the adjoining arid plains as well as increased fishing potential for the riparian communities. Even in the absence of a detailed social cost-benefit analysis, one could argue plausibly that, on balance, it was socio-economically desirable to pursue the VRP. The acceptance of this is essential to the formulation of the appropriate Government policies.

In an attempt to corroborate this general view and hence prepare the way for the appropriate Government counter-strategy, the underlisted benefits and costs can be broadly identified.

First, the Volta Dam and powerhouse have been established. As Table 5-1 demonstrates, nearly all of the electricity now generated in Ghana comes from Volta hydro-electricity.

Now, two-fifths of VRA's electrical energy sales go to non-VALCO/non-export sector of the Ghanaian economy. The non-VALCO/

TABLE 5-1: The Generation Of Electricity In Ghana
(in million kilowatt-hours)

	1976	1977	1978	1979
Volta River Authority (VRA)	4,174	4,394	3,721	4,631
Electricity Corporation of Ghana (ECG)	47	36	34	32
Mines	5	2	2	2
TOTAL	4,226	4,432	3,757	4,665
of which, consumption of VALCO	2,2645	2,784	2,086	2,908

Source: Central Bureau of Statistics (Accra, Ghana), "Preliminary Economic Survey 1977-1979", April 1980, Table 6, p.10.

non-export electricity sales made by the VRA jumped from 435.8 million kilowatt-hours in 1966 (the first full year of VRA's operation) to 1,317.7 million kilowatt-hours in 1979[1]. Such an increase represents a compounded annual growth rate of 8.9% which clearly outperforms the Ghanaian economy. According to World Bank estimates, the average annual growth of Ghana's GNP/capita was -0.5% for 1960-1978 and that for the country's GDP for 1970-1978 was 0.4%[2].

Secondly, if the dam had not been built, Ghana may have had to rely on the importation of fossil fuel to generate the same quantity of electricity currently available to the economy. The savings on the import bill for fossil fuel which would have been required to generate the same amount of non-VALCO/non-export electricity sold by the VRA can be estimated conservatively at $333.4 million for the 1966-1979 period (See Appendix A5-5).

Thirdly, the Ghanaian consumer of electricity has also gained significantly from using Volta hydro-electricity rather than power from the alternative thermal sources. For example, the energy index cost for Kpong hydro-electric power has been estimated at 14.9 mills/kwh. Compared with Kpong hydro-electricity, the energy index cost for

the following alternatives have been estimated as: 26.6 mills/kwh for Compact Steam Electric plant; 52.6 mills/kwh for a Gas Turbine; and 62.0 mills/kwh for a Diesel Plant. (See Appendix A5-6). By using hydro-electricity, the Ghanaian consumer is paying much less than would be the case if the same electricity were generated thermally.

Fourthly, the sale of energy to Communaute Electrique du Benin (i.e. Togo and Benin) yields for the Ghanaian treasury additional foreign exchange. Up to 1979, Ghana had earned about $12.5 million. (See Appendix A5-7).

Fifthly, VALCO periodically transfers dollars to the Bank of Ghana at the official rates of exchange to meet its obligations in Ghana. But, because the official exchange rate grossly overvalues the Ghanaian currency, the cedi, the boost to the country's balance of payments through the cumulative transfer of $295.7 million (see Appendix A5-2) for the period 1967-1980 is more beneficial than officially conceded. VALCO's transfers include power payments totalling $117.3 million for the period 1967-1980. The transfers also include direct tax payments. The direct taxes payable to the Ghanaian exchequer for the following years earnings were: $15.2 million (1979); $26.7 million (1980); and $18.2 million (1981). The cumulative total is $60.1 million[3]. Besides paying these amounts in dollars at the official exchange rates (while unofficially, the cedi changes hands at 15-20 times the official rates), there are plausible reasons to believe that such payments could increase over time. Present and future tax receipts from VALCO help reduce the budget deficits as well as help combat the high deficit-induced inflation which has plagued the economy for several years.

The sixth benefit is that the large Volta Lake means that Ghana now has a considerable but not fully utilized potential for lake transportation, lake fishing and irrigated farming in the arid plains which adjoin the lake. Fishing in the Volta Lake now accounts for about 10% of the country's total fish consumption (See Table 1-3).

The seventh identifiable benefit is that 1,600-2,500 jobs per year have been created by VALCO's "tolling" operations. Although the jobs involve considerable skills, the Ghanaians who are employed by VALCO are at liberty to opt out of the VALCO system after their training for comparable or higher employment in the rest of the Ghanaian economy - thereby introducing multiplier effects. By August 1976, the number of Ghanaians of supervisory grade and those of hourly grade who had left VALCO for other jobs in the Ghanaian economy were 103 and 1,355 respectively[4].

And finally, through the implementation of the power project and the concomitant need to establish the VRA to administer it, Ghana can now boast of a highly skilled and entirely Ghanaian team of operators and managers for hydro-electric power generation.

All the socio-economic gains outlined above are very significant, particularly since, in the absence of the dam and VALCO, there would be little else other than the precarious dependence on cocoa. Consequently, the formulation of a counter-strategy to cope, first with the aluminium industry's fragmentation, and second with VALCO's probable response to it, ought to take into account these substantial benefits derived from the status quo. The above also represent very significant economic interests which are at stake for Ghana and which should not be jeopardized by ill-thought out strategies.

To gain these, Ghana has had to bear some socio-economic costs. To what extent the costs compare to the benefits listed above is a matter of individual opinion. Besides the capital outlay for the power project, the identifiable costs which have so far been incurred by Ghana are listed as follows:

(i) Ghana Government has lost revenues from the fiscal incentives offered to KAISER and REYNOLDS in 1962. The quantification of these costs require very detailed analysis which are beyond the scope of this study.

(ii) The large lake created by the Akosombo dam inundated 3,275

square miles of Ghanaian territory (i.e. one twentieth of Ghana's total land area).

(iii) The flooding of this large area meant that 80,000 people living in 739 villages had to be re-settled.

(iv) Because of the lake, there has been an increase in the incidence of schistosomiasis (or bilharziasis) and onchocerciasis (or river blindness) among the riparian communities. This health problem is serious because it represents a continuing socio-economic burden on the stretched resources of the Ghanaian Government.

(v) The agreements which were negotiated in 1962 sanctions the institutionalization of the fragmentary character of Ghana's aluminium industry. Through the fragmentation, Ghana's terms of trade in bauxite, alumina, aluminium, and semi-fabricated aluminium (whose price ratio is about 1 : 6 : 41 : 80-100) could very well be unfavourable.

Although the fragmentation of the industry effectively truncates the benefits accruable from the bauxite-to-aluminium venture, its perpetuation does not necessarily justify the continued pursuit of integration at any cost. Given the 1962 agreements, the cost of pursuit could be high. Also, because of the probable strategy of KAISER and REYNOLDS (as outlined in Chapter 5.2), there is a need to re-assess the alternative policy options open to the Ghana Government.

The alternative options open to the Ghana Government, in the light of the foregoing, are listed as follows:

(i) First, it could abandon the attempts to woo VALCO's owners with further costly and unaffordable inducements which could turn out to be ineffective in the long run. In the circumstances, Ghana could attempt to re-negotiate the 1962 agreements on the basis that fundamental changes have occurred in the GHANA/KAISER-REYNOLDS relationship. Under this option, the establishment of a mine-to-metal complex would still remain central to the Government's overall strategy. The success of

this option is, however, problematic because of resistance from the producers.

(ii) Secondly, Ghana could abandon integration as a central policy goal altogether.

In the event of opting for the abandonment of integration, there are a number of feasible alternative strategies which could be pursued by the Ghanaian Government. It could, for a start, encourage VALCO to "toll-process" (i.e. convert) more imported alumina to the extent of utilizing fully the company's power off-take to the power ceiling of 415,000 kilowatts permitted by the 1962 agreements. (VALCO's present power off-take is about 370,000 kilowatts). The increased volume of alumina "toll-processed" by VALCO would imply that Ghana would earn: higher income tax; larger VALCO payments into the VALCO Fund; a greater amount of dollar transfers (significantly at the overvalued official rates of exchange) so as to meet VALCO's higher wage bills and increased operating and construction expenditures in Ghana. VALCO would certainly not be averse to this policy since Ghana has been shown to be a highly competitive location for converting alumina into aluminium.

The additional dollar inflows could then be used for the following specific purposes:

(a) To acquire the shares of KAISER and REYNOLDS on international stock markets with the specific aim of gaining control and influence over the company's investment decisions (that is to say, backdoor nationalization);

OR (b) To acquire the shares in profitable international companies (not necessarily the aluminium companies) with the explicit aim of establishing a high income equity portfolio.

If Ghana were to choose the option of re-negotiating the 1962 agreements, it would need to secure in advance international goodwill, in spite of the fact that such a step could be justified within international legal conventions.

Rouhani has argued that, the justification for the renegotiation would be that:

> " .... the international law of treaties contains a principle, operating either by way of interpretation of a condition presumed to be implied in the treaty, or as a substantive rule of law requiring the adaptation of treaties to changing circumstances, to the effect that if circumstances arise which were not contemplated by the parties and which are of such a nature that they affect fundamentally the relations of the parties, then the treaty will lapse or will require revision"[5].

Rouhani also draws attention to the "doctrine of frustration" in English Law and the "doctrine of imprevision" in French administrative law. New preceptions of these doctrines, argues Rouhani, justify re-negotiation when fundamental aspects of a relationship change[6]. Rouhani quotes Sir David Hughes Parry, Professor of English Law, who wrote in his book on the "Sanctity of Contracts in English law" that:

> "The doctrine of frustration is now so well recognised and established that it no longer needs the fiction of an implied term to support it. So it is generally but gradually being displaced by the theory that a change of circumstances that fundamentally strikes at the root of a contract justifies the imposition by the court of a solution that is just and reasonable in the new circumstances"[7].

VALCO's own willingness to re-negotiate "voluntarily" the power price upwards is indicative of the fact that fundamental changes (such as the higher energy prices elsewhere) have occurred in the relationship between the Ghana Government and the KAISER-REYNOLDS consortium and that these changes are recognized and accepted by VALCO's owners as a basis for re-negotiation.

Also, the fact that alumina of Ghanaian origin can be argued

to be comparable to and competitive with currently imported alumina offers a good reason to re-examine the relationship between Ghana and the aluminium multinationals.

Writing in the American journal - THE MULTINATIONAL MONITOR - Nicholas Burnett is even reported to have charged that: "KAISER never acted in good faith in its professed efforts to help Ghana develop the alumina refining operation for integrated aluminium production"[8].

Should it be the policy of the Ghanaian Government to re-negotiate the Master Agreement of 1962, the Government may specifically seek to revoke the exemptions from import and export duties and replace them with tariffs along the lines of those adopted by the EEC. It could renegotiate the power price upwards, or raise the company tax upwards from the stabilized rate of 40% to the 50% rate applicable to other major companies such as Lonhro now operating in the country. The duration of the agreement could also be curtailed from the 50 years (effective from April 1967) to a much shorter period. The ownership of VALCO should however be left alone because any attempt to bring about changes in ownership would imply expropriation and very costly complications.

The purpose of the renegotiation would be to increase the resource rent payable to the Ghana Government if the status quo is to remain unchanged. If the American companies decide to withdraw, it would offer the Ghana Government a new and fresh basis to negotiate new entry terms with some other producers who need not necessarily be members of the aluminium oligopoly. If they stay, the increases in resource rent payments could make the development of the alumina plant less urgent. By raising the cost of alumina (through the imposition of tariffs), it may no longer be attractive for VALCO's owners to rely on alumina imports from Jamaica and elsewhere. Hence, they may reconsider indigenous alumina production. Improperly handled, however, this strategy could very well back-fire - hence the recommendation to avoid it.

The remaining feasible option, but one which could prove prohibitively expensive, is for Ghana to arrange for certain Ghanaian companies to start acquiring the shares of aluminium producers on the various international stock markets where those shares are quoted. The aim, in this instance is to share in the success of the producers in their international operations rather than to secure the same benefits through the development of a locally integrated aluminium industry. This would be a much better alternative to renegotiation (and probable nationalization). Politically, it would be viewed with less repugnance. Commercially, it would leave open to the government access to the goodwill enjoyed by the company, the expertise of the company's management, the company's research and development facilities, markets, and capital markets. It also takes advantage of the free-market principles which forms the accepted basis of economic relations in the Western world. The recent takeover of the British-based company Guthrie by Malayan interests is a case in point[9]. The implementation of such a strategy is constrained by a mine-field of legal obstacles in the home country of the companies.

If it were to become a policy to invest in shares, there would be a need to differentiate between the issue of investing for the sake of achieving the best possible return or the acquisition of shares with the specific aim of achieving control.

If the aim is merely to seek the best possible return, it may very well lead to investing in non-aluminium companies and spreading the investment rather than in KAISER in particular.

In either case, the acquisition of shares is by no means easy for a country with serious foreign exchange problems. The scale of investment required is demonstrated by Table 5-1 below. Based on the year-end share price and on the average number of outstanding primary shares of 41,586,000, the market value of KAISER was $946.1 million in 1980. (The authorized common shares was 100 million in 1979)[10].

TABLE 5-2: Market Value of Kaiser Aluminium And Chemical Corporation
(U.S. $ millions)

Year (a)	Market Price of Kaiser On The New York Stock Exchange (in U.S. $)			Average Number of Primary Shares Outstanding ('000) (e)	Market Value as at the close of the year (U.S. $ millions) (f) = (e) x (d)
	High (b)	Low (c)	Close (d)		
1970	21¼	13 3/8	17½	38,080	666.4
1971	19¼	8¼	10 1/8	38,100	385.8
1972	13 1/8	8 1/8	8 7/8	38,194	339.0
1973	14¼	6½	10	38,322	383.2
1974	13 3/8	6	6 3/8	38,326	244.3
1975	17¼	6 3/8	13 7/8	38,434	533.3
1976	20 1/8	13¾	18 3/8	38,953	715.8
1977	20 1/8	13 7/8	15 3/8	39,589	606.7
1978	20½	14	17½	39,969	699.5
1979	22 1/8	17¼	19¼	40,575	781.1
1980	30¼	15 3/8	22¾	41,586	946.1

Estimates of KAISER's market value was based on data from the following sources: (i) Annual Reports of Kaiser Aluminium And Chemical Corporation.

(ii) Data submitted to the Securities And Exchange Commission on Form 10-K Reports by KAISER.

In comparison, Ghana's foreign exchange reserves, at the best of times, is about $250 million.

Given the severity of the internal politico-economic problems, it would appear advisable for the Ghana Government to abandon the pursuit of integration and opt for the policy of encouraging KAISER to increase the level of "tolling" imported alumina. The additional dollar inflows that would result can then be used to build up a high income equity portfolio in successful companies abroad. This would ensure foreign exchange earnings even in the post-VALCO era.

CHAPTER 6: CONCLUSIONS/RECOMMENDATIONS

The upshot of this study is essentially that, the Ghana Government's active pursuit of the Volta River Project (VRP) and, in particular, the policy of offering inducements to KAISER and REYNOLDS in the hope that the resultant investments in the country's aluminium industry would diversify the single crop (cocoa) economy, has achieved mixed results. Ghana now has a dam and powerhouse which have become all the more valuable since OPEC forced energy prices upwards. But, to the extent that Ghana wanted the establishment of a bauxite-to-aluminium processing complex, the VRP has failed. This apparent failure to achieve a bauxite-to-aluminium complex does not in itself imply that the overall benefits derived by Ghana from the status quo is not substantial.

