Africa Centre for Energy Policy

EVALUATION OF THE PROPOSED INTEGRATED ALUMINIUM INDUSTRY AND THE $2 BILLION CHINESE BARTER DEAL

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Abbreviations

CDB	Chinese Development Bank
FID	Financial Investment Decision
GIADEC	Ghana Integrated Aluminium Development Corporation
IAI	Integrated Aluminium Industry
ICT	Information Communication Technology
IMF	International Monetary Fund
LIBOR	London Inter Bank Offered Rate
LME	London Metal Exchange
MFA	Master Facility Agreement
MPSA	Master Program Support Agreement
MW	Megawatts
NGLs	Natural Gas Liquids
RBL	Reserve Based Lending
SEA	Strategic Environmental Assessment
SME	Small and Medium Enterprises
USGS	United States Geological Survey
VRA	Volta River Authority

Executive Summary

The aluminium industry is projected to play a vital role in Ghana's development trajectory. The value addition process to Ghana's bauxite began with constructing an aluminium smelter, Volta Aluminium Company Limited (VALCO). A bauxite refinery, which converts raw bauxite into alumina, was required to complete the aluminium value chain. However, failed attempts to create a bauxite refinery has created the situation where refined bauxite (alumina) is imported to operate the smelter.
In 2017, the Government of Ghana announced its renewed effort towards creating an Integrated Aluminium Industry (IAI), which it has envisaged to be a pivotal contributor to government revenue and a conduit for development. Two key elements characterise this effort;

1. The Government has passed an Act of Parliament that sets up the Ghana Integrated Aluminium Development Corporation (GIADEC) to oversee, participate, and ensure the integration of local businesses and skills in the aluminium industry.
2. The Government has committed to receiving an upfront payment for part of the projected benefits from the value chain. Hence, it is implementing a $2 billion barter deal with Sinohydro Corporation, a Chinese state-owned company, for immediate infrastructure for future alumina or aluminium from the integrated aluminium industry.

The focus on the structure of the Chinese barter deal has shadowed other essential considerations. These considerations include a credible estimation of bauxite reserves, the required production to reserve ratio to offset the $2 billion barter deal, contextual challenges that may impede a successful IAI, and public engagement on the impact of extraction of the bauxite.

This paper seeks to analyse the various opportunities and challenges of the IAI programme. The analysis focuses on VALCO as a key player and assesses critical components that impact the company's profitability. Also, the study examines various strategies available to the Government towards increasing bauxite production and constructing a bauxite refinery.

The results of the economic analysis of VALCO show that the company stands a chance to obtain substantial cost savings through efficiency improvement and reduced power costs. The results indicate that VALCO can reduce its annual power costs by about $65.5 million if it can reduce power costs to 3.5 US cents and improve smelter efficiency to about 13MWh per tonne of aluminium produced. However, reducing power costs for VALCO requires a robust assessment of its input and returns to justify government subsidies. Also, private capital may be a viable option for VALCO to generate the necessary investments to retool the smelter and increase its capacity.

The repayment structure for the $2 billion facility has a 12-year repayment period. This analysis estimates that Ghana must pay about $221 million annually to amortise the $2 billion facility, with receipts or outputs from bauxite and alumina production.

The Government of Ghana's projected receivables under the IAI were estimated under two scenarios. The first scenario is the *vertically integrated scenario* where the Government identifies an investor that invests in bauxite production and alumina production. The second is the *segregated scenario* which consists of different entities within each value chain of bauxite production and refinery. An assessment of these scenarios shows that the potential receipts from bauxite and alumina production are not enough to repay the $2 billion facility from Sinohydro. While the *vertically integrated scenario* provides 22 per cent of the facility's annual repayment amount, the *segregated* provides about 16 per cent.

The integrated aluminium industry provides several economic benefits in terms of its contribution to national revenue, employment creation, reduced imports of finished aluminium products, and an expansion of the economy. However, the Government of Ghana must pay attention to critical factors that impede the optimisation of such benefits. These factors include purchasing power at a lower cost, environmental concerns and the threat of recycled aluminium.
In the light of the analysis, it is recommended that;

1. Government should find other sources of financing development projects in the country. The bauxite barter deal introduces complexities that will delay disbursement as a result of the likely repayment problems.
2. Government should pursue the IAI agenda with deep reflection on the global situation of the aluminium industry. An option is for Government to start processes to refine the output of the Awaso mine, which is enough to feed VALCO.
3. Cost benefits studies should be conducted to justify subsidies in electricity to VALCO. If justified, this will require a strong commitment from the Government to pay for the subsidy amount. If a subsidy regime is introduced, it should be done to incentivise further investment in electricity generation, including leveraging domestic gas.
4. An independent and robust Strategic Environmental Assessment is required for the bauxite mining in the new prospects. The impact of crushing down the hills of the prospective areas should be justified by properly estimating associated benefits and mitigation plans.
5. Government should be transparent in its IAI agenda and exhaust public engagement on the need for integrated aluminium industry. There has been little engagement on the IAI with relevant stakeholders beyond the government agencies. Therefore, the Government should recognise the citizenry's knowledge to contribute to the success of the IAI.
6. Recycling of Aluminium must form an integral part of the integrated aluminium industry.

Background

The aluminium industry is projected to play a significant role in Ghana's development trajectory. The Government of Ghana is keen to activate the prolonged effort of developing an Integrated Aluminium Industry conceived in the formative years after Ghana's independence. The first president of Ghana started the process of value addition by establishing an aluminium smelter, the Volta Aluminium Company (VALCO). The smelter was established with a top-down approach at a time the country had no bauxite refinery. However, the establishment of VALCO was important to create a significant market for electricity to ensure that the planned Akosombo hydroelectric project reached a Financial Investment Decision (FID). The reassessment of the hydroelectric dam project by Kaiser Aluminium & Chemical Corporation, as a major investor in VALCO, lowered the cost of the Akosombo project by about $30 million.[1] Thus, the smelter was key to developing the hydroelectric dam, which has been the energy backbone of Ghana for over half a century, providing a baseload for the country's power needs. The Akosombo Dam was the country's first source of baseload and currently has an installed capacity of about 1020MW and contributes about 29.5 per cent of installed capacity.[2]

Bauxite was already being mined in Ghana for more than forty years before the smelter was commissioned in 1967.[3] However, failed attempts to develop a bauxite refinery created the situation where the country exported raw bauxite and imported alumina to operate the smelter. Kaiser, which owned and operated VALCO, was also not interested in building a bauxite refinery in Ghana. The company controlled part of the global value chain that allowed it to obtain surplus alumina from Louisiana produced from bauxite mines in Jamaica. Therefore, cheap power from Akosombo to optimise Kaiser's value chain was all the company needed. At the time, the average cost of obtaining power for the aluminium industry was 0.7 US cents in the USA. However, Kaiser got power in Ghana at 0.26 US cents, fixed for 50 years.[4]

The current concept of the integrated aluminium industry

Earlier attempts by successive governments to complete the aluminium value chain proved unsuccessful. However, in June 2017, the Government of Ghana (Government) announced a renewed effort towards an integrated aluminium industry by increasing bauxite production and refining same into alumina. The current effort has two distinct elements:

1. Government has passed an Act of Parliament that sets up the Ghana Integrated Aluminium Development Corporation (GIADEC) to oversee, participate, and ensure the integration of local businesses and skills in the aluminium industry.
2. Government has committed to receiving an upfront payment for part of the projected benefits from the value chain. Hence, it is implementing a $2 billion barter deal with Sinohydro Corporation, a Chinese state-owned company, for immediate infrastructure for future alumina or aluminium from the integrated aluminium industry.

[1] Volta River Authority. (1966). Speech by Edgar F. Kaiser, President and Chief Executive of the Kaiser Industries Corporation. Inauguration of Volta Power. Available at http://www.vra.com/kmportal/learning/non-tech/Inauguration%20of%20Volta%20river%20Authority.pdf

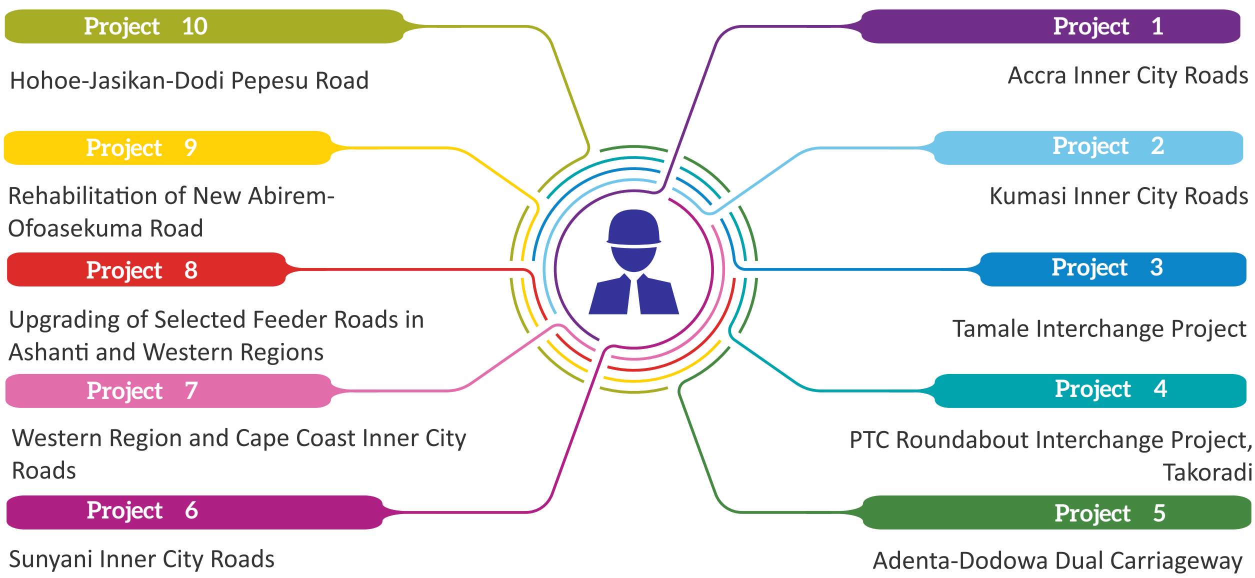
[2] Energy Commission. (2020). 2020 Energy (Demand and Supply) outlook for Ghana.