The failure to achieve an integrated aluminium industry is attributable to the interplay of domestic and external factors. For, after a long, tortuous and complicated negotiations which culminated in the 1962 Master Agreement and its Scheduled Documents, the operating framework for a mutually dependent relationship between Ghana and VALCO (KAISER - 90%; REYNOLDS - 10%) were established. Besides paying for the power project and the supportive infrastructure, the Ghana Government granted VALCO exclusive access to a large block of non-interruptible power, and exemptions from import and export duties as well as exchange control regulations. In addition, it stabilized the tax rate after a ten year tax holiday, and guaranteed highly competitive power prices for large blocks of non-interruptible power. The company was also given a free hand to conduct the business. VALCO's owners, for their part, gave assurances that they would pay for pre-specified blocks of power - whether or not this power was used. VALCO's assurance was highly significant because it made possible the mobilization of capital from external sources and provided a guaranteed means to service the Akosombo debts.

But, because of the absence of a linkage between the incentives conceded by the Ghana Government and indigenous alumina usage, the

Ghana/VALCO relationship has produced two contentious outcomes. First, the loopholes in the agreement have sanctioned the institutionalization of the industry's fragmentation. While Ghanaian bauxite is exported to Scotland by BACO, VALCO's smelter at Tema "toll-process" (i.e. converts) alumina imported principally from Jamaica for a fee. The entire quantity of VALCO-produced aluminium is exported while local fabricators have to import all the requirements of semi-fabricated aluminium. Secondly, the nature of the agreement has ensured that the appropriation of the direct financial benefits from VALCO's tolling operations is neither zero-sum nor obviously equitable.

The fragmentation of the aluminium industry has been seen as having a negative impact on Ghana's terms of trade. Its perpetuation certainly implies the permanent truncation of the benefits derivable from a bauxite-to-aluminium complex for which the raw material inputs are, to a large extent, available locally. Not unnaturally, the disquiet over the state of the industry has become more widespread and the pressure on VALCO to integrate its operations backwards into mining and refining have intensified.

While people are increasingly questioning VALCO's role and intentions, Ghana's politico-economic situation has, over the years, been deteriorating. Investor confidence has declined. Within this worsening scenario, Ghanaian inflation has remained substantially high (over 100%) for several years. Coupled with this, the Ghanaian currency - the cedi - changes hands unofficially at 15-20 times the official exchange rate. In these circumstances, recent KAISER-led investment appraisals for the bauxite-to-alumina venture, contrary to previous KAISER findings in 1959, have reached the negative conclusion that the project to integrate current operations backwards is uneconomic and must, hence, be shelved.

To Ghanaians, the disquiet over VALCO's unwillingness to integrate their operations backwards stems from the fact that the critical input and expense items in the commercial production of aluminium are: power (which is now reported to account for 50% of the

cost of extracting aluminium from bauxite); alumina (i.e. semi-processed bauxite); and capital. With the exception of capital, these critical inputs are available in Ghana, not only at competitive prices, but also in sufficient quantities to sustain the operation of large-scale plants for a long time to come.

Paradoxically also, the process of extracting aluminium from bauxite requires that 75% or more (by weight) of the main input material (bauxite) has to be discarded in one form or other. Besides the large quantities of material to be discarded, it is necessary to transport very large volumes of process chemicals as well to the processing plants. Yet, notwithstanding the high cost of conveying cargoes of bauxite, alumina, and process chemicals, the cost-conscious producers have, traditionally, been prepared to cross-ship these voluminous cargoes to the geographically dispersed downstream plants - even in circumstances where the availability of processible bauxite and cheap power are obtainable in commercial quantities to justify in situ processing.

Because of the particular situation in Ghana, the treatment of capital and the allocation of a fair price to the alumina output (for which, there is virtually no arm's length trading) are the crucial determinants of the viability of the Ghanaian proposals for backward integration.

By adopting a short payback period for what ought to be a long-term project, and assuming borrowing from sources which are not the most competitive in international capital markets, the KAISER-led BASCOL study in 1975 reached the verdict that the 600,000 tonne/year alumina venture was uneconomic, and must, therefore, be shelved in the meantime.

In contrast to BASCOL's conclusions, the Hungarian firm of ALUTERV-FKI examined the same project later in 1977 and reached the verdict that alumina plant capacity variants which exceed 600,000 tonnes/year are feasible and profitable.

Given the contradictory conclusions of the BASCOL and ALUTERV-FKI studies, as well as the intensity of the debate on the fragmentation of the Ghanaian aluminium industry, a re-assessment of the bauxite-to-alumina venture is warranted. Not least of the reasons for the re-assessment is the fact that it could be argued that the continued fragmentation of the industry is explicable by political considerations rather than the economics of producing alumina in Ghana.

To re-assess the project, BASCOL's estimates of costs and its approach of using constant dollar treatment (as opposed to projected prices) were accepted. However, the price assigned to the alumina output was assumed to be equivalent to that being received by KAISER and REYNOLDS for the alumina imported (principally from Jamaica) to be "toll-processed" at their VALCO plant at Tema. These alumina prices, as inferred from the publicly declared information from KAISER and REYNOLDS, differ markedly from that used for the BASCOL study. The use of these prices in the project appraisal confirms the profitability of the alumina venture. In the 1975 BASCOL study, the alumina pricing formula applied effectively assigned only 30.4% of the ruling ingot price to every two tonnes of alumina produced from the proposed venture.

If, as argued, significant savings in transport costs are derivable from the localization of all stages of aluminium production, and in addition, the alumina project can be shown to be viable in its own right, the neutral observer may very well have to ask why KAISER and REYNOLDS are unwilling to promote such a project. After all, relative to its rival metals, aluminium (hence alumina) demand and prices are relatively buoyant despite the anticipation of lower growth rates in the developed economies who account for over 90% of the metals consumption. Moreover, the intensification of anti-pollution pressures and measures in the developed countries, which have hitherto been the traditional sites for refinery/smelter complexes, have given a greater impetus to the relocation of downstream aluminium plants in those developing countries who can offer both competively-priced bauxite and power.

A scrutiny of the deomestic and international contexts in which the Ghanaian alumina venture ought to be considered reveals that the unwillingness of VALCO's owners to integrate their "tolling" operations backwards into mining and refining is traceable to and explicable by a number of genuine disincentives for the producers.

First, KAISER and REYNOLDS cannot justifiably embark on a project whose estimated current cost is $500 - $800 million in an unstable environment in which several foreign-owned mining and timber concerns have been partially nationalized in the recent past. To establish this high-cost plant is simply to render the resultant integrated complex more easily nationalizable.

Secondly, at stake for the companies are the current financial benefits derived from the status quo. Besides the stabilization of VALCO's tax liabilities at 40% after a ten year tax holiday, KAISER and REYNOLDS have a free hand to conduct its "tolling" operations. And because of the Long Term Tolling Agreement, VALCO is not obligated to process Ghanaian bauxite. The requirements of alumina necessary for VALCO to meet its power commitments is supplied by KAISER and REYNOLDS from other off-shore alumina plants in proportion to their equity holdings. Mainly as a result of these key provisions, the massive scale of the financial interests at stake for VALCO are:

(i) an estimated gross turnover of $1,628.7 million for (1967-1980) out of which only $295.7 million (18%) was required to be transferred to sustain the operations in Ghana;

(ii) a large volume of intra-company trade which has resulted in the Tema investment contributing 33.1% of KAISER's global net income for 1967-1977 period;

(iii) a compounded annual growth rate of 20.8% in the undistributed income of VALCO for 1977-1981 which helps improve the debt-to-equity ratio of the parent company in an era of high interest rates.

Why then invest in the alumina project when by so doing the foregoing will be placed in jeopardy?

Transfer pricing (employed principally at Jamaica's cost) has, however, inflated the profits derived from the Tema investment. Nevertheless, the ability to use transfer pricing is clearly instructive of the degree of flexibility enjoyed by the parent companies in their intra-company pricing policies. This flexibility would be clearly jeopardized if the status quo were to be altered by the Ghanaian alumina venture.

Thirdly, the sluggish growth in the economies of the developed countries in recent years has meant that KAISER and REYNOLDS have excess installed alumina capacity. On grounds of marginal cost, it is logical for the producers to supply the additional tonnage of alumina from idle facilities, which are largely amortized, rather than from greenfield plants. Besides the risks and the high cost of installation, there is the 4-5 year pre-production period during which the market situation could very well change.

Moreover, there are indications that the dominating hold once held by the major producers over supply, marketing and prices is slipping because of the entry into the industry of other producers. As such the market for alumina and aluminium is increasingly becoming uncertain. These market factors have coalesced to discourage the alumina investment.

Fourthly, although the world market for alumina and aluminium could very well expand in the future, local and regional markets are unlikely to be that significant. Even if the West African market were to grow significantly, problems with currency convertibility is likely to dissuade the producers from extensive commitments in the region.

Fifthly, the advantages conferred by the 1962 agreements are likely to be reduced in any re-negotiation. Should the proposal to integrate aluminium production in Ghana be implemented, re-negotiation would be inevitable because of issues concerning ownership, alumina supply contracts, tax liabilities, repatriation of capital and

dividends, pricing mechanisms, etc. To KAISER and REYNOLDS, the consequent loss of flexibility for no identifiable additional benefits is bound to be considered as unacceptable.

Although VALCO is unenthusiastic about the alumina project, it is significant that the company has invested $91,000 in 2,500 shares (about 1% interest) in ALUWORKS - an aluminium rolling mill to produce semi-fabricated aluminium at Tema. For its operation, VALCO has agreed to sell to ALUWORKS 500 tonnes of aluminium ingot each year in quarterly instalments of 125 tonnes each. (VALCO, 1981 Annual Report).

It is also significant that KAISER and a group of Ghanaian banks have teamed up to invest in a large agricultural project in the Accra plains. The aim is to produce several crops with emphasis on rice. (VALCO 1981 Annual Report).

Looking at the rationale of VALCO's unwillingness to invest specifically in the alumina project but their readiness to promote other non-alumina projects, it would be incorrect and simplistic to see VALCO's role and contributions in predatory terms.

The extent to which Ghana can optimize the benefits derivable from the opportunities created by the KAISER-REYNOLDS entry very much depends on Ghana itself. The sale of electricity to VALCO is only a small aspect of the VRP. As an example of the wider opportunities made possible by the entry of KAISER and REYNOLDS, one could cite the undeveloped potential of the Volta Lake for fishing, farming, and transportation. These are matters that lie within the purview of the Ghana Government's developmental obligations to its own people. It cannot be a matter for VALCO or its owners. Also, the floundering of the non-VALCO sector of the Ghanaian economy - including, specifically, the cocoa sector - is a cause for national self-examination. VALCO or its owners have nothing to do with those failures or any obligations to improve them.

But, because of the deterioration in Ghana's political-economy

attention has naturally been focussed on one of the few successes in the Ghanaian economy - VRA and VALCO. In view of the frustration in Ghana, VALCO could be of the view that it could not present the rationale behind their lack of enthusiasm for the alumina project to Ghanaians in the manner argued above. If, however, the project were to be shown to be unviable, then the pressure on the company to integrate backwards would abate.

Given this background to the problems of fragmentation, Ghana has a number of feasible policy strategies. But the one most likely to be effective is to abandon the integration of the aluminium industry as the central policy objective. The fragmentation of the aluminium industry should be accepted as a fait accompli. The Government should then encourage VALCO to raise the level of its "tolling" operations such that its power off-take is raised to 415,000 kilowatts (i.e. the maximum power ceiling in negotiated in 1962). This should accord with the wishes of VALCO because of the competitive power price in Ghana.

The increased level of operations would lead to higher dollar transfers to the Bank of Ghana to meet the following obligations:

(i) a larger wage bill to cover increased man-hours necessary to sustain the higher level of "tolling" activity;

(ii) a higher operational and construction spending;

(iii) the bills for the additional power used;

(iv) larger VALCO Fund Contributions;

(v) greater income tax payments.

The additional revenue can then be used solely for the purchasing of shares in profitable international companies. By the gradual establishment of a high income equity portfolio, dollar incomes could be guaranteed for the Ghanaian economy for several years - even in the post-VALCO era.

The hidden advantage of this strategy is that, by abandoning

integration now, Ghana would effectively be conserving her bauxite resources. The conserved bauxite deposits could be exploited at any time in the future when the country finds itself able to raise the capital and expertise to exploit the deposits for the specific benefit of Ghanaian manufacturing industry and economy.

NOTES ON THE TEXT

Notes on Chapter 1.1

1. Krassowski provides a full survey of the strengths and weaknesses of the Ghanaian economy before Nkrumah even attempted his high-speed industrialisation schemes.
   See: Andrej Krassowski, "Development and the Debt-Trap. Economic Planning and External Borrowing in Ghana", 1974, Croom Helm Ltd., Chapter 2.1, pp.4-11.

2. In an illuminating article, Mr, Kwame Pianim (the then Chief Executive of the Ghana Cocoa Marketing Board) admitted to the following problems facing the industry and the Cocoa Marketing Board. The Cocoa Marketing Board purchases all cocoa output in Ghana for resale overseas. His observations were: unsatisfactory controls within the Cocoa Marketing Board on the disbursement of funds and hence abuse and misuse of funds allocated to the industry; excessive centralisation; disincentives due to poor producer prices; poor maintenance of farms and infrastructure; inadequate levels of replanting and poor harvesting; labour migration-leaving only the old (average age 50 years) to tend the farms; and finally, the Busia Government's Alien Compliance Act of the early 70's which curtailed the industry's access to hired hands in the form of cheap migrant labour.
   See: WEST AFRICA, no.3261, 21st January, 1980, p.130.

3. Ghanaian bauxite fetched a U.K. price of £13.21 per tonne on average, in 1976 (See: Mineral Resources Consultative Committee, Mineral Dossier 20, "Bauxite, Alumina, Aluminium", compiled by R.N. Crockett, available from Department of Industry, Millbank Tower, Millbank, London, SW1P 4QU). Taking £1.00 - US$1.8066, then the average price per tonne in the U.K. is equivalent to $23.87. Given that the price of aluminium ingot in 1976 was about $980.8 per tonne, then the ratio of earnings is about 1 : 41 - that is, aluminium ingot is over 40 times more valuable than bauxite.

Notes on Chapter 1.1 (continued)

4. Tony Killick, "Development Economics in Action. A Study of Economic Policies in Ghana", 1978, Heinemann, p.185.

5. ibid.

6. Krassowski, op. cit., p.52.

7. Horst Habenicht, "Processing Raw Materials", INTERECONOMICS, No.9/10, 1977, pp.230-232. Habenitch argues that the effects of investments in downstream processing plants on the national economy in terms of cost-benefit ratio is not necessarily the highest. Other branches of the economy could prove even more beneficial.

8. Emily Card, "The Political Economy of Ghana", published in Richard Harris, (ed), "The Political Economy of Africa", 1975, Schenkman Publishing Company, p.78.

9. ibid. p.81.

10. ibid.

Notes on Chapter 1.2

1. Ref. The British Aluminium Company Limited, Publication No. 1A.2, Sheet 1 of 2, September 1975.

2. Bauxite Alumina Study Company (BASCOL), "Feasibility of Bauxite And Alumina Production In Ghana", July 1975.

3. The disquiet over the Volta River Project are manifested in a number of articles and a recent book.
   (a) See: THE LEGON OBSERVER, Volume 12, No.6, 11th April, 1980, pp.123-128. This article attempted to argue that the price of electricity paid by VALCO is too low and must therefore be raised.

Notes on Chapter 1.2 (continued)

(b) See: THE LEGON OBSERVER, Volume 12, No.8, 29th May, 1980, pp.170-177. The attempt was made in this article to argue that the 1962 Agreements reached between the Ghana Government and the KAISER-REYNOLDS consortium are not only unfair but are such that they will continue to frustrate the countries attempts to develop a mine-to-metal complex.

(c) See: WEST AFRICA, 24th March, 1980, 31st March, 1980, 7th April, 1980, and 14th April, 1980 issues. In a series of four articles which were generally headed as: "Imperialism And The Volta Dam", an attempt was made to argue that Ghana's plight is the result of multi-national intrigues which were supported by the American government.

(d) See: NEW SCIENTIST, 16th September, 1976, pp.596-197. Peter Goodwin, in an article headed: "Volta ten years on", attempts from a neutral position to draw a balance sheet of the Volta River Project. The benefits of the project in its current state is acknowledged but he suggests that it is still necessary to reach satisfactory compromises with the aluminium producers before all the benefits derivable from the project could be achieved.

(e) See: David Hart, "The Volta River Project. A Case Study In Politics And Technology", Edingburgh University Press, 1980. Hart states in his introduction to the book:

> "The VRP is generally described as a successful development scheme, but the end result of this study has been a questioning of this description. The VRP seems not to have assisted Ghana's development. Even if the definition of development is restricted to a purely technical criterion such as whether industrialisation has occurred, the VRP remains open to severe criticism. If development is defined in terms of economic criteria (in terms of monetary gain or loss), the success of the VRP is even more in

doubt. And when development is defined in terms of the achievement of political autonomy, the VRP looks as much a backward as a forward step".

Notes on Chapter 1.3

1. REPORT OF THE GOLD COAST MINES BOARD OF INQUIRY, 1956, p.28.

2. See: WEST AFRICA, number 3336, 6th July, 1981, p.1558.

3. GHANA ALUMINIUM PRODUCTS LTD., Annual Report 1979, p.4.

4. WEST AFRICA, Number 3334, 22nd July, 1981, p.1438.

Notes on Chapter 1.4

1. Three topical examples of how political factors influence the industry spring to mind.

First, the break-up of the monopoly of Aluminium Company of America (ALCOA) and the simultaneous emergence of KAISER and REYNOLDS as major primary aluminium producers were the outcome of deliberate political decisions on the part of the Government of the United States.

Second, the British Government's initial interest in the development of an integrated aluminium industry in the early 50's was so strong that it was willing to lend £50 million repayable in 80 years if it would, at the time, be guaranteed 75% of the output. Reason - such a project "would guarantee the United Kingdom industry additional Sterling Area supplies of aluminium at competitive prices to meet rapidly growing requirements for which it would be unwise to rely on other sources". This was a time of acute dollar shortage and 80% of the U.K. aluminium requirements were being paid for, at the time, with scarce dollars. (U.K. Government White Paper, "Volta River Aluminium Scheme", November 1952, Cmd.8702, paragraphs 2,14,15, pp.2,5 and 6).

Notes on Chapter 1.4 (continued)

Thirdly in the '60's, the U.K. Government, through the Industrial Expansion Act of 1968, provided direct and indirect support to private enterprise companies (including BACO, KAISER, ALCAN and RIO TINTO ZINC) to develop primary aluminium production in certain development areas. Such a development was considered to be in the 'national interest'.
See: (a) Great Britain, Board of Trade, "The Production of Primary Aluminium", November 1968, Cmd.3810.

(b) Specifically, the development of the Invergodon smelter is discussed in: G. Gordon Drummond, "The Invergodon Smelter. A case study in management", 1977, Hutchinson Benham.

In a way, the closure of BACO's Invergodon Smelter, as reported by the "Financial Times", "Guardian", and "Daily Telegraph" of 30th December, 1981 is also instructive of the way in which political decisions influence the industry. After only 10 years of operation, the 100,000 tonne/year smelter will close with a direct loss of 980 jobs and thousands of jobs in sub-contracting and service industries dependent on it. The smelter, which cost £20 million to build received direct and indirect support mainly in the form of 40% Investment grants and power at cut rate. The U.K. government subsidies to the North Scotland Hydro-Electric Board (and hence, indirect help to BACO) for the ten years amounted to £113 million. The closure of the plant was announced only because the present Government is unwilling to come up with further indirect subsidies of £16 million/year. The anxiety that the closure has caused even among politicians stems from the fact that the politico-economic repercussions will extend well beyond the aluminium industry itself. First, the unemployment in the area is expected to jump from 14% to 20%. Second, the demise of the smelter which accounted for 7% of the power demand in Scotland will threaten the future of the Hunterston nuclear power programme. Thirdly, British Rail, whose operations in the

Notes on Chapter 1.4 (continued)

Highlands are already fragile, anticipate further annual losses of £500,000 with more to follow. Finally, if the other producers who got similar government support are unable to negotiate a power rate substantially below the full economic cost they may also be threatened. The closures would have a negative impact on the balance of payments.

2. See: A.E. Kitson, "The Possible Sources of Power for Industrial Purposes in the Gold Coast, British West Africa" published in the FIRST WORLD POWER CONFERENCE, Transactions June 30th - July 12th, 1924, Vol.1, pp.325-337, pub. Percy Lund Humphries & Co., (London).

3. Report of the Gold Coast Mines Board of Inquiry, 1956, Government Printers, Accra, Ghana, p.28.

4. ibid.

5. The British Government tried to involve BACO in the development of an integrated aluminium complex during the dyarchy. The U.K. Government White Paper "Volta River Aluminium Scheme" of November 1952 (Cmd.8702), specifically states that: "This White Paper sets out a scheme under which the United Kingdom Government, the Gold Coast Government and the Canadian and United Kingdom producers would develop large scale aluminium production in the Gold Coast", p.1.

6. Commander Sir Robert Jackson, "The Volta River Project", Progress (Unilever), n.4, p.147.

7. U.K. Government White Paper, Cmd.8702, op.cit.

8. Thomas Balogh's (1956) criticism (in "Time And the Volta, Once More", WEST AFRICA 40, September 753-4 and October 775-6) are reported by: David Hart "The Volta River Project. A case study in politics and technology", 1980, Edinburgh University Press, pp.23-24.

Notes on Chapter 1.4 (continued)

9. The figure of 91% comes from the U.K. Government White Paper, Cmd.8702, p.16. Here it was pointed out that "the contract (i.e. the power contract) would recognize that other users in the Gold Coast would require up to 50,000 kw of the power which would be available". With the expected generating capacity of 564,000 kw, the non-aluminium demand represents about 9%.

10. See David Hart, op.cit., p.24.

11. James Moxon, "Volta: Mans' Greatest Lake", 1969, Andre Deutsch, pp.85-86.

12. See: Philip Siekman, "Edgar Kaiser's Gamble in Africa", FORTUNE, November 1961, p.128.

13. See: FORBES, Vol.101, pt.5-8, April 15th, 1968, p.34.

14. Philip Siekman, op.cit.

15. See: Hart, op.cit., p.25. Hart quotes from Henry J. Kaiser and Co., 1959. "Re-assessment Report on the Volta River Project for the Government of Ghana", Report No.H.C.59-1-RE, Oakland, California.
See also: David Hilling, "Ghana's Aluninium Industry. Some locational considerations", Tijdschrift voor economische en social geographie, May 1964, p.128.

16. Hart, op.cit., p.25.

17. Hilling, op.cit., p.128.

18. See: SHAWMONT LTD., "Power Rate Study", August 1976, p.1-5.

19. Siekman, op.cit.

Notes on Chapter 1.4 (continued)

20. Jackson, op.cit., p.154.

21. "Kaiser's Global Empire", FORBES MAGAZINE, Vol.101, pt.5-8, April 15th, 1968, p.34.

22. Jackson, op.cit., p.154.

23. "JFK Opens Purse to Volta Dam", ENGINEERING NEWS RECORD, Volume 167, Number 25, December 21st, 1961, p.43.

24. ibid.

Notes on Chapter 2.1

1. Most of the articles and letters published about the VRP tends to see the Ghana/KAISER-REYNOLDS relationship in terms of a weak, unsophisticated nation exploited by the powerful aluminium producers.
See Note 3 of Notes on Chapter 1.2.

2. Norman Girvan, "Making The Rules Of The Game: Company-Country Agreements In The Bauxite Industry", SOCIAL AND ECONOMIC STUDIES, Volume 20, Number 4, p.383.

Notes on Chapter 2.2

1. VRA Annual Report.

2. See: "Imperialism And The Volta Dam: A Reply", by Mr. Ward B. Saunders, Managing Director of VALCO, WEST AFRICA, 2nd June, 1980, p.959.

Notes on Chapter 3.1

1. UNIDO, "Workshop On Case Studies Of Aluminium Smelter Construction In Developing Countries", ID/WG.250/18, 26th August, 1977, paragraph 31, p.11.

Notes on Chapter 3.2

1. Robson, R.J., "The Energy Factor In The Bauxite/Alumina/Aluminium Industry", IBA QUARTERLY REVIEW, Volume 6, Number 3, JANUARY - MARCH, p.42.

2. United States Bureau of Mines, "Aluminium", MCP-14 Mineral Commodity Profiles, May 1978, pp.12-13.

3. Douglas, Conrad G.C., "Notes On The Processing Of Bauxite To Alumina", IBA QUARTERLY REVIEW, Volume 6, Number 4, APRIL-JUNE, 1981, pp.18-25.

4. UNITED NATIONS CENTRE ON TRANSNATIONAL CORPORATIONS, "Transnational Corporations In The Bauxite/Aluminium Industry," Sales No.E. 81.II.A.5, ST/CTC/20, May 1981, p.17.

5. ibid., p.27. See also:- E. Balaz and I. Molnar, "Bauxite-Alumina-Aluminium: Main Factors For Decision-Making On Industrial Development", UNIDO, ID/WG.273/8, 31st July, 1978, p.26.
For energy consumption, ALCOA's 1980 Annual Report (p.6) reports that in the last 40 years, energy usage in smelters has been reduced from 12 kwh/pound metal to an average of 7.3 kwh/pound. In the most efficient plants, power usage is 6 kwh/pound.

6. JOURNAL OF OCCUPATIONAL MEDICINE, Vol.19, n.1, January 1977.
Also work on environmental impact of the aluminium industry include:
   (a) International Primary Aluminium Institute (IPAI), "Health Protection In The Aluminium Industry,"Proceedings of Seminar, Copenhagen, 28-30 June, 1977.
   (b) IPAI, "Environmental Reconsiderations for Siting and Operation of New Primary Aluminium Facilities, "December, 1977.

Notes on Chapter 3.2 (continued)

(c) United Nations Environmental Programme (UNEP), "Environmental Aspects of Aluminium Smelters. A Technical Review," 1981.

7. According to William Hobbs, the increasing stringency of environmental legislation in the industrialised countries make the developing countries a natural home for new major refineries and smelters.
See: William Hobbs (Vice President and Chief Financial Officer of Kaiser Aluminium and Chemical Corporation), "Financing Aluminium Industry in the 1980's, "First International Aluminium Conference, Madrid, Spain, September 29th, 1980, p.2 of paper delivered. Proceedings have been published by METAL BULLETIN.

8. WORLD BUSINESS WEEKLY, "Cracks Appear in Australia's Plans To Expand its Aluminium Industry," March 30th, 1981, pp.44-45.

Notes on Chapter 3.3

1. UNITED NATIONS CENTRE ON TRANSNATIONAL CORPORATIONS, "Transnational Corporations in The Bauxite/Aluminium Industry," ST/CTC/20, Sales No. E.81.II.A.5, May 1981, p.1.

2. See: (i) Farrell, J.W., "Kaiser Aluminium - 11 Years of Progress", TRAFFIC MANAGEMENT, Volume 15, Number 4, April 1976, pp.24-27.

and (ii) Farrell, J.W., "An American Trading Company Links International Markets", Volume 16, Number 10, October 1977, pp.52-59.

3. Swapping, toll-processing and barter are features of the aluminium industry enforced by the main producers to reduce the size of open market trading of bauxite and alumina.

Swapping is used to avoid the cost of redesign of

Notes on Chapter 3.3 (continued)

existing refineries and smelters which are necessitated by the introduction of bauxite/alumina feedstock from another locality. By swapping, the costly cross-shipping of the ore could be avoided.

Toll-processing also has the effect of reducing the open trading of bauxite and alumina. As with the VALCO smelter of KAISER and REYNOLDS, the owners or third parties supply their excess alumina from their operations elsewhere to be converted into the metal. The alumina feedstock is delivered f.o.b. to the factory gate while the metal output is delivered likewise to the owners of VALCO f.o.b. factory gate. The smelter derives its income from the fee it charges the alumina suppliers for the conversion. Tolling therefore enables the participants to sustain their global operations at or near their rated capacities.

The best example of barter is that between ALCAN and Norwegian smelters. Alumina is supplied by ALCAN in exchange for cheap metal. See Cornish, Note 3 below.

4. J.K. Cornish, "A Study Of The Potential Size Of Intra-Company Transfers And Open Market Sales Of Bauxite And Alumina In 1976 and 1982", Special Paper, IBA QUARTERLY REVIEW, Volume 4, Numbers 2 and 3, March 1979, p.33.

5. METAL BULLETIN, "World Aluminium Survey," 1977, p.16.

6. János Zámbó, "Bauxite and Alumina Production. Historical Retrospection. Review Of The Present Situation And Prognosis", UNIDO, ID/WG. 273/9, 9th August, 1978, Table 3, p.24.

7. R.S. Pyndyck, "Cartel Pricing and The Structure of The World Bauxite Market", BELL JOURNAL OF ECONOMICS, Autumn 1977, Vol. 8, n.2, p.346.

Notes on Chapter 3.3 (continued)

8. Sandford Rose, "Third World 'Commodity Power' is a Costly Illusion," FORTUNE, November 1976, pp.146-150, 154, 158, 160, 162.

Notes on Chapter 3.4

1. THE ECONOMIST, April 24th, 1982, p.88.

2. THE GUARDIAN (United Kingdom), January 21st, 1982.

3. THE ECONOMIST, January 30th, 1982, p.40.

4. FINANCIAL TIMES, (United Kingdom), April 22nd, 1982, p.4.

5. WORLD BUSINESS WEEKLY, "Cracks Appear in Australia's Plans To Expand Its Aluminium Industry", March 30th, 1981, pp.44-45.

6. ibid.

7. FINANCIAL TIMES (United Kingdom), April 22nd, 1982, p.37.

8. THE ECONOMIST (United Kingdom), April 24th, 1982, p.88.

9. THE GUARDIAN (United Kingdom), 5th June, 1982, p.18.

10. David Mathurin, "A Study of The Components and Determinants of (Unit) Prices Costs and Revenues in Jamaica's Bauxite and Alumina Industry," April 1978, Mimeograph (Institute of Social and Economic Research, University of the West Indies, Kingston, Jamaica).