[3] Ghana Export Promotion Council. (2010). The export of bauxite from Ghana. Available at http://www.gepcghana.com/bauxite.php

[4] Payer, C. (1982). World Bank: A Critical Analysis. New York and London: Monthly Review Press.

In 2018, the Parliament of Ghana (Parliament) approved the Master Project Agreement to establish the barter relationship between the Government of Ghana and Sinohydro Corporation for the $2 billion to be used for various infrastructure projects at different tranches. Subsequently, Parliament approved 10 projects to access the first tranche of $646 million. The first tranche of the facility was committed to road infrastructure to enhance intra-urban and regional traffic flow and strengthen economic and regional integration. The specific projects are listed in Figure 1.

Figure 1: Projects aligned to the first tranche of the Sinihydro facility



Source: Parliament of Ghana (2018)

The barter arrangement generated many discussions about whether the $2 billion facility should be treated as part of the country's public debt. As a result, the Minority in Parliament officially sought clarity with the International Monetary Fund (IMF) on the facility's eligibility as a barter rather than a loan. The IMF, according to media reports, subsequently determined that it is a barter arrangement.[5]

The focus on whether the facility is a loan or a barter arrangement seems to have dwarfed other important considerations:

1. the credible estimation of bauxite reserves that validates the barter agreement
2. the required production to reserve ratio to offset the $2 billion facility
3. contextual challenges that may impede a successfully integrated aluminium industry
4. public engagement on the impact of the bauxite's extraction on the environment.

This paper analyses the various opportunities and challenges to the Integrated Aluminium Industry (IAI) programme. The importance of such analysis is anchored on the fact that the medium-term Coordinated Programme of Economic and Social Development Policies (2017 to 2024)[6] of the country highlights the aluminium industry as a key driver of economic growth. Therefore, central to this analysis is the examination of the challenges of VALCO as a critical component of IAI.

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[5] https://www.myjoyonline.com/politics/2018/September-27th/its-not-a-loan-imf-classifies-2bn-infrastructure-for-bauxite-deal-with-china.php

[6] Akufo-Addo, N.A.D. (2017). The coordinated programme of economic and social development policies. National Development Planning Commission (NDPC). Available at https://s3-us-west-2.amazonaws.com/new-ndpc-static1/CACHES/PUBLICATIONS/2018/04/11/Coordinate+Programme-Final+(November+11,+2017)+cover.pdf

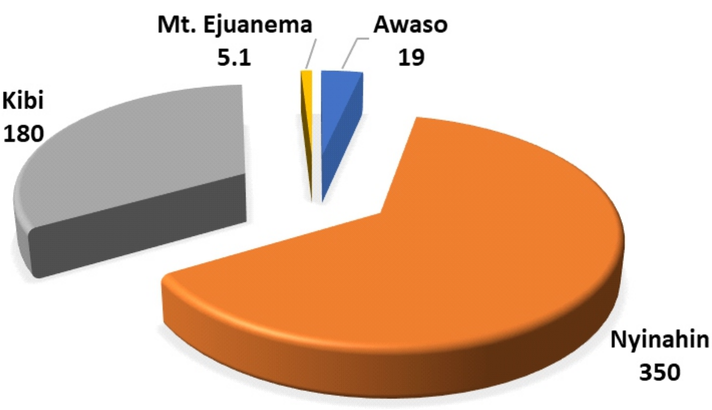
Bauxite Mining in Ghana

Aluminium is arguably one of the most abundant elements in the earth's crust. Only oxygen and silica are known to exist in more significant quantities than aluminium. Bauxite is the dominant source of aluminium, contributing about 99% of metallic aluminium globally .[7] However, it is present in other non-bauxite resources such as igneous rocks, aluminous shales, and alumina clays. However, extracting aluminium from other sources is noted to be too expensive, requiring high energy intensity. Ghana is one of the few countries with commercially exploitable bauxite deposits.

The United States Geological Survey (USGS) estimates global bauxite reserves to be about 30 billion tonnes. As of 2020, Guinea, Australia and Vietnam had the largest reserves of 7.4 billion tonnes, 5.1 billion tonnes and 3.7 billion tonnes respectively.[8] Africa has the highest reserves at the continental level, with about 32 per cent of global estimates.

Data on Ghana's bauxite reserves are not well documented in various global natural resource statistics. However, the most established and referenced reserve estimation puts Ghana's total reserves at about 550 million[9] tonnes, concentrated in four main areas; Nyinahin, Kibi, Awaso and Mt. Ejuanema (see Figure 2).

Figure 2: Ghana's bauxite deposits (million tonnes)



Source: Kesse (1985)

[7]International Aluminium Institute. (2008). Fourth Sustainable Bauxite Mining Report.
[8]United States Geological Survey. (nd). Bauxite and Alumina. Available at https://pubs.usgs.gov/periodicals/mcs2021/mcs2021- bauxite-alumina.pdf
[9]Kesse, G. O. (1985). The mineral and rock resources of Ghana. A. A. Balkema.

Recent data from Engineers and Planners shows that Ghana's reserves could be as high as 1 billion metric tonnes. Even though no official government records confirm the work of Engineers and Planners, the time gap and improvement in technology makes a higher reserve estimation possible. Again, cumulative production from Awaso, where Ghana's bauxite has been produced over the years, shows that the area reserves are more than the original estimates. Available statistics from USGS show that the cumulative production of bauxite between 2012 and 2016 is about 5.3 million tonnes.[10] Between 2017 and now, the average production has stayed above 1 million tonnes.[11]

Mining bauxite requires critical infrastructure such as port, road and rail. Historically, Ghana transported Bauxite from Awaso to the port using rail. However, with the collapse of the railway system, road haulage has become the alternative means of transporting bauxite. An annual production of 12 million tonnes is possible with 400 trucks over a 285km road from Nyinahin to Takoradi port which has implications on the durability and maintenance of the road network. Road haulage is also expensive and has negative implications for the profitability of the mine and national take, making the investment in a new rail system unavoidable for increased production.

Additionally, an expansion of the[12] existing port infrastructure is required to accommodate the expected high volumes of bauxite.

[10] United States Geological Survey. (n.d.). Mineral Commodity Summaries 2019. https://doi.org/10.1007/978-3-540-47108-0-4
[11] GHEITI mining reports for 2016, 2017 and 2018.
[12] Amegashie, A. A. (2015). Ghana: A developing bauxite source. 21st Bauxite and Alumina Conference. Miami, USA.

CHINA'S RESOURCE BACKED INVESTMENT STRATEGY

After the global financial crisis in 2008, sources of long-term finance available to third world countries for infrastructure reduced, heightened by tight fiscal policy conditions from donor institutions.[13] As a result, many developing countries saw the need to seek funds from other sources to meet their development needs. Resource-rich countries, in particular, tend to leverage their natural resources to raise capital to finance development.

As a fast-growing economy, China capitalises on the infrastructure needs of resource-rich developing countries by extending credit facilities to them. These credit facilities tend to have longer repayment periods and competitive interest rates than other Western institutions.[14] In exchange for these benefits, China demands more stable guarantees such as natural resources and steady revenue sources of the countries. Through this, China has become a major economic partner to African economies in deepening bilateral relations.[15]

Ghana and China in recent history on Reserve Based Lending (RBL)

The barter arrangement with Sinohydro is among the high-profile reserve backed development agreements between Ghana and China. Apart from the $2 billion barter arrangement with Sinohydro, there are two notable infrastructure projects; Sinohydro's financing of the $600 million Bui Hydropower Dam project, and the Chinese Development Bank's $3 billion financing of critical oil and gas infrastructure.

The Bui Dam project was securitised in 2007 with an annual sale of 30,000 tonnes of cocoa to China at global market prices.[16] In 2011, Ghana entered another RBL with the Chinese Development Bank (CDB) with over 13,000 barrels of crude oil as collateral. However, the CDB facility encountered significant challenges that should guide future RBLs. Out of the $3 billion CDB facility, Ghana could draw down only $1.5 billion.

The list of projects provided in Figure 3 was to be developed under separate subsidiary agreements tied to the Master Facility Agreement (MFA) between Ghana and CDB. The MFA required that Ghana and the various Chinese contractors agree on the relevant documentation, designs and costing of all the projects. Unfortunately, these subsidiary agreements could not be finalised in time, especially for the period when the oil price was high. Consequently, China began to demand more security with the plummeting oil price in 2014 to allow Ghana access the entire $3 billion facility.

In the Supplementary budget of 2014, the Minister of Finance indicated that "*CDB has introduced a new condition precedent to the effectiveness of the subsidiary agreement for the two additional projects, namely a side agreement to amend some of the terms of the MFA, the Five Party Agreement and the Account Agreement".* The demand of CDB was to recognise the loan as oil-backed and allow 49% of revenue from oil liftings to be paid into a debt service account for servicing the loan. This led to a cabinet decision to cap the loan at $1.5 billion to reduce the payment of commitment fees on the part of the loan that could not be accessed.[17]

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[13] Halland, H., & Canuto, O. (2013). Resource-backed investment finance in least developed countries. World Bank Economic Premise, (123).

[14] Alves, A. C. (2013). Chinese Economic Statecraft: A Comparative Study of China's Oil-backed Loans in Angola and Brazil. Journal of Current Chinese Affairs, 42(1), 99–130. https://doi.org/10.1177/186810261304200105

[15] Begu, L. S., Vasilescu, M. D., Stanila, L., & Clodnitchi, R. (2018). China-Angola investment model. Sustainability (Switzerland), 10(8). https://doi.org/10.3390/su10082936

[16] Odoom, I. (2017). Dam in, cocoa out; pipes in, oil out: China's engagement in Ghana's energy sector. Journal of Asian and African studies, 52(5), 598-620.