11. Minerals Yearbook (1976), Vol.1, U.S.B.M., P.202, Table 12.

Notes on Chapter 3.5

1. Thomas G. Langton (Chase Econometrics), "Economic Aspects of The Bauxite/Aluminium Industry," JOURNAL OF METALS, August 1980, Table 1, p.13.

Notes on Chapter 3.5 (continued)

2. Pan A. Yotopoulos and Heffrey B. Nugent, "Economics of Development. Empirical Investigations" HARPER & ROW, 1976, Table 1.1, p.5.

3. WORLD BANK, "World Development Report", Table 2, pp.112-113.

4. THE ECONOMIST, September 25th, 1976, p.92.

5. William A. Vogely discusses Milfred Malenbaum's "law of demand" in:
William A. Vogely, "Is There a Law of Demand For Minerals", EARTH AND MINERAL SCIENCES (The Pennsylvania State University), Vol.45, no.7, April 1976, pp.1, 52-53.

6. ibid.

7. ibid.

8. R. Vedavalli, "Market Structure of Bauxite/Alumina/Aluminium: And Prospects for Developing Countries", Commodity Paper No.24 (3/77), INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT, p.5.

9. William Hobbs (Vice President and Chief Financial Officer, Kaiser Aluminium and Chemical Corporation), "Financing The Aluminium Industry In The 1980's," FIRST INTERNATIONAL ALUMINIUM CONFERENCE, Madrid, Spain, September 29th, 1980. Proceedings of Conference to be published by METAL BULLETIN.

10. U.S.B.M., "Aluminium", MCP-14 Mineral Commodity Profiles, May 1978, p.14.

11. P. Relle, "History and Analysis of Marketing Activities in The Field of Bauxite and Alumina (Case Study of Hungarian Experience), UNIDO, ID/WG. 273/6, 10th July, 1978, pp.22-25.

Notes on Chapter 3.6

1. CHEMICAL WEEK, "Aluminium Makers Like The Odds", January 30th, 1980, pp.16-17.

2. Raymond F. Mikesell, "New Patterns of World Mineral Development", BRITISH - NORTH AMERICAN COMMITTEE, September 1979, Appendix C, pp.92-93.

Notes on Chapter 4.2

1. As VALCO has pointed out:

   "A financial incentive for the shareholders of VALCO (i.e. Kaiser 90%; Reynolds 10%) to obtain alumina from bauxite mined in Ghana is the provision that will reduce the tolling charge from 60% to 56% when all of the alumina tolled at VALCO's Tema plant comes from Ghanaian bauxite. This will reduce VALCO's tax payments and VALCO Fund payments significantly. At current prices, the reduction would be in the order of US $6-7 million annually." (VALCO Information, March 31, 1981).

2. As Appendix A3-6 shows, the import tariffs (as a percentage of the value) on primary aluminium in the following markets are: Canada and U.S.A. - 4%; EEC - 7%; Japan - 10.4%. Consequently, the use of 4% (rather than 7% and 10.4% in the EEC and Japanese markets to which Ghana's aluminium is also exported) reduces the gross income obtained from the sale of the metal overseas. Accordingly, the price imputable to the Ghana-produced alumina is also reduced.

3. R. Vedavalli, "Market Structure of Bauxite/Alumina/Aluminium: And Prospects For Developing Countries," Commodity Paper No.24(3/77), INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT, paragraph 44, p.13 and Table 7, p.14.

4. Capital Structure is defined as:

"the permanent financing of the firm, represented by primarily by long-term debt, preferred stock, and common equity, but excluding all short-term credit. Thus a firm's capital structure is only a part of its 'financial structure."

The 'financial structure' is defined as "the way the firm's assets are financed: it is the entire right hand side of the balance sheet."

- See: J. Fred Weston and Eugene F. Brigham, "Managerial Finance, "Sixth Edition, Holt-Saunders Ltd., p.663.

5. MINING JOURNAL, July 24th, 1981, p.67.

6. Mr. Ward B. Saunders, Managing Director of VALCO, "Imperialism and the Volta Dam: A Reply," WEST AFRICA, 2nd June, 1980, pp.958-959.

7. NEW AFRICAN, June 1980, p.31.

8. ibid, p.32.

Notes on Chapter 5.2

1. AFRICAN BUSINESS, May 1980, p.22.

2. Letter by Managing Director of VALCO to the DAILY GRAPHIC (Ghana), March 7, 1980. Quoted in THE LEGON OBSERVER (Ghana), Volume 12, No.6, 11th April, 1980, p.127.

3. Letter by Managing Director of VALCO to the DAILY GRAPHIC (Ghana), March 7, 1980.

4. "Imperialism and The Volta Dam: A Reply", Letter by Mr. Ward B. Saunders, (Managing Director of VALCO), WEST AFRICA, 2nd June, 1980, p.958.

5. ibid., p.959.
See also: "VALCO's Positive Impact", letter by Mr. Ward B. Saunders (Managing Director of VALCO), WEST AFRICA, 28th June, 1982.

Notes on Chapter 5.2 (continued)

6. The contributions of VALCO to the global performance of its parent companies have been somehow inflated by transfer pricing. The existence of a ten year tax holiday, the stabilization of tax liabilities at the rate of 40% thereafter, the blanket exemptions from import and export levies, coupled with the exemption from exchange control regulations have made it highly advantageous for KAISER and REYNOLDS to transfer profits - at Jamaica's cost - to Ghana.

Transfer pricing can be corroborated by a comparison of alumina production costs in Jamaica with the port-of-shipment values of Jamaican alumina exports to the U.S. market and the declared landed costs of alumina at Tema, Ghana.

Quoting from the Jamaica Bauxite Institute, Mathurin has indicated that the average cost of producing alumina in Jamaica in 1976 was $182/long ton - that is, $179.1/tonne (See Mathurin, David, op.cit.).

Transfer pricing is demonstrated when the data from the Jamaica Bauxite Institute (which, significantly, excludes the cost of delivering the alumina to Jamaican ports for export) is compared to the port-of-shipment values (i.e. f.a.s. values). The f.a.s. value of Jamaican alumina exports in 1976 was $144.7/long ton - that is, $142.4/tonne. (See Table 3-7). The alumina production costs registered in Jamaica (hence, income tax liabilities to the Jamaican Government) exceed the port-of-shipment valuation (which determines the income tax liabilities in the U.S.A.) by $36.7/tonne.

In contrast, the average cost of procuring and delivering alumina f.o.b. vessel Tema was registered with the Ghanaian authorities as $121/tonne. This average figure was obtained as follows:

$$\frac{\$35.67 \text{ million (Procurement and delivery costs-Appendix A5-1, Column(d))}}{151{,}113 \text{ tonnes (of VALCO-produced aluminium)} \times 1.95 \text{ (specific alumina usage assumed for the VALCO operations)}}$$

Notes on Chapter 5.2 (continued)

The difference between the cost imputed to the Jamaican alumina imported into Ghana and the production costs registered in Jamaica is estimated here at $58.1/tonne in 1976.

7. This information is based on the 1979-1981 Annual Reports of VALCO which are the only ones published so far.

8. S. Moment, "Experiences in Creating An Alumina Industry in Developing Countries", UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION (UNIDO), ID/WG.11/8, 29 April, 1968, paragraph 109, p.44.

Notes on Chapter 5.3

1. See Annual Reports of the VRA.

2. WORLD BANK, World Development Report, August 1980.

3. VALCO Annual Reports, 1979, 1980 and 1981.

4. SHAWMONT LOD., "Power Rate Study - Volta Aluminium Company Limited/Volta River Authority", August 1976, p.5-22, Table 5-3(c).

5. Fuad Rouhani, "Assignment and Renegotiation", Paper No.2, published in "Negotiation and Drafting of Mining Development Agreements", An inter-regional Workshop Arranged by the United Nations, Buenos Aires, 1973, Published By: MINING JOURNAL BOOKS LIMITED, London 1976, page 29.

6. ibid., p.29.

7. ibid.

8. Nicholas Burnetts's comment is cited by: THE LEGON OBSERVER (Ghana), 29th May, 1980, p.174. VALCO attempted to refute this charge in an article to the DAILY GRAPHIC (GHANA), 7th March, 1980.

9. SOUTH, January 1982, p.105-107.

10. KAISER, 1979 Annual Report.

APPENDIX A1-1: Production of Raw Cocoa in Ghana

Year	World Production (thousand tonnes)	Ghana Production (thousand tonnes)	Ghana Production as a % of World Production
1957-'58	783	210	26.8
1958-'59	924	259	28.0
1959-'60	1,061	322	30.3
1960-'61	1,195	439	36.7
1961-'62	1,146	417	36.3
1962-'63	1,177	429	36.4
1963-'64	1,224	428	35.0
1964-'65	1,531	581	37.9
1965-'66	1,228	417	33.9
1966-'67	1,354	382	28.2
1967-'68	1,357	422	31.1
1968-'69	1,242	339	27.3
1969-'70	1,442	416	28.8
1970-'71	1,499	427	28.5
1971-'72	1,583	470	29.7
1972-'73	1,398	422	30.2
1973-'74	1,447	355	24.5
1974-'75	1,547	382	24.7
1975-'76	1,510	401	26.6
1976-'77	1,339*	329	-
1977-'78	-	271	-
1978-'79	-	265	-

Compiled from the following sources:

(i) Central Bureau of Statistics (Accra) - Various Economic Survey Reports.

(ii) Bank of Ghana Quarterly Bulletins.

Note: Information in these reports were based on data from Gill & Duffus Reports.

APPENDIX A1-2: Volta River Authority Load Forecast 1980-1990

PEAK DEMAND (MW)

CUSTOMER	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
VALCO	319	380	380	390	390	390	390	390	390	390	390	390	390	390	390
EGG	172	180	185	191	180	193	207	217	228	239	251	264	277	291	305
MINES	43	41	43	44	44	44	44	44	44	44	44	44	44	44	44
TEXTILES	4	4	5	4	3	4	4	4	4	4	4	4	4	4	4
TOWNSHIP	1	1	1	2	2	2	2	2	2	2	3	3	3	4	4
CEB	28	33	38	56	75	80	85	90	90	90	90	90	90	90	90
TOTAL	567	639	652	687	694	713	732	747	758	769	778	795	808	823	837

← ACTUAL → FORECAST →

ENERGY SALES (GWH)

CUSTOMER	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
VALCO	2645	2784	2086	2908	3348	3348	3348	3348	3348	3348	3348	3348	3348	3348	3348
EGG	980	1035	2063	1028	1057	1134	1216	1275	1339	1369	1326	1343	1627	1709	1791
MINES	278	260	250	259	270	270	270	270	270	270	263	263	270	270	270
TEXTILES	23	24	24	18	23	23	23	23	23	23	22	22	23	23	23
TOWNSHIP	10	11	11	13	13	14	15	16	17	17	18	18	24	28	32
CEB	155	179	217	299	450	512	544	576	576	576	500	500	576	576	576
TOTAL	4091	4293	3651	4525	5161	5301	5416	5508	5573	5603	5477	5494	5868	5954	6040
SYSTEMS POTENTIAL ENERGY POTENTIAL	5400	5400	5400	5400	5400	5870	6340	6340	6340	6340	5580	5580	7515	7515	7515

Source: The Volta River Authority, Accra, Ghana.

APPENDIX A1-3: The Pra and Tano Hydro-electric Power Developments

Site	Dependable Annual Electrical Energy kilowatt hours x 10^6	Installed Power Capacity (MV)	Total cost (1971 US$ in millions)
PRA RIVER			
Heman	232	42.5	39.4
Awisam	156	88	45.0
Kojokrom	95	36	31.6
Abatumesu	165	63	41.2
TOTAL	640	229.5	
TANO RIVER			
Tanoso	131	34	38.2
Asuaso	90	51	38.3
Sedukrom	66	26	18.6
Jomuro	69	26	18.6
TOTAL	356	137	

Source: ACRES INTERNATIONAL LTD., "Republic of Ghana. Volta River Authority Generation Expansion Study", Vol.1, "Power And Energy Studies", May 1975, pp.4-8 and 4-9.

APPENDIX A1-4: Contribution of Awaso Bauxite Operation to Ghana's Export Trade

Year	Ghana's bauxite output (thousand tonnes) (a)	Exports of Ghana Bauxite (thousand tonnes) (b)	Export Revenues (in millions ¢) (c)	Total Value of Ghana's Exports (in millions ¢) (d)	Bauxite as a % of Total Exports (e)
1967	351.0	315.8	1.6	245.1	0.7
1968	284.7	253.0	1.5	338.8	0.4
1969	269.0	274.7	1.4	333.3	0.4
1970	342.0	316.4	1.3	467.4	0.3
1971	328.6	358.8	3.3	495.8	0.7
1972	340.3	337.3	3.4	565.1	0.6
1973	354.4	331.5	2.4	730.1	0.3
1974	363.3	342.1	3.3	839.6	0.4
1975	325.2	336.0	4.3	929.4	0.5
1976	267.3	260.9	4.0*	948.3*	0.4
1977	275.4	250.8	2.5*	1208.0*	0.2
TOTALS	3501.0	3377.3	29.0	7100.9	0.4

The estimates were based on information from the following sources:

Column (a) - Metal Statistics, 1978.

Column (b) - ibid.

Column (c) - Bank of Ghana, Quarterly Economic Bulletin, Vol.11, n.4, 1971; Vol.17, n.3, 1977; Vol.18, n.3, 1978.

* Obtained from CENTRAL BUREAU OF STATISTICS (Accra, Ghana).

APPENDIX A1-5: Revenues Forgone By Shipping Raw Awaso Bauxite As Opposed To Aluminium Exports

Year	Export of Bauxite (thousand tonnes) (a)	Aluminium Equivalent (thousand tonnes) (b)	Price/tonne of Aluminium (U.S.$/tonne) (c)	Potential Income (US$ in millions) (d) = (b) x (c)
1967	351.8	58.6	550.71	32.3
1968	253.0	42.2	563.72	23.8
1969	274.7	45.8	599.22	27.4
1970	316.4	52.7	633.17	33.4
1971	358.8	59.8	639.34	38.2
1972	337.3	56.2	583.12	32.8
1973	331.5	55.3	558.43	30.9
1974	342.1	57.0	750.89	42.8
1975	336.0	56.0	656.76	36.8
1976	260.9	43.5	980.84	42.7
1977	250.8	41.8	1,131.63	47.3
TOTALS	3413.3	569.9	-	388.4

Estimated and compiled from data from the following sources:

Column (a) - Metal Statistics 1978.

Column (b) - Calculations were based on the assumption that the conversion ratio for Awaso Bauxite is: 6 tonnes of Bauxite is equivalent to 1 tonne aluminium ingot.

Column (c) - INTERNATIONAL BAUXITE ASSOCIATION, "Pricing of Aluminium in the '70's" (Secretariat Paper) IBA/SC - PR/VIII/10/80, IBA/EB/XVIII/23/80, September 1980, p.7, Table 1.

APPENDIX A1-6: Sales of Ghana Aluminium Products Ltd., 1967-77

Year	Sales (thousand tonnes)
1967	2.3
1968	1.8
1969	1.8
1970	1.3
1971	1.7
1972	1.8
1973	2.4
1974	2.4
1975	2.2
1976	1.7
1977	3.0
TOTAL	22.4

Source: Ghana Aluminium Products Ltd., Annual Reports.