[17] Terkper, S.E. (2014). US$3 billion term loan facility agreement between China Development Bank Corporation (CDB)and the government of Ghana- update on cabinet directive to cap the facility at US$ 1.5 billion. Parliament of Ghana. available at http://ir.parliament.gh/bitstream/handle/123456789/253/doc02099220150610181052.pdf?sequence=1&isAllowed=y

Twelve (12) eligible projects, primarily infrastructure development projects under a variety of MDAs, were identified and confirmed for financing under the facility. The details of the 12 projects are provided in Figure 3.

Figure 3: Projects to be delivered under the Master Facility Agreement in 2011 under CDB

01	Western Corridor Infrastructure Renewal Project Takoradi-Kumasi; Dunkwa-Awaso Railway Line
02	Western Corridor Infrastructure Renewal Project - Takoradi Port Retrofit Phase 1
03	Sekondi Free Zone Project – Shared Infrastructure and Utility Services
04	Accra Plains Irrigation Project (Phase 1: 5000 ha)
05	Coastal Fishing Harbours and Landing Sites Re-development Project (Axim, Dixcove, Elmina, Winneba, Mumford, Senya-Beraku, Jamestown, Teshie, Tema, Ada, Keta)
06	Eastern Corridor Multi-modal Transportation Project – Upgrade of Volta Lake Ferries, Pontoons + Landing Sites (Kpandu-Amankwakrom; Kete Krachi-Kwadokrom; Yeji-Makongo; Tapa Aboatoase; Dzemini); Upgrade of Akosombo and Buipe Ports
07	Western Corridor Gas Infrastructure Project a.Offshore Gas Gathering Pipeline; Early Phase Gas Processing Plant; Onshore Gas Trunk Pipeline, including Pumpuni Dispatch Terminal; NGLs Processing Retrofit (Tema Oil Refinery); and Helicopter Surveillance Fleet
08	Western Corridor 'Petroleum Terminal' Project
09	Western Corridor 'Oil Enclave' Toll Road Project
10	Accra Metropolitan Area ICT- Enhanced Traffic Management Project (including urgent road completion components)
11	Integrated National Security Communications Enhancement Project – Deployment of ICT Enhanced Surveillance Platform for Western Corridor "Oil Enclave"
12	US$ 100 million SME Projects Incubation Facility – Facility Management Contract(s) with local financial institution(s)

The effect of the non-disbursement of the loan was that the critical infrastructure projects which were programmed under the facility could not be delivered. Out of the 12 projects, only two were delivered amidst delays (See **7** & **11** in Figure 3). In addition, the slow disbursement to the Atuabo gas processing plant (Western Corridor Gas Infrastructure Project) significantly distorted Ghana's plans for fuel supply to the power sector, deepening the power crises which contributed to the economic hardship experienced by the public between 2012 and 2014. Therefore, potential signals that could distort the Government's plans under the Sinohydro facility should be treated with seriousness to avoid a similar situation with the CDB facility.

THE ROLE OF VALCO AS A PIVOT IN THE IAI PLAN

VALCO is a limited liability company wholly owned by the Government of Ghana after it purchased the 90 per cent stake owned by Kaiser Company Limited in 2004. The company has a smelting capacity of 200,000 tonnes per annum. However, it currently operates 20 per cent of its capacity. One of the objectives of IAI is to increase the capacity of VALCO from 200,000 tonnes to 350,000 tonnes per annum (tpa). **The current production of bauxite of 1.4 million tonnes per annum (mtpa), if transformed into alumina at a ratio of 2-to-1, would be enough to produce 700,000 tpa of alumina. With an average of 2 tonnes of alumina required to produce a tonne of aluminium, the 700,000 tpa of alumina will be the needed quantity if VALCO is expanded**. Consequently, any bauxite production above the current level of 1.4 mtpa is either likely to be exported as raw Bauxite or Alumina if the requisite investment is raised to refine the bauxite.

The critical question for Government to answer is why Ghana has been unable to attract the needed investments to refine bauxite mined at Awaso after 52 years since VALCO was commissioned. Answering this question will help Government identify the various challenges faced in developing an integrated aluminium industry and proffer solutions to smoothen the process of completing the aluminium value chain.

VALCO is currently struggling to optimise its capacity of 200,000 tonnes. Two key challenges account for this; the cost of power and the efficiency of the smelter. The company currently obtains power at 5 US cents from Akosombo, which is one of Ghana's least-cost tariffs. However, even at this tariff level, VALCO is not profitable. Between 2016 and 2018, VALCO made an average loss of about GHS 121 million per annum. Also, the company's increasing gearing ratios demonstrate that the state's equity is declining to accommodate more debt financing.[18] Table 1 provides details of VALCO's revenues and net profits from 2016 to 2018.

The Ministry of Finance has cited the following as key reasons for the poor performance of VALCO:

1. **Uneconomical one cell line operation**: VALCO currently operates a single potline out of its five. Thus the company produces at about 20 per cent of its original capacity and does not benefit from economies of scale.
2. **Insufficient and erratic power supply**: The process of aluminium production is power intensive. The power supply has been unstable and has implications for profitability.
3. **Globally uncompetitive power price**: VALCO purchases electricity at 5 US cents per kWh against the global average of about 3.5 US cents per kWh.

[18] Ministry of Finance. 2018 State ownership report. Accra.