Note: Over the 10 year period 1967-1977, GHANAL's sales of fabricated aluminium represent only 1.6% of VALCO's output. The demand for the company's fabricated aluminium products is much higher.

APPENDIX A1-7: Comparison Of The Estimates of U.K. Government (1952) And The Preparatory Commission (1955) For The Volta River Project (in £ millions).

	ALUMINIUM SMELTER					
	80,000 tonnes/year		120,000 tonnes/year		210,000 tonnes/year	
	1952	1955	1952	1955	1952	1955
Power Project	45.5	60.2	49.5	64.0	54.0	67.6
Smelter and Mines	29.0	43.1	39.0	57.9	64.0	91.2
Ghana Government: Public Works or Infrastructure	26.0	59.3	26.0	63.0	26.0	72.5
TOTALS	100.5	162.6	114.5	184.9	144.0	231.3

Note: The Preparatory Commission suggested that total project cost should be escalated by 45% to cater for contingencies such as global inflation and rises in local costs.

Source: David Hart, "The Volta River Project. A case study in Politics And Technology" 1980, Edinburgh University Press, Table 4, p.23.

APPENDIX A1-8: Key Dates In The History Of The Volta River Project

1914	Bauxite first discovered in the Gold Coast
1915	Akosombo dam site first noted in geological survey.
1925	Publication of official bulletin drawing attention to hydro-electric and aluminium production potential of Volta River.
1939-49.....	Duncan Rose hydro-electric investigations in association with West African Aluminium Ltd.
1951 (February)	Dr. Kwame Nkrumah invited to form Convention Peoples Party government. The Election manifesto promised realisation of the Volta River Project.
1951 (August)	Report published on Volta Basin development potential by Sir William Halcrow & Partners, commissioned (1949) by British & Gold Coast Governments.
1952	U.K. White Paper "The Volta River Aluminium Scheme.
1953 (May)	Volta River Project Preparatory Commission established.
1954	Tema port contract awarded to Parkinson Howard.
1956 (January)	Report of Preparatory Commission published.
1957 (March)	Ghana achieved independence.
1958 (July)	Dr. Kwame Nkrumah and President Eisenhower issued joint statement on Volta River Project.
1959 (February)	Kaiser re-appraisal report published.
1959 (December)	Principles of Agreement signed between Volta Aluminium Co. Ltd., and Ghana Government.
1960 (July)	Ghana became a Republic.
1961 (April)	Volta River Authority established.
1961 (May)	Contract for dam awarded to Impregilo (Ghana) Ltd.
1961 (December)	U.S. Government announced financial participation in Volta River Project.
1962 (January)	Master Agreement between Ghana Government and Kaiser signed in Accra.
1962 (January)	Formal start of work on the Project inaugurated by Dr. Kwame Nkrumah.
1962 (February)	Financial agreements signed in Washington

Appendix A1-8 (continued)

1962 (June)	Diversion tunnel opened.
1963 (February)	Cofferdams completed.
1963 (July)	Resettlement of 80,000 people started.
1963 (September)	Peak floods recorded.
1964 (May)	Diversion tunnel closed and lake formation started.
1964 (August)	Agreement with KAISER Engineers for the feasibility of a 250,000 tonne/year alumina facility (Ref. KAISER ENGINEERS, Report No.66-41-RE, November 1966).
1964 (December)	Groundbreaking ceremony at VALCO smelter, Tema.
1965 (February)	Ceremony to mark formal completion of the dam. The cost of the Akosombo dam, powerhouse, transmission network and support facilities amounted to $175 million (as compared to the original estimate of $196 million).
1975 (September)	Formal switch-on by Dr. Kwame Nkrumah to mark the first Akosombo electric power generated on a commercial basis.
1966 (January)	Planned date for the official inauguration of the VRP.
1966 (Late)	The VALCO smelter consisting of 3 potlines with a rated capacity of 110,000 tonnes/year was completed at a cost of $120 million.
1972 (June)	The fourth potline was installed at the Tema smelter at a cost of $22 million.
1975 (July)	The KAISER-led feasibility study report on alumina production by BASCOL returned negative findings.
1977 (March)	The fifth potline was added to the Tema smelter at a cost of $63 million.
1977 (April)	The feasibility report on alumina production in Ghana by ALUTERV-FKI of Hungary reported that a refinery is viable.

Basic information compiled from the following sources:

(i) Keith Jopp, "Volta - The story of Ghana's Volta River Project", 1965.

(ii) Garcia, A.F., "The Volta Aluminium Company, Ghana", UNIDO Workshop rep. ID/WG.250/18, 26th August, 1977, pp.44-46.

APPENDIX A3-1: The Control of Aluminium Capacity By The Six Major Producers (1976)

Company	Primary Aluminium Capacity (million tonnes)	% Western World Capacity
(a)	(b)	(c)
ALCAN*	1.5	12
ALCOA*	1.8	14
KAISER*	1.1	9
REYNOLDS*	1.2	10
PUK*	1.0	8
ALUSUISSE*	0.7	5
TOTAL COMPANIES* :	7.3	58
TOTAL WESTERN WORLD**:	12.5	100
TOTAL WORLD*** :	15.8	

Sources: * Isiah A. Litvak and Christopher J. Maule, "The International Bauxite Agreement: A Commodity Cartel in Action", INTERNATIONAL AFFAIRS, Summer 1980, pp.296-314, Annexe, pp.312-314.

** IPAI, Statistical Summary 1980.

*** Minerals Yearbook (1976), Vol.1, United States Bureau of Mines, Table 15, p.164.

APPENDIX A3-2: Investors in the Aluminium Industry: Aluminium Smelters*, 1979 (Thousands of tonnes/percentage)

	Capacity in developed countries	Capacity in developing countries	Total capacity: Thousands of tons	Total capacity: As percentage of market economy countries' capacity	Total capacity: As percentage or world capacity
Six major transnational corporations					
Alcan	1 355	154	1 509	11.2	8.6
Alcoa	1 673	131	1 804	13.4	10.3
Alusuisse	649	-	649	4.8	3.7
Kaiser	884	227	1 111	8.2	6.3
Pechiney	973	71	1 044	7.7	6.0
Reynolds	1 043	82	1 125	8.3	6.4
Total	6 577	665	7 242	53.6	41.3
Other TNCs and private investors					
Europe	686	13	699	5.1	4.0
United States and Canada	1 218	32	1 251	9.3	7.1
Other	1 652	26	1 678	12.4	9.6
Total	3 556	71	3 628	26.8	20.7
Governments of developed market economy countries	1 569	-	1 569	11.6	9.0
Governments of developed centrally planned economies	3 732	-	3 732	-	21.2
Developing country governments	-	979	979	5.2	5.6
Developing country private investors	-	378	378	2.8	2.2
Market economy countries, total	11 703	1 821	13 522	100	
World, total	15 434	2 093	17 528		100

Source: United Nations Centre on Transnational Corporations, "Transnational Corporations in The Bauxite/Aluminium Industry", ST/CTC/20, Table 15, p.37.

* Capacity for each investor was assigned on the basis of direct and/or

APPENDIX A3-3: Investors in the Aluminium Industry: Alumina Refineries* 1979 (Thousands of tonnes/percentage)

	Capacity in developed countries	Capacity in developing countries	Total capacity: Thousands of tons	Total capacity: As percentage of market economy countries' capacity	Total capacity: As percentage of world capacity
Six major transnational corporations					
Alcan	2 208	1 344	3 552	12.2	10.3
Alcoa	4 135	1 966	6 101	20.9	17.8
Alusuisse	1 265	36	1 301	4.5	3.8
Kaiser	2 645	471	3 116	10.7	9.1
Pechiney	2 169	130	2 299	7.9	6.7
Reynolds	2 318	430	2 749	9.4	8.0
Total	14 740	4 377	19 118	65.6	55.7
Other TNCs with private investors in developed market economy countries	5 772	738	6 510	22.3	18.9
Governments of developed market economy countries	1 569	18	1 587	5.4	4.6
Governments of centrally planned countries	5 208	-	5 208	-	15.2
Governments of developing countries	-	1 590	1 590	5.5	4.6
Private investors in developing countries	-	355	355	1.2	1.0
World total	27 289	7 078	34 368	100.0	100.0

Source: United Nations Centre on Transnational Corporations, op.cit., Table 14, p.35.

* See footnote (a) on Appendix A3-2.

APPENDIX A3-4: Size and Distribution of World Bauxite Reserves (1975)

Country	Reserves (Millions of tonnes)	Percentage of Reserves to Total World Reserves	Remarks
Developing Country			
Dominican Republic	60	0.4	IBA member
Ghana	330	2.1	"
Guinea	3,500	21.9	"
Guyana	200	1.3	"
Haiti	25	0.2	"
Indonesia	500	3.1	"
Jamaica	1,000	6.3	"
Sierra Leone	120	0.8	"
Surinam	700	4.4	"
Cameroon	1,100	6.9	-
Brazil	950	5.8	-
Others	1,300	8.0	-
TOTAL DEVELOPING COUNTRIES	9,785	61.2	
Developed Countries			
Australia	4,700	29.3	IBA member
Others	1,000	6.3	-
Total: Developed Countries	5,700	35.6	-
Yugoslavia	250	1.6	IBA member
C.P.E.'s	265	1.6	-
WORLD TOTAL	16,000	100%	-

Source: R. Vedavalli, "Market Structure of Bauxite/Alumina/Aluminium: And Prospects for Developing Countries," International Bank for Reconstruction and Development, Commodity Paper No.24 (3/77), Table 1, p.3.

Appendix A3-5: Contribution of the IBA to Production in the World Aluminium Industry.
(Thousand tonnes).

Country	← 1967 →			← 1977 →		
	Bauxite	Alumina	Aluminium	Bauxite	Alumina	Aluminium
Yugoslavia	2131.0	101.4	44.6	2044.0	498.0	197.5
Indonesia	920.2	-	-	1301.4	-	-
Guinea	1639.2	530.0	-	11,300.0	562.0	-
Ghana	351.0	-	50.5	275.4	-	154.1
Sierra Leone	334.5	-	-	745.0	-	-
Dominican Republic	983.0	-	-	728.7	-	-
Guyana	3381.4	273.2	-	3344.3	277.0	-
Haiti	375.8	-	-	685.0	-	-
Jamaica	9395.6	837.8	-	11,433.3	2046.0	-
Surinam	5466.0	741.0	31.5	4856.0	1215.0	56.0
Australia	4243.6	854.4	92.8	26,070.0	6659.2	247.6
TOTAL IBA	29,221.3	3,337.8	219.0	62,783.1	11,257.2	655.2
TOTAL WORLD PRODUCTION	45,367.2	16,442.3	7,933.1	84,981.0	30,053.2	14,220.8

Calculations were based on data from Metalgesellschaft Aktiengesellschaft 1978

Notes: IBA contribution to bauxite, alumina, and aluminium production in the world in 1967 were 64.4%, 20% and 2.8% respectively. In 1977, contribution had changed to 73.9%, 37.5% and 4.6% respectively.

APPENDIX A3-6: Import Tariffs on Bauxite/Alumina/Aluminium

COMMODITY / TARIFFS (as a % of commodity value)	BAUXITE	ALUMINA	PRIMARY ALUMINIUM	FABRICATED ALUMINIUM PRODUCTS
1961				
Canada	0	0	-	15-20
European Economic Community	0	11.1	9	15-20
Japan	0	0	15	20
United States of America	0	0	5.3	15-20
1973				
Canada	0	0	4 approx.	10 approx.
European Economic Community	0	5.6	7	10 approx.
Japan	0	0	10.4	-
United States of America	0	0	4 approx.	10 approx.

SOURCE: Michael Morris, Farid G. Lavipour, and Karl P. Sauvant, "The Politics of Nationalisation: Guyana vs. ALCAN", Published as Chapter 6 of: "Controlling Multinational Enterprises: Problems, Strategies, Counterstrategies," edited by Karl P. Sauvant, and Farid G. Lavipour, Published by WEST VIEW PRESS, Boulder, Colorado, 1976, TABLE 1A, pp.114-115.

APPENDIX A3-7: Trend of Known Bauxite Reserves of The World Since 1900

	1900	1920	1936	1953	1958	1963	1964	1967	1974	1978	million tonnes estimated 2000
Western Europe	50	150	191	306	306	310	420	460	600	685	650
European Socialist Countries	-	20	248	360	376	380	660	700	790	870	900
Asia	-	30	50	150	250	350	720	1680	1800	2345	4000
Australia	-	-	4	20	613	1000	2000	3000	4000	4200	4500
Oceania	-	-	-	-	20	20	210	210	210	225	200
America	20	50	137	679	989	1180	1310	2400	5200	6230	6500
Africa	50	100	274	300	842	2000	2970	6380	9000	13960	15000
Total	120	350	904	1815	3396	5240	8290	14830	21600	28515	31750

Source: Janos Zambo, "Bauxite and Alumina Production - Historical Retrospection. Review of the Present Situation And Prognosis," UNIDO, ID/WG.273/9, 9th August, 1978, Table 2, p.23.

This table does not contain the bauxite reserves extracted meanwhile.

In the given years, the data for the quantity of known and available bauxite are taken from the literature, and since 1964 these are the author's estimations.

APPENDIX A3-8: Potential Aluminium Raw Materials

Name of Rocks	Alumina (Al_2O_3) Content %	Aluminium-Bearing Minerals	Main Accessory Minerals	Occurrences (Country)	Reserves (million tonnes)
1. Bauxitic clays	25-40	Kaolinite gibbsite	Quartz, Hematite, Goethite	(i) Transdanubian mountain of medium height	≈ 100
				(ii) Soviet Union	200-400
				(iii) India	≈ 500
				(iv) Guyana	≈ 300
				(v) Surinam	≈ 300
				(vi) Guinea	≈ 1,000
				(vii) Jamaica	≈ 300
				(viii) Venezuela	≈ 200
2. Kaolinic clays	20-36	Kaolinite	Quartz, Feldspar, Mica, Clay Minerals	(i) Soviet Union	500
				(ii) U.S.A.	2,000
				(iii) China	1,000
				(iv) Brazil, Japan, India, Guyana, Surinam, Australia, Poland, GDR	2,000-4,0(
3. Dawsonitic argillaceous slates	15-30	Dawsonite	Clay minerals, quartz	(i) U.S.A.	≈ 1,0(
				(ii) Australia	≈ 3(
4. Alunitic volcanic tuff	20-30	Alunite	Kaolinite, quartz, feldspars, sericite	(i) Soviet Union	≈ 5(
				(ii) U.S.A.	≈ 2,0(
				(iii) Iran	≈ 1,0(
				(iv) China	≈ 5(
				(v) Korea	≈
				(vi) Mexico, Chile, Spain, Japan, Australia, etc.	≈ 5(

APPENDIX A3-8: (continued)

Name of Rocks	Alumina (Al_2O_3) Content %	Aluminium-Bearing Minerals	Main Accessory Minerals	Occurrences (Country)	Reserves (million tonnes)
5. Anorthosite	22-32	Anorthite	Pyroxenes, Amphiboles	(i) Soviet Union (ii) U.S.A. (iii) Brazil (iv) Norway (v) Canada	Several hundreds of billions
6. Nepheline syenite urtite	24-30	Nepheline	Augite, amphibote, titanomagnetite	(i) Soviet Union (ii) U.S.A. (iii) Canada	Inestimable
7. Leucite syenite, Leucitite	22-30	Leucite	Augite, amphibote	(i) Italy (ii) U.S.A.	Several hundreds of billions
8. Metamorphosed Schists	22-30	Andalusite, sillimanite, kyanite	Quartz, mica, rutile, plagioclase	(i) U.S.A. (ii) Soviet Union (iii) Canada	Inestimable

Source: János Zámbó, "Bauxite And Alumina Production. Historical Retrospection. Review of The Present Situation And Prognosis," UNIDO, ID/WG.273/9, 9th August, 1978, Table 5, p.27.

APPENDIX A3-9: Evolution Of Single-Voyage Freight Rates For Full Cargoes Of Bauxite, 1972-1977

(Dollars per ton)

Trade		Jamaica-United States Gulf	N. Australia-N.W. Europe	Port Kamsar-United States Gulf
Distance (miles)		1 050	10 080	4 500
Size of vessels (d.w.t.)		25 000-35 000	45 000-65 000	25 000-35 000
1972	Jan.	0.80 - 0.90	3.80 - 3.85	-
	Apr.	0.90 - 0.95	4.00 - 4.10	-
	July	1.15 - 1.20	4.30 - 4.40	-
	Oct.	1.50 - 1.60	5.00 - 5.20	-
1973	Jan.	1.90 - 2.00	6.70 - 7.00	-
	Apr.	2.80 - 3.00	7.60 - 8.00	-
	July	3.75 - 3.90	9.50 - 11.50	6.25 - 6.30
	Oct.	4.40 - 4.60	16.00 - 17.10	6.35 - 6.45
1974	Jan.	4.90 - 5.00	18.00 - 18.50	6.60 - 6.75
	Apr.	5.30 - 5.50	18.15 - 18.75	7.10 - 7.25
	July	4.75 - 4.90	18.00 - 18.25	6.75 - 6.90
	Oct.	3.75 - 3.90	16.40 - 16.95	6.00 - 6.25
1975	Jan.	2.90 - 3.00	12.10 - 13.95	4.50 - 4.75
	Apr.	2.25 - 2.50	7.70 - 8.80	3.50 - 3.75
	July	2.15 - 2.30	5.50 - 5.70	3.40 - 3.50
	Oct.	2.15 - 2.20	6.00 - 6.50	3.40 - 3.45
1976	Jan.	2.10 - 2.20	7.60 - 7.80	3.30 - 3.50
	Apr.	2.25 - 2.50	8.50 - 9.00	4.00 - 4.30
	July	2.00 - 2.25	8.50 - 9.00	3.00 - 3.25
	Oct.	2.10 - 2.25	8.90 - 9.50	3.20 - 3.40
1977	Jan.	2.00 - 2.20	8.00 - 9.00	3.00 - 3.20
	Apr.	2.10 - 2.30	7.25 - 7.45	3.20 - 3.45
	July	2.35 - 2.55	6.50 - 6.75	3.45 - 3.50
	Oct.	2.15 - 2.35	7.50 - 8.00	3.40 - 3.60

Source: UNITED NATIONS CENTRE ON TRANSNATIONAL CORPORATIONS, "Transnational Corporations In The Bauxite/Aluminium Industry", ST/CTC/20, Sales No.E.81.II.A.5, May 1981, Table 21, p.70.

APPENDIX A3-10: Shipping Distances Between Principal Bauxite Loading/Discharging Ports

(Nautical Miles)

Discharging Port / Loading Port		JAMAICA Ocho Rios	SURINAM Paranam	BRAZIL Trombetas	GUINEA Kamsar	INDONESIA Bintan Is	AUSTRALIA Weipa	AUSTRALIA Gove
U.S.A.	Corpus Christi	1,255	2,760	3,820	4,820	12,070 P	10,220 P	10,405 P
	Mobile	1,055	2,465	3,525	4,495	11,900 P	10,050 P	10,230 P
VIRGIN IS	St. Croix	795	920	1,955	3,010	11,545 P	9,690 P	9,875 P
CANADA	Port Alfred	2,435	2,995	3,870	3,715	13,520 P	11,685 P	11,865 P
W. GERMANY	Stade (Hamburg)	4,550	4,280	4,815	3,205	7,985 S	13,440 C	13,195 C
NETHERLANDS	Botlek (Rotterdam)	4,325	4,055	4,595	2,980	8,315 S	13,235 C	12,950 C
FRANCE	Fos (Marseilles)	4,615	3,985	4,030	2,580	6,555 S	8,915 S	8,635 S
ITALY	Porto Vesme	4,650	4,010	4,405	2,595	6,250 S	8,635 S	8,360 S
JAPAN	Shimizu	8,360 P	9,409 P	10,465 P	11,735 S	2,780 S	3,505	3,260
USSR	Nicholaiev	6,070	5,440	5,820	4,010	6,190 S	8,550 S	8,275 S

S = Suez Canal, C = Cape of Good Hope, P = Panama Canal

Source: HPD Shipping Consultants Ltd. (London), "The Structure of Bauxite/Alumina Trade And Trends in Ocean Transportation", Report No.85, August 1980, Table 49, p.60.

APPENDIX A3-11: Market Structure as Illustrated by the Consumption of Primary and Secondary Aluminium by End-Uses in Selected OECD Countries

	WEST GERMANY			FRANCE			UNITED KINGDOM			UNITED STATES			JAPAN		
	1967	1977	% Increase	1967	1977	% Increase	1967	1977	% Increase	1967	1977	% Increase	1967	1977	% Increase
1. Transport+.....	113.9	242.0	112.5	102.6	174.8	70.4	124.4	115.0	-7.6	846.9	1349.0	59.3	132.6	413.2	211.6
2. Mechanical Eng....	45.7	74.5	63.0	25.1	31.5	25.5	25.5	30.9	21.7	252.2	351.1	39.2	42.0	82.7	96.9
3. Electrical Eng....	75.8	54.4	- 28.2	44.2	84.3	90.7	62.6	54.6	-12.8	552.5	584.2	5.7	87.1	190.9	119.2
4. Building & Construction+.....	58.6	168.8	188.1	28.7	55.2	92.3	34.5	55.6	61.2	846.4	1360.8	60.8	103.2	621.5	502.2
5. Chemical, food and agricultural appliances	12.5	14.0	12.0	7.6	10.4	36.8	8.7	3.9	-55.2	27.7	80.3	189.9	16.7	34.3	105.4
6. Packaging.....+	43.0	91.9	113.7	27.2	43.6	60.3	30.9	50.5	63.4	393.7	1259.6	219.9	12.7	111.1	774.8
7. Domestic, office appliances.....	15.4	81.6	429.9	20.8	32.4	55.8	40.0	47.0	17.5	307.5	409.2	33.1	99.8	116.0	16.2
8. Powder consuming industries.....	5.0	4.4	12.0	2.3	1.8	-35.7	6.1	12.3	101.6	105.7	48.5	-54.1	1.9	8.4	342.1
9. Steel industry....	-	-	-	-	-	-	14.0	20.8	48.6	-	-	-	27.1	51.9	91.5
10. Destructive Aluminotherine uses..	23.4	49.1	109.8	18.4		*		-	-	87.5	108.0	23.4	-	-	-
11. Metal Industries n.e.s.	18.0	100.8	84.6	30.9		*	8.1	80.9	47.1	73.5	177.8	-47.7	35.5	184.5	118.1
12. Miscallaneous	36.6				63.8	*	46.9			266.5			51.1		
13. Direct exports of semi-manufacture+	95.7	301.900		65.2	167.5	156.9	42.4	71.2	67.9	297.8	329.3	10.6	22.2	93.8	322.5
TOTAL	543.6	1183.4	117.7	372.9	686.7	84.2	444.2	542.7	22.2	4057.9	6057.8	49.3	629.8	1908.4	203.0

Source: Data obtained from Metalgesellschaft Aktiengesellschaft, 1978.

Notes: * Shot for metallurgical purposes, which was previously included with item (12) is now with item (10). Consequently, comparisons cannot be made with the other countries.

APPENDIX A3-12: Production and Consumption of Primary Aluminium In The Western World. (million tonnes)

	Production	Consumption
1972	9.2	9.4
1973	10.1	11.2
1974	11.1	11.3
1975	9.9	8.6
1976	10.2	11.1
1977	11.3	11.4
1978	11.6	12.1
1979	12.0	12.6

Sources: Metal Statistics

Note: This data has been plotted as Figure 3.4, Chapter 3.5 of the text.

APPENDIX A3-13: Capacity Utilisation

YEAR	(a) Production (million tonnes)	(b) Capacity (million tonnes)	(c) = (a)/(b) Capacity Utilisation
1972	9.1	11.0	83
1973	10.0	11.4	88
1974	10.9	11.9	92
1975	9.7	12.0	81
1976	10.0	12.5	80
1977	11.1	12.7	87
1978	11.4	13.1	87
1979	11.8	13.3	89
1980	12.6	13.8	91

Sources: (a) International Primary Aluminium Institute (IPAI), Statistical Summary, 1976, 1980.

(b) IPAI, Statistical Summary, 1976, 1980.

Note: Data has been plotted as Figure 3.5, Chapter 3.5 of the text.

APPENDIX A3-14: Ratio of Stocks To Consumption - Western World

YEAR	Year-End Stocks (Million Tonnes) (a)	Consumption of Primary Aluminium (million tonnes) (b)	Ratio of Stocks to Consumption (%) (c) = $\frac{(a)}{(b)}$ x 100
1972	1.7	9.4	18
1973	1.4	11.2	13
1974	2.0	11.3	18
1975	3.1	8.6	36
1976	2.3	11.1	21
1977	2.5	11.4	22
1978	2.1	12.1	17
1979	1.5	12.6	12

Sources: (a) International Primary Aluminium Institute (IPAI), Statistical Summary, 1976, 1980.

(b) Metal Statistics.

Note: Data has been plotted as Figure 3.6, Chapter 3.5 of the text.

APPENDIX A3-15: Aluminium Prices (U.S. $/tonne) - American Metal Market

Year	Price ($/tonne)
1972	583.1
1973	558.4
1974	750.9
1975	887.2
1976	980.8
1977	1131.6
1978	1200.2
1979	1345.0

Source: AMERICAN METAL MARKET, METAL STATISTICS, p.24.

Note: Data has been plotted on Figure 3.3 of Chapter 3.5 in the text.

APPENDIX A3-16: Ownership of Alumina Refineries in the World, 1979

	Location of refinery	Capacity (Thousand of tonnes)	Percentage Ownership
	A. Transnational corporations (Big Six)		
Alcan	Arvida, Quebec, Canada	1 225	100
	Ewarton, St. Catherine, Jamaica	1 095	93
	Kirkvine, Manchester, Jamaica		
	Saramenha, M.G., Brazil	120	100
	Muri, Bihar, India	77	55
	Belgium, Mysore, India	159	55
	Shimizu, Japan	515	50
	Tomakomai, Japan	340	50
	Gladstone, Queensland, Australia	2 440	21
	Aughinish, Ireland a/	800	40
	San Ciprian, Spain	800	14
Alcoa	Bauxite, Arkansas, U.S.A.	340	100
	Mobile, Alabama, U.S.A.	900	100
	Point Comfort, Texas, U.S.A.	1 332	100
	Woodside, Clarendon, Jamaica	511	100
	Pocos de Caldas, MG., Brazil	170	50
	Paranam, Suriname	1 352	100
	Kwinana, W.A. Australia	1 400	51
	Pinjarra, W.A. Australia	2 400	51
Alusuisse	Burnside, Louisiana, U.S.A.	544	40
	Bergheim, Federal Republic of Germany	349	100
	Gove, N.T., Australia	1 100	70
	Friguia, Kimbo, Guinea	700	5
Kaiser	Baton Rouge, Louisiana, U.S.A.	930	100
	Gramercy, Louisiana, U.S.A.	726	100
	Nain, St. Elizabeth, Jamaica	2 400	37
	Gladstone, Queensland, Australia	1 179	39
	Porto Vesme, Sardinia, Italy	720	9
Pechiney	Gardanne, France	745	100
	Salindres, France	240	100
	La Barasse, France	350	100
	Distomon, Greece	500	73
	Gladstone, Queensland, Australia	2 400	20
	Friguia, Kimbo, Guinea	700	19
	San Ciprian, Spain	800	14
Reynolds	Hurricane Creek, Arkansas, U.S.A.	762	100
	Corpus Christi, Texas, U.S.A.	1 256	100
	Stade, Federal Republic of Germany	517	50
	Nain, St. Elizabeth, Jamaica	1 179	37

APPENDIX A3-16 - continued

	Location of refinery	Capacity (Thousand of tonnes)	Percentage Ownership
B. Other transnational corporations and private investors from developed countries			
Atlantic	Nain, St. Elizabeth, Jamaica	1 179	27
	Auginish, Ireland	800	25
Australian Investors	Kwinana, W.A., Australia	1 400	49
	Pinjarra, W.A., Australia	2 400	49
	Gladstone, Queensland, Australia	2 400	2
	Porto Vesme, Sardinia, Italy	720	2
Giulini	Ludwigshafen, Federal Republic of Germany (Chemical)	150	100
Gove Alumina	Gove, N.T., Australia	1 100	30
Greek investors	Distomon, Greece	500	27
Hanna Mining	Pocos de Caldas, M.G., Brazil	170	32
Japanese investors	Shimizu, Japan	515	50
	Tomakomai, Japan	340	50
	Wakamatsu, Japan	420	2
Martin Marietta	St. Croix, Virgin Islands, U.S.A.	530	100
Metallgesellschaft	Porto Vesme, Sardinia, Italy	720	18
Mitsui	Wakamatsu, Japan	420	99
Montedison	Porto Marghera, Italy	200	6
	Porto Vesme, Sardinia, Italy	720	1
	Mettur, Tamil Nadu, India	50	27
Noranda	Friguia, Kimbo, Guinea	700	20
Phelps Dodge	Burnside, Louisiana, U.S.A.	544	26
Revere	Burnside, Louisiana, U.S.A.	544	34
	Maggotty, St. Elizabeth, Jamaica [b/]	200	100
Billiton	Auginish, Ireland	800	35
Rio Tinto Zinc	Gladstone, Queensland, Australia	2 400	19
	Porto Vesme, Sardinia, Italy	720	9
Showa Denko	Yokohama, Japan	620	100
Spanish investors	San Ciprian, Spain	800	72
Sumitomo	Kikumoto, Japan	766	100
Tube Investments	Burntisland, UK (Chemical)	120	100
	Friguia, Kimbo, Guinea	700	5

APPENDIX A3-16: (continued)

	Location of refinery	Capacity (Thousand of tonnes)	Percentage Ownership
C.	Governments of developed market economies		
Germany, Federal Republic of	Stade	517	50
	Lippenwerke, Lunen	430	100
	Nabrewerk, Schwandorf	210	100
	Friguia, Kimbo Guinea	700	3
Italy	Porto Marghera [c/]	200	94
	Porto Vesme, Sardinia	720	61
D.	Governments of developed centrally planned economies		
Czechoslovakia	Zaire	100	100
German Democratic Republic	Lauta	630	100
Hungary	Ajka I Ajka II Almasfuzito Magyarovar	815	100
Romania	Oradea	250	100
	Tulcea	250	100
USSR	Achinsk Dneprovsk Kamensk-Uralsky Kandalaksa Kirovabad Krasnoturinsk Novo Kuznetsk Pavlodar Pikalevo Sumgait Volgograd Volkhov-Tikhium	3 350	100
Yugoslavia	Titogra, Montenegro	200	100
	Kidricevo, Slovenia	140	100
	Mostar, Bosnia	280	100
	Obravak	300	100
	Zvornik	600	100

APPENDIX A3-16 (continued)

	Location of refinery	Capacity (Thousand of tonnes)	Percentage Ownership
	E. Governments of developing countries		
Brazil	Sorocaba, São Paulo	100	20
China	Nanting and other	750	100
Guinea	Friguia, Kimbo	700	49
Guyana	MacKenzie	354	100
India	Korba, Madhya, Pradesh	200	100
	Mettur, Tamil Nadu	60	73
Jamaica	Ewarton-Kirkvine	1 095	7
	Woodside, Clarendon	511	6
	F. Private investors in developing countries		
Brazilian groups	Pacoa de Caldas, Minas Gerais	170	18
Brazil Vot-orantim	Sorocaba, Sao Paulo	100	80
Indian groups	Jaykaynagar, West Bengal[c/]	23	100
	Renukoot, Uttar Pradesh	165	100
	Muri Bihar		
	Belgium, Mysore	159	45

Source: UNITED NATIONS CENTRE ON TRANSNATIONAL CORPORATIONS, "Transnational Corporations In The Bauxite/Aluminium Industry", ST/CTC/20, Sales No.E.81.II.A.5, May 1981, Table 26, pp.76-79.

a/ Under construction.

b/ Scheduled to be closed.

c/ Closed since 1973.