Table 1: Financial position of VALCO for 2016, 2017 and 2018

Indicator	2016 (GHS M)	2017 (GHS M)	2018 (GHS M)
Revenue	258.32	336.03	467.53
Net Profit	-105.73	-107.35	-153.64
Total Assets	1241.82	1275.27	1359.77
Total Liabilities	537.81	642.54	822.7
Equity	704.01	632.78	537.07
Ratios			
Net Profit Margin	40.93	31.95	32.86
Current Ratio	2.3	2.15	2.02
Gearing Ratio	3.11	4.3	7.21

Sources: Ministry of Finance (2019)

Cost saving scenario analysis for VALCO's smelter under power costs and efficient systems

Globally, the power costs for aluminium smelting range between 2 to 5 US cents per kWh with an average of 3.5 US cents per kWh. However, companies operating at the upper tariff of 5 US cents have the advantage of scale and market. VALCO, however, purchases power at 5 US cents per kWh and is further disadvantaged with a limited scale of production. At the current level, VALCO produces at most 40,000 tonnes per annum, which is inadequate to meet its increasing operating costs.

The company also operates inefficient smelters, which consume excessive power, and worsens its power costs. VALCO's existing smelters consume between 16 to 17 MWh per tonne of aluminium produced. However, modern smelters can operate at 13.5MWh per tonne of aluminium or less.[19]

This section presents three cost reduction scenarios required to make VALCO competitive on power consumption. The scenarios are explained in Figure 4.

[19] Husband, C., Mcmahon, G., & van der Veen, P. (2009). The Aluminium Industry in West and Central Africa Lessons Learned and. (December).

Figure 4: Power cost and efficiency assumptions for VALCO

a. Current scenario:

This scenario is characterised by higher tariffs and a smelter with power consumption of 16.5MWh per tonne. In this scenario VALCO pays 5 US cents per kWh for power consumption.

b. Scenario one:

This scenario maintains the cost of power while increasing the efficiency of the smelter. Thus, VALCO obtains power at 5 US cents per kWh whereas the smelter consumes an average of 13.5MWh per tonne of aluminium produced.

c. Scenario two:

Scenario two characterises a reduction of power cost (3.5 US cents per kWh) while maintaining the current efficiency of the smelter (16.5MWh per tonne)

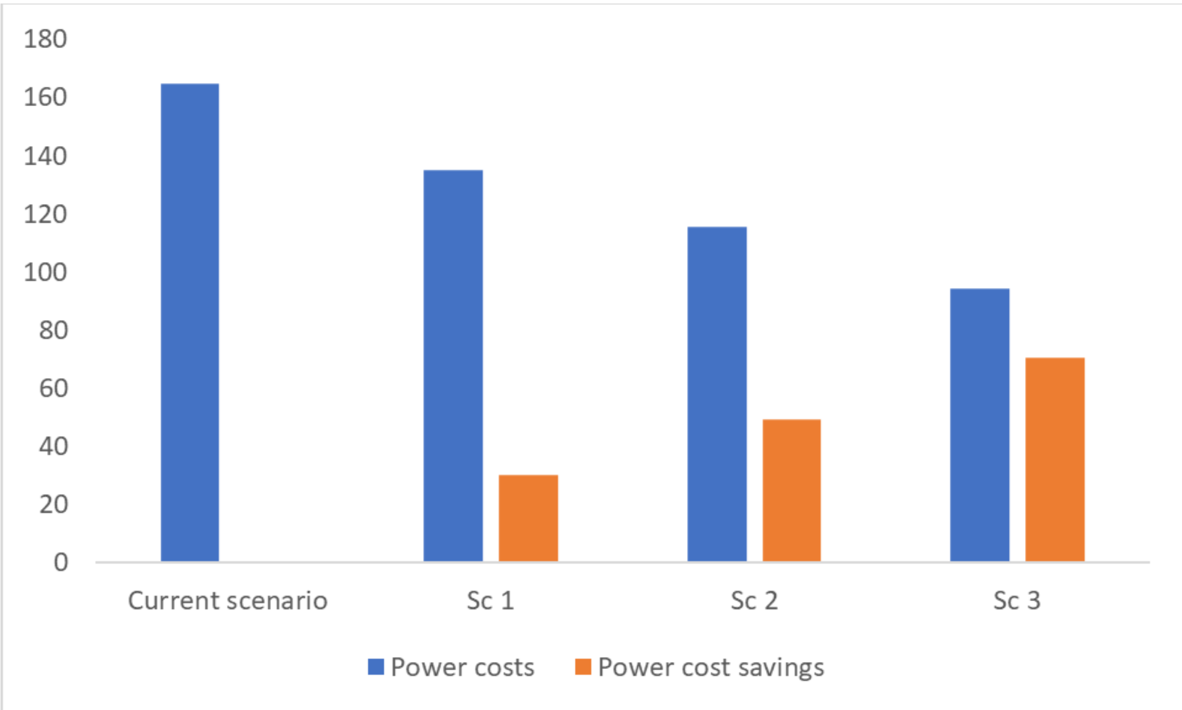
d. Scenario three:

Scenario three characterises increasing the power consumption efficiency of the smelter (13.5MWh per tonne) and reducing the cost of power supply for VALCO (3.5 US cents per kWh). z

a. **Current situation**: Currently, VALCO consumes 16.5MWh per tonne of aluminium at 5 US Cents per kWh, translating to $825 per tonne of aluminium. If VALCO operates at a peak capacity of 200,000 tpa, it would require about $165 million for power.
b. **Scenario one**: At 5 US cents per kWh and a smelting power consumption of 13.5MWh, VALCO's power cost is estimated to be $675 per tonne, translating to an annual power cost of $135 million at a peak capacity of 200,000tpa. Thus, VALCO saves about $30 million per annum in power costs at peak capacity if it invests in a more efficient smelter.
c. **Scenario two**: At the global average price of 3.5 US cents and a smelting power consumption of 16.5MWh per tonne, power cost amounts to $577.5 per tonne, which translates to an annual power cost of $115.5 million at peak capacity. This scenario will save VALCO about $49.5 million per annum in power costs.
d. **Scenario three**: Scenario three is the scenario that generates maximum power savings for VALCO. At a global average of 3.5 US cents per kwh and an improved smelter efficiency of 13.5MWh, VALCO incurs a power cost of $472.5 per tonne, translating to $94.5 million at peak capacity. Thus, VALCO saves about $65.5 million per annum in power costs.

The analysis shows significant cost savings through efficiency improvement and reductions in power costs (see Figure 5). However, it is essential to recognise that improving the efficiency of the smelter requires substantial investment. Private sector participation is a viable option for Government to generate the necessary investment to retool VALCO and enhance the efficiency of the smelter. However, for VALCO to operate at a maximum power saving of $65.5 million while operating at its current efficiency level, it needs to purchase power for as low as 2.9 US cents per kwh, a situation which may seem infeasible. This is because Volta River Authority (VRA), the generation company that supplies power to VALCO, supplies power to VALCO at a subsidy. Whiles VRA operates at about 6 US cents per kwh,[20] it supplies power to VALCO at 5 US cents per kwh.

Figure 5: VALCO power costs and power cost savings at full capacity



Sources: World Bank , VALCO

[20] Volta River Authority. (2019). 2018 Annual report and Financial Statement.

THE $2 BILLION SINOHYDRO REPAYMENT STRUCTURE

Ghana signed an MFA with Sinohydro for a $2 billion facility for a 15-year repayment period. The facility has a 3-year grace period, which means that Ghana has 12 years to repay. The interest rate is set to be the prevailing six-month LIBOR rate plus 2.8 to 3.3 per cent. This analysis assumes a LIBOR of 1.9 per cent, the average LIBOR over a 15-year period (2005-2019). Also, the analysis accounts for the 0.7 per cent flat management fee, the 0.5 per cent commitment fee and the Sinosure premium of 7 per cent.

Table 2: Ghana's repayments for the $2 billion facility

Item	Amount ($ million)*
Loan principal	2,000
Commitment Fee	10
Management Fee	14
Future value of the facility	3,704
Annual payment required	221

***This report uses the lower rate of the interest payments, i.e. LIBOR + 2.8 per cent.**

Given a LIBOR rate of 1.9 per cent plus the lower bound rate of 2.8 per cent, the total amount to be paid by the Government at the end of the 12 years amounts to about $3.7 billion, which corresponds to an annual payment of $221 million to amortise the debt. Thus, the yearly government take from IAI should be at least $221 million to meet the barter requirement.

Government's receipts in the IAI

The barter arrangement for the $2 billion facility demands that the equivalent amount of alumina or aluminium must be used for repayment. The model for the integrated aluminium industry requires the development of bauxite mines at Kibi and Nyinahin, the construction of bauxite refinery, and the expansion of VALCO to increase its aluminium production.

The Government of Ghana estimates that the additional production from Kibi and Nyinahin reserves will increase production to 5 million metric tonnes.[21] Legally, Government's entitlements from minerals are royalties, dividends and taxes as stipulated in the Minerals and Mining Act, 2006 (Act 703). However, it is only royalties and other petty payments such as property rates and rents guaranteed to be received by the government. This is because other possible receipts (taxes and dividends) will be based on the profitability of the mine and will demand some investments from Government. This report presents two scenarios that explain the government's receivables from the IAI in taxes and royalties(see Figure 6).

Figure 6: Description of the Vertically integrated and Segregated scenarios under IAI

Vertically integrated scenario	Segregated scenario
The bauxite mining company is the same company that refines bauxite into alumina	There are separate investors involved in mining and refining
The refinery capacity is estimated at 2.5 million tonnes of alumina (this is equivalent to the amount of bauxite produced i.e. 5 million tpa)	The refinery capacity is estimated at 2.5 million tonnes of alumina (this is equivalent to the amount of bauxite produced i.e. 5 million)
The government takes royalty in the form of alumina	The government will take royalty in the form of bauxite (250,000 tonnes)
Government obtains 125,000 tonnes of alumina based on a 2:1 refining ratio.	Government will also obtain taxes from bauxite mining
To meet the estimated revenues, government needs to seek investor / investment worth over $2.5 billion in bauxite refinery to be able to refine the 5 million tonnes output of bauxite.	To meet the estimated revenues, government needs to seek investment worth over $2.5 billion in bauxite refinery.