APPENDIX A3-17: World Alumina Production and Capacity, 1971-1978

(Thousands of tonnes)

Year	Production	Capacity	Percentage utilization
1971	22 278	25 212	88.4
1972	23 601	28 439	82.6
1973	26 421	31 709	83.3
1974	28 553	32 443	87.9
1975	26 050	34 342	75.9
1976	26 855	34 876	77.0
1977	30 053	34 299	87.6
1978	30 844	34 804	88.6

Sources: UNITED NATIONS CENTRE ON TRANSNATIONAL CORPORATIONS, "Transnational Corporations In The Bauxite/Aluminium Industry", ST/CTC/20, Sales No.E.81.II.A.5, May 1981, Table 22, p.71.

APPENDIX A3-18: Estimates of World Primary Aluminium Capacity, 1979-1989

(Millions of Tonnes)

Year	Capacity	Remarks
1979	17.0*	Actual Average increase 1969-79 is 5.5%.
1980	17.7	Announced Increase 1979-80 is 4.1%
1981	18.5	Announced Increase 1980-81 is 4.5%
1982	19.2	Announced Increase 1981-82 is 3.8%
1983	19.8	Announced Increase 1982-83 is 3.1%
1989	25.0	Estimate Increase 1984-89 is 4.0%

SOURCE: William Hobbs (Vice President, Kaiser Aluminium and Chemical Corporation), "Financing the Aluminium Industry In The 1980's", First International Aluminium Conference, Madrid, Spain, September 29, 1980, p.5. Proceedings of conference has been published by METAL BULLETIN.

Note:* Actual installed capacity of 17.0 million tonnes is made up of 13.3 million tonnes for the Western World and 3.7 million tonnes for the Eastern World.

APPENDIX A3-19: Smelter Expansion Projects

Company	Location	Capacity Being Added (Tonnes)	Expected Start-up
1. Aardal og Sunndal	Hoyanger, Norway	18,144	1981-82
2. ALCAN Aluminio	Aratu, Brazil	29,931	Late 1981
3. ALCAN	La Baie, Quebec, Canada	171,423	1980-82
4. ALCAN Australia	Newcastle, NSW, Australia	22,040	1981
5. ALCAN Queensland	Gladstone, Qld., Australia	99,951*	1983
6. ALUMAX Inc.[1]	Mount Holly, S.C., U.S.	178,679	1980-81
7. ALUMAX Inc.	Humber Valley, NSW, Australia	235,820	1984
8. ALUMETAL SpA.	Fusina, Italy	35,010	Not Set
9. PUK	France - various plants	69,839	1980-83
10. PUK	Newcastle, NSW, Australia	220,401	1985
11. PUK	Edea, Cameroons	38,094	1981
12. PUK[2]	Labuan Island, Malaysia	217,680	Dec. 1982
13. ALCOA	U.S. - various plants	181,400	1981-85
14. ALCOA	Pocos de Caldas, Brazil	90,700	1984
15. Asahan Aluminium[3]	Kuala Tanjung, Indonesia	226,750	1983-84
16. British Aluminium	Fort William, Scotland	9,977	1981
17. Gladstone Aluminium[4]	Gladstone, Qld., Australia	205,889	1982-83
18. Lista Aluminiumverk[5]	Lista, Norway	29,024	1985
19. Martin Marietta	Goldendale, Wash., U.S.	58,955	1982
20. Mosjoen Aluminiumverk[5]	Mosjoen, Norway	59,862	1985-86
21. Norsk Hydro	Karmoey, Norway	47,164	1982
22. Soer-Norge Aluminium[6]	Husnes, Norway	29,931*	Not yet

Notes on Appendix A3-19

(a) Total addition to smelter capacity = 2,276,664 tonnes

(b) * Under consideration

1. Joint venture with Mitsui and Co.

2. Joint venture with Hyundai Heavy Industries Co. and Sabah State government.

Notes on Appendix A3-19 (continued)

3. Joint venture by 12 Japanese companies and the Indonesian government.

4. Joint venture by Kaiser Aluminium and Chemical Corporation, Comalso Limited (owned 45% by Kaiser) and five Japanese companies.

5. Jointly owned by Elkemspigerverket and ALCOA.

6. Owned 74.8% by Swiss Aluminium.

SOURCE: CHEMICAL WEEK, January 30, 1980, p.17.

APPENDIX A4-1: Projected Income Statement For The Proposed Alumina Plant As Per 1975 Bascol Study

Year	Ten Years (Millions of U.S. Dollars)									
	1	2	3	4	5	6	7	8	9	10
Production (Mt 000's)	550	600	600	600	600	600	600	600	600	600
Revenue $131/Mt*	72.1	78.6	78.6	78.6	78.6	78.6	78.6	78.6	78.6	78.6
Manufacturing Cost*	49.0	50.2	50.2	48.1	46.1	43.7	43.5	42.0	42.0	42.0
Gross Profit	23.1	28.4	28.4	30.5	32.5	34.9	35.1	36.6	36.6	36.6
Depreciation	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8
Interest*	24.6	22.1	19.6	17.1	14.5	12.0	9.5	7.0	4.4	1.9
Net Income Before Tax	(14.3)	(6.5)	(4.0)	6	5.2	10.1	12.8	16.8	19.4	21.9
Provision for Taxes (i.e. deferred taxes)										
Net Income (Loss)	(14.3)	(6.5)	(4.0)	6	5.2	10.1	10.9	8.4	9.7	10.9

Source: BAUXITE ALUMINA STUDY COMPANY, "Ghana: Feasibility of Bauxite and Alumina Production", July 1975, Table 3-B.

APPENDIX A4-2: Projected Source And Application Of Funds As Per 1975 BASCOL Study

Ten Years
(Millions of U.S. Dollars)

Year	Pre-production Expenditure or Expenditure prior to First Year of Operation	1	2	3	4	5	6	7	8	9	10	
SOURCE OF CASH												
Net Income		(14.3)	(6.5)	(4.0)	6	5.2	10.1	10.9	8.4	9.7	10.9	
Depreciation		12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	
Deferred Ghana Income Tax								1.9	8.4	9.7	11.0	
Increase in Current Liabilities	$ 6.5											
Long Term Debt	255.0											
Capital Stock	85.0											
Total Source	$ 346.5	(1.5)	6.3	8.8	13.4	18.0	22.9	25.6	29.6	32.2	34.7	
APPLICATION OF CASH												
Increase in Cash	$ 2.2											
Increase in Accounts Receivable	6.5											
Increase Inventories	17.3											
Property, Plant Equipment	320.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	Plant and equipment replacement
Loan Repayments		25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	
Total Application	$ 346.5	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0	
Cash Surplus (Shortfall)		(28.5)	(20.7)	(18.2)	(13.6)	(9.0)	(4.1)	(1.4)	2.6	5.2	7.7	

95.5 million

Source: BASCOL, Op.Cit., Table 3-C.

Notes: 1) Cumulative Cash Deficit for the first seven years of operation is $95.5 million (constant mid-1975 dollars)
2) For the first ten years of operation, BASCOL projected a cash deficit of $80 million (constant mid-1975 dollars).

APPENDIX A4-3: Estimates of the Landed Alumina Prices at Tema (Ghana)

YEAR	Tonnes of Aluminium Produced at the Tema Smelter	Inferred Alumina Usage @ 1.95 (Tonnes)	Total Tolling Fees charged by VALCO's Tema Smelter[1] ($ millions)	Total Income from aluminium exports less tariffs[2] ($ millions)	Gross Sales Income Before The Application of Tariffs @ 4%[3]	Gross Sales Revenues LESS the 15% deductions (for selling costs, tariffs, freight, market development and general administrative costs) as sanctioned by Article 18 of the Master Agreement[4] ($ millions)	Alumina Value ($/tonne) as landed at Tema (Ghana)[5] (h) = $\frac{0.44(g)}{(c)}$(1967-1977) (h) = $\frac{0.40(g)}{(c)}$(1977 onwards)
(a)	(b)	(c) = 1.95(b)	(d)	(e)	(f) = $\frac{100}{96}$(e)	(g) = 0.85 (f)	
1967	52,463	106,203	11.565	20.562	21.512	18.285	75.8
1968	110,548	215,569	35,022	57.182	59.565	50.630	103.3
1969	113,109	220,563	36.882	65.861	68.605	58.314	116.3
1970	113,040	220,428	37.879	67.641	70.459	59.890	119.5
1971	111,126	216,698	37.149	66.337	69.101	58.736	119.3
1972	131,954	257,310	45.120	80.571	83.928	71.339	122.0
1973	152,208	296,806	44.976	80.314	83.660	71.111	105.4
1974	157,200	306,540	62.294	111.239	115.874	98.493	141.4
1975	143,220	279,279	68.516	122.350	127.448	108.331	170.7
1976	151,113	294,670	71.272	127.271	132.574	112.688	168.3
1977	154,123	300,540	102.980	171.633	178.784	151.966	202.3
1978	113,462	221,251	92.025*	153.375	159.766	135.801	245.5
1979	168,729	329,022	132.800*	221.333	230.555	195.972	238.2
1980	191,195	372,830	160.194*	266.990	278.115	236.398	253.6

Calculations were based on the following sources: Tonnes produced (Column (b)) and the "Tolling Fees" declared by VALCO (Column (d)) were obtained from VALCO, and also from the various Annual Reports of VALCO.

1. Article 17 of the Master Agreement (executed in 1962) stipulates that for 1967-1977, the Tolling Fees charged by VALCO (that is, VALCO's income) should be 56% of the published aluminium prices LESS the tariffs applicable to aluminium produced in Ghana.

* It has been assumed that sundry revenue for VALCO for the period 1967-1977 is minimal. Therefore, the total revenues declared by VALCO in the period represents the tolling fees. The 1980 and 1979 VALCO Annual reports, however, give the exact tolling fees charged by VALCO.

2. The total income generated from the sale of aluminium produced from the Tema is, by inferrence from Note 1, $\frac{100}{56}$(d) for the 1967-1977 period; and $\frac{100}{60}$(d) for 1977 onwards.

3. The market for Ghana's aluminium output range from Japan, Europe, U.S. to South America. To estimate the tariffs levied on Ghana's aluminium the U.S. tariff of 4% is used as opposed to 10.4% for Japan and 7% for the EEC (See Appendix A3-6 for the tariffs).
Therefore, if it is conservatively assumed that Ghana's aluminium attracts a tariff of 4%, then column (e) above represents 96% of the gross aluminium sales revenue before the application of duties.

4. Article 18 of the Master Agreement states that: "VALCO represents at the time of the execution of this Agreement approximately 15% of the fair market value of the aluminium is represented by the cost of selling, tariffs, freight, reasonable allowance for market development and general administrative costs".

5. The alumina price as computed above represents the landed (c.i.f.) alumina costs, including profit margins.

APPENDIX A4-4: Financial Structure Of Guinea's Boké Bauxite Project

Export Credits-Equipment and Services		
Belgium: 7.1% loans, due in 16 semi-annual instalments from 1973	6.7	
France: 6.15%, 6.3% and 6.83% loans, due in semi-annual instalments from 1973	22.7	
France: 6.52% supplier credit due in 10 semi-annual instalments from 1973	0.6	
Federal Rep. of Germany: 6-6 5% loan, due in 20 semi-annual instalments from 1972	7.9	
U.S.A.: 6% loan, due 1972-'79, and 7% loan, due 1980-'87	18.3	
Yugoslavia: 7.5% promissory notes, due in 10 semi-annual instalments from 1973	4.0	
TOTAL Export Credits		60.2
Commercial Bank Loans		
8% loan due 1973-'84	9.2	
Floating rate (LIBO + 1%) due 1974-'82	15.0	
Floating rate (LIBO + 1-1.5%) due 1975-'82	15.0	
7% DM loan due 1977-'86	3.1	
Floating rate (LIBO + 1-1 3/8%) due 1976-'81	25.0	
TOTAL Commercial Bank Credits		67.3
Fixed Rate Notes and Bonds		
8% Guaranteed Bonds (Europe) due 1990	30.0	
8.5% Guaranteed Notes (Japan) due 1988	30.0	
TOTAL Fixed Rate Notes and Bonds		60.0
Subordinated Debt		
Interest-free advances from Halco shareholders due 1978-'88		20.0
Equity		
Government of Guinea shares	1.0	
Halco shares	1.0	
Halco capital contributions	15.0	
TOTAL Equity		17.0
TOTAL Capitalization		224.5
of which:		
long-term debt	187.5	
subordinated (shareholder) debt	20.0	
equity	17.0	

Source: Marian Radetzki and Stephen Zorn, "Financing Mining Projects in Developing Countries', MINING JOURNAL BOOKS LTD. (London), 1979, Table 26, p.62.
Quoted from: Prospectus for 8% Guaranteed Bonds, December 1972.

Note: The Boké bauxite project was developed by Compagnie des Bauxites de Guinée. The company is owned as follows:

- Guinea Government ---------- 49%
- The Halco consortium ---------- 51%
- The equity of the Halco consortium is distributed as follows: 100%

Alcan Aluminium Ltd. (Canada)	27 per cent
Aluminium Company of America (U.S.)	27 per cent
Martin Marietta Aluminium, Inc. (U.S.)	20 per cent
Aluminium Pechiney (France)	10 per cent
Vereinigte Aluminium-Werke (Fed. Rep. of Germany)	10 per cent
Montedison S.P.A. (Italy)	6 per cent

APPENDIX A5-1: Estimates of The Economic Significance of the Long-Term Tolling Agreement for KAISER

YEAR	Total Revenues declared by VALCO (in millions US dollars) (a)	Net Income declared by VALCO (in millions of US Dollars) (b)	Total Revenues allocated to Kaiser and Reynolds for supplying alumina to Tema (in millions of US Dollars) (c)	Procurement and delivery costs incurred by Kaiser and Reynolds for supplying alumina (in millions of US Dollars) (d)	Net Income gained by Kaiser and Reynolds for supplying alumina (in millions of US Dollars) (e)	Total Net Income provided by the VALCO investment for Kaiser and Reynolds (millions US $) (f)	Kaiser's share of the total net income from the investment (in millions $) (g)	Global Net Income of Kaiser (in millions of US $) (h)	Kaiser's Gains from the VALCO investment as a % Global Net Income (i)
1967	11.56	(0.67)	9.08	7.02	2.06	1.39	1.25	53.8	2.3
1968	35.02	4.27	27.52	17.05	10.47	14.74	13.27	49.0	27.1
1969	36.88	7.02	28.98	14.69	14.29	21.31	19.18	70.4	27.2
1970	37.88	4.30	29.76	17.63	12.13	16.43	14.79	50.6	29.2
1971	37.15	4.07	29.19	15.71	13.48	17.55	15.80	10.0	158.0
1972	45.12	8.56	35.45	22.50	12.95	21.51	19.36	12.7	152.4
1973	44.98	2.85	33.34	19.35	15.99	18.84	16.96	27.1	62.6
1974	62.29	11.31	48.94	29.94	19.0	30.31	27.28	110.9	24.6
1975	68.52	10.38	53.84	33.51	20.33	30.71	27.64	94.7	29.2
1976	71.27	5.86	56.0	35.67	20.33	26.19	23.57	44.5	53.0
1977	102.98	6.54	68.65	40.52	28.13	34.67	31.20	112.1	27.8
TOTALS	553.65	64.49	422.75	253.59	169.16	233.65	210.3	635.8	33.1

Calculations were based on data from the following sources:

(1) VALCO Information, 1979 and 1980 VALCO Annual Reports - data for Columns (a) and (b)

(2) For column (d), data supplied to Central Bureau of Statistics (Accra, Ghana) and made available by Aluminium Industries Commission.

(3) For columns (h), data obtained from the Annual Reports of Kaiser Aluminium and Chemical Corporation and Form 10-K Reports submitted to the U.S. Securities And Exchange Commission by KAISER.

Notes: (i) Column (c) = $\frac{44}{56}$ x column (a):- as implied by Article 17 of the Master Agreement for the period 1967-25th April, 1977.

= $\frac{40}{60}$ c column (a):- as implied by Article 17 of the Master Agreement for imported alumina after 25th April, 1977.

It is assumed for computational convenience that for 1977, Column (c) = $\frac{40}{60}$ x Column (a).

(ii) Column (e) = Column (c) - Column (d)

(iii) Column (f) = Column (b) + Column (e)

(iv) Column (g) = $\frac{90}{100}$ x Column (f):- Ownership of VALCO is Kaiser (90%); Reynolds (10%)

(v) Column (i) = $\frac{\text{Column (g)}}{\text{Column (h)}}$ x 100%

APPENDIX A5-2: The Cumulative Foreign Exchange Contributions to the Ghanaian Economy By VALCO (millions of U.S. Dollars)

YEAR	VALCO's power payments to the Volta River Authority (VRA) (a)	Operating and Construction Spending in Ghana (b)	Direct Taxes Paid to The Ghana Government) (c)	Indirect Taxes (i.e. duties on imports and exports (d)	VALCO Fund Contributions (e)	TOTALS (f)
1967	2.1	4.0	-	-	-	-
1968	4.9	3.9	-	-	-	8.8
1969	5.2	4.2	-	-	-	9.4
1970	5.3	4.8	-	-	-	10.1
1971	5.0	4.2	-	-	0.3	9.5
1972	6.0	3.2	-	-	0.1	9.3
1973	8.0	7.5	-	-	0.1	15.6
1974	8.5	11.1	-	-	0.2	19.8
1975	7.9	11.7	-	-	0.2	19.8
1976	8.2	22.6	-	-	0.2	31.0
1977	16.6	21.0	-	-	0.2	37.8
1978	10.3	14.6	-	-	0.2	25.1
1979	13.3	16.1	-	-	0.2	29.6
1980	16.0	23.6	15.2	-	9.0	63.8
TOTALS	117.3	152.5	15.2	-	10.7	295.7

Sources: Data was compiled from:

(1) Data for 1967-1974 made available by the courtesy of Mr. Ward B. Saunders - Managing Director of VALCO.

(2) Data for 1979-1980 obtained from VALCO Annual Reports 1979 and 1980.

APPENDIX A5-3: Estimates Of The Gross Income From VALCO-produced Aluminium

YEAR	Metric Tonnes of Aluminium produced (a)	Total Revenues declared by VALCO (in millions US dollars) (b)	Total Revenues derived from aluminium exports less tariffs applicable to aluminium from Ghana (in millions of US dollars) (c)
1967	52,463	11.565	20.652
1968	110,548	32.022	57.182
1969	113,109	36.882	65.861
1970	113,040	37.879	67.641
1971	111,126	37.149	66.337
1972	131,954	45.120	80.571
1973	152,208	44.976	80.314
1974	157,200	62.294	111.239
1975	143,220	68.516	122.350
1976	151,113	71.272	127.271
1977	154,123	102.980	171.633
1978	113,462	98.065	163.442
1979	168,729	133.159	221.932
1980	191,195	163.365	272.275
	1,863,490	945.244	1,628.700

The estimates above were calculated from data from the following sources:

(1) Data for 1967-1974 made available by the courtesy of Mr. Ward B. Saunders, Managing Director of VALCO.

(2) Data for 1979-1980 obtained from VALCO Annual Reports, 1979 and 1980.

Notes: On account of Article 17 of the Master Agreement:

Total Revenues for 1967-1977: $C = \frac{100}{56}$ (b)

Total Revenues for 1977 onwards: $C = \frac{100}{60}$ (b)

APPENDIX A5-4: Kaiser Aluminium & Chemical Corporation
And Subsidiary Companies

Investments In, Equity In Earnings Of, Dividends Received From,
And Non-Current Indebtedness Of Related Parties

(millions of dollars)

Column A	Column B	Column C Additions		Column D Deductions		Column E
Name of Related Party	Beginning Balance	Equity Income (Loss) for the Period	Other	Distribution of Earnings During the Period	Other	Ending Balance
Year Ended December 31, 1980						
EQUITY METHOD						
Comalco Limited:						
Investment	$165.3	$ 49.3		$16.6		$198.0
Kaiser Aluminium Europe Inc:						
Investment	64.0	35.6	$ 1.3(1)			100.9
Volta Aluminium Company Ltd:						
Investment	91.5	24.0		18.0		97.5
Advances	.1					.1
Anglesey Aluminium Ltd.:						
Investment	21.7	(.3)				21.4
Westward Properties, Inc.:						
Investment	38.9	7.4				46.3
Advances	54.6		6.0(2)		$ 2.4(3)	58.2
Alumina Partners of Jamaica:						
Investment	20.6	(.1)	5(4)			21.0
Advances	14.1		7.8(5)			21.9
Queensland Alumina Ltd.:						
Investment	28.8	3.9				32.7
Kaiser Jamaica Bauxite Co.:						
Investment			9.5(6)			9.5
Advances			6.4(5)			6.4
Other Companies:						
Investment	29.5(14)	(8.1)	11.4(5)			32.8
Advances	8.9(14)		1.3(5)			10.2
COST METHOD	7.5		4(5)			7.9
TOTAL	$ 545.5	$111.7	$44.6	$34.6	$ 2.4	$664.8
Less equity income included in cost of products sold		20.5				
Equity in earnings of companies not consolidated		$ 91.2				

(1) Tax liability transferred to parent.
(2) Cash transactions for assignment of liabilities to parent.
(3) Tax credit from parent.
(4) Amortization of excess of the corporation's equity in net assets over its investment.
(5) Cash transactions.
(6) Initial investment for a 49% interest.
(7) Return of advances.
(8) Redemption of preference stock.
(9) Write-off of investment.
(10) Tax liability on redemption of preference stock.
(11) Tax credit transferred to parent repayment of advances, and re-valuation of advances in foreign currency.
(12) Reorganization.
(13) Sale of investments.
(14) Includes KACOR Australia Development Pty. Ltd.

Source: FORM 10-K Submitted to the Securities and Exchange Commission in the U.S.A.

APPENDIX A5-5: The Cost of Petroleum Imports Needed to Generate The Non-VALCO/Non-Export Hydro-electric Energy Sold In Ghana

Year	(a) Non-VALCO, Non-Export Energy Sales in millions kwh	(b) Approximate Amount of Fuel needed to generate the electricity in Col.(a) (in million tonnes)	(c) Average Prices of Fuels (£/tonne) £ per tonne	(d) = (b) x (c) IMPORT COSTS £ millions (d)= (b)x (c)	$ millions (e)
1966	435.8	0.11	7.17	0.79	2.21
1967	530.7	0.14	7.17	1.00	2.80
1968	606.3	0.16	12.28	1.96	4.70
1969	701.4	0.18	11.81	2.13	5.11
1970	793.6	0.21	13.64	2.86	6.86
1971	915.4	0.24	16.11	3.87	9.29
1972	972.0	0.26	16.28	4.23	10.15
1973	1045.7	0.28	17.16	4.80	11.90
1974	1126.8	0.30	36.24	10.87	26.96
1975	1198.3	0.32	45.91	14.69	36.43
1976	1290.9	0.34	56.90	19.35	47.99
1977	1330.3	0.35	68.95	24.13	59.84
1978	1348.6	0.35	71.51	25.03	51.06
1979	1317.7	0.35	81.32	28.46	58.06
TOTALS	13,613.5	3.59	-	153.20	333.36

Calculations were based on data from the following sources:

(i) Column (a):- VRA Annual Reports, 1966-1979

(ii) Column (b):- Department of Energy (United Kingdom), Digest of United Kingdom Energy Statistics, 1981, page 137. Conversion factors for order-of-magnitude estimates are:

1 million tonnes of petroleum = 3800 Gwh of electricity produced.

(iii) Column (c): Department of Energy (United Kingdom), Digest of United Kingdom Energy Statistics, 1981, page 125, Table 88.

APPENDIX A5-5: (continued)

(iv) Average price per tonne for petroleum for 1966 was obtained from Table 90, Ministry of Power Statistical Digest, 1967, p.146. Average cost per ton of oil fuel was given as 145s. 8d. This price was also assumed for 1967.

Notes of Calculations:

(1) The above estimates are only approximate estimates. The estimates were arrived at on the assumption that the thermal generation of electricity in Ghana would have been carried out as the Central Electricity Generating Board operates in the United Kingdom.

(2) In column (e), the dollar equivalent was obtained at the following exchange rates:

Up to 1967: £1 = $2.80

1968-1972 : £1 = $2.40

1973-1977 : £1 = $2.48

1978-1979 : £1 = $2.04

APPENDIX A5-6: Comparative Capital/Generation Costs and Ranking of Potential Power Projects (In millions of 1975 US Dollars)

TYPE OF POWER PROJECT	(a) Installed Capacity (mega-watts)	(b) Average Annual Energy (Gwh)	(c) Total Capital Costs Including IDC	Annual Generation Costs		(f) Capacity Index Cost	(g) Energy** Index Cost (in US mills per kwh)
				Operation and Maintenance (d)	Fuel (e)	US $/kwh	
A. HYDRO-ELECTRIC POWER PROJECTS							
A. (i) Kpong 4 x 36	144	940	148.6	0.44	-	1,030	14.9
A. (ii) Akosombo Expansion..	147		59.3	0.44	-	400	-
A. (iii) Bui 2 x 85	170	1,040	197.9	0.51	-	1,165	18.0
B. THERMAL POWER PROJECTS							
B. (i) Steam Electric.....	150	985	56.5	-	15.75	377	23.4
B. (ii) Compact Steam Electric*.....	70	368	25.0	0.71	6.48	357	26.6
B. (iii) Gas Turbine*.....	50	44	8.0	0.14	1.27	160	52.6
B. (iv) Diesel*.....	6	8	2.1	0.07	0.19	356	62.0

Source: Compiled from: Acres International Ltd. and The Shawinigan Engineering Company Ltd., "Power And Energy Studies", Volume 1, May 1975, Table 4.10, page 4-17.

Notes: (1)* On account of the very high cost of the resultant electricity output, these sources were considered for stand-by purposes only.

(2) IDC means "interest during construction."

(3) A "mill" is a unit used in the power industry to define power price. The "mill" is equivalent to 1/10 of a U.S. cent.

(4)** Index Costs are to be considered as long-term average based on estimated plant factors. The actual costs will depend on how efficiently the plants are operated. They are, therefore, to be seen order-of-magnitude purposes only.

(5) 150 Megawatt plant was considered for the Steam Electric plant rather than smaller units because more economical.

(6) Service life of facilities were: hydropower - 50 years; conventional Steam Electric - 25 years; Compact Steam Electric - 25 years; Gas Turbine - 20 years; Diesel - 25 years.

(7) If X represents the number of years in which the total costs of construction and the cumulative costs of operation of the hydro-power facilities at Kpong (A(i)) and the Conventional Steam Electric option (B(i) become equal, then:

$148.6 million + $0.44 million = $56.5 million

∴ 15.31 X = 92.1

∴ X = 6 years

This means that after six years, the hydro-power facilities would start yielding savings because of the much lower and power generation costs.

APPENDIX A5-7: Annual Energy Sales To Communaute Electrique du Benin

Year	(a) Energy Sales 10^3 kilowatt-hrs	(b) Sales Revenue in thousand cedis	(c) Revenue equivalent in thousands of pounds sterling	(d) Revenue equivalent in thousands of U.S. dollars
1972	1,257	14.8	4.9	11.6
1973	99,723	955.7	335.3	831.0
1974	127,780	1,200.0	421.1	1,043.5
1975	136,700	1,248.2	438.0	1,085.4
1976	155,340	1,542.0	541.1	1,340.9
1977	178,810	2,009.0	704.9	1,747.0
1978	216,630	5,308.0	944.5	1,930.2
1979	299,250	12,267.0	2,182.7	4,460.7
TOTALS	1,215,490	24,544.7	5,572.5	12,450.3

Sources of the data: Volta River Authority Annual Reports.

Notes on the calculations:

1. The accounting policy of the VRA is to convert foreign exchange into cedis at the rates of exchange ruling at the balance sheet date.

2. The revenue equivalent in sterling and dollars were obtained at the following rates of exchange:

1972 : £1.00 = ¢3.01 and $1.00 = ¢1.28
1973 : £1.00 = ¢2.85 and $1.00 = ¢1.15
1974 : £1.00 = ¢2.85 and $1.00 = ¢1.15
1975 : £1.00 = ¢2.85 and $1.00 = ¢1.15
1976 : £1.00 = ¢2.85 and $1.00 = ¢1.15
1977 : £1.00 = ¢2.85 and $1.00 = ¢1.15
1978 : £1.00 = ¢5.62 and $1.00 = ¢2.75
1979 : £1.00 = ¢5.62 and $1.00 = ¢2.75

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