[21] Modern Ghana News (n.d). Bauxite mining in Atewa will give room for galamsey, illegal logging – A Rocha. Available at https://www.modernghana.com/news/1073483/bauxite-mining-in-atewa-will-give-room-for-galamse.htm

Vertically integrated scenario

The *vertically integrated* scenario assumes that Government obtains an investor that mines and refines bauxite simultaneously. Second, it also assumes that Government enters an agreement that seeks to receive its royalties from alumina. Thus, this scenario provides the Government of Ghana with the ability to take royalty from the refined alumina. The 5 million tonnes convert to 2.5 million tonnes of alumina of which 125,000 tonnes is the royalty value of alumina.[22] This volume translates to annual revenue of about $48 million given an alumina price of $387 per tonne (see figure 5), without accounting for refining costs.

The capital cost for alumina investment is a function of scale, technology, and siting. The average investment cost for alumina refineries is estimated at $1000 per tonne of production.[23] Thus, Ghana needs investment worth over $2.5 billion to build a mine and a refinery with a capacity of 2.5 million tonnes of alumina. Amortising the $2.5 billion investment requires about 15 years, making corporate income tax payments virtually non-existent.

Thus, Ghana obtains royalties as guaranteed receipts from IAI in the vertically integrated scenario. The royalty amount translates to about 22 per cent of the total annual amount required to amortise the Sinohydro facility.

Table 3: Government receivables in the vertically integrated scenario

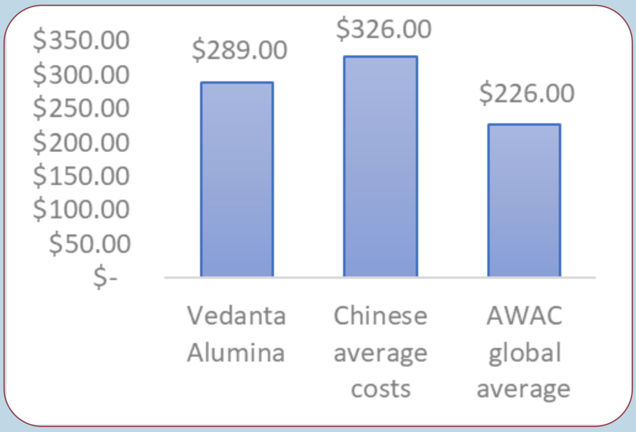
Item	Amount ($ million)*
Average alumina price ($/tonne)	$387
Estimated annual production (Tonne)	2.5 million
Government royalty (Tonnes of alumina)	125,000
Government royalty ($)	$48.4 million

[22] The first amendment of the Minerals and Mining Act (ACT 794, 2010) provided the rate of mineral royalties to be 5 percent.
[23] Tuler & Scott-Taggart. (2001). Aluminium. *Encylopedia of materials: science and technology* (2nd ed), 97-100.

Box 1: Estimation of alumina production costs and global alumina margins
Alumina production costs

Alumina production costs for some Alumina producing companies

Globally, top alumina producing companies average their cost of alumina production to approximately $289 per tonne:



Sources: (Dash, 2019; Wood, 2019)

A simulation of alumina production costs reveals 69 percent likelihood that alumina production cost ranges between $250 and $350 and a 20 percent likelihood that production cost is less than $250. The simulations present justification of the use of the average cost of $289.

Global alumina prices and alumina margin estimation

Global alumina prices from 2013 show instances of increase and declines in prices year on year. For instance, prices of alumina increased by 1 per cent from 2013 to 2014 but reduced by 9 per cent in 2015. The trend of reduction continued in 2016 as alumina prices reduced by 20 per cent. Between 2017 and 2018, the global price of alumina increased by 30 per cent to about $472 per tonne. Daily closing prices from March 2019 on the London Metal Exchange (LME) show fluctuations in the one-month futures price of alumina which averages to $375 dollars. Average price of alumina is estimated to be $387 per tonne. Given this price, margins from alumina production is estimated to be $98 dollars per tonne.

Segregated scenario

The *segregated scenario* highlights a situation where the processes of bauxite mining and refinery into alumina are segregated. In this scenario, there are two players, one at the mining end and the other at the refining end of the IAI. This scenario presents three possible cash flows for the government.

a. Royalties from 250,000 tonnes of bauxite based on an estimated price of $32 per tonne.[24]
b. Corporate income tax received from bauxite production
c. Corporate income tax received from alumina.

Total royalties from bauxite mining will amount to $8 million per year, given a price of $32 per tonne. Tax commitments by the bauxite production companies depend primarily on their margins after accounting for production costs and amortisation of capital investment. Generally, the production costs for bauxite range between $16 per tonne to about $30 per tonne.[25] For the purpose of estimation, we assume that bauxite is produced at the least cost of $16 per tonne. At a margin of $16 per tonne, the net revenue for producing 4.750 million tonnes after accounting for production cost is about $76 million.

The average capital cost for bauxite production is estimated to range between $40 to $50 per tonne, although investment cost differs depending on the scale of production and location. Thus, a 5 million tonne production capacity requires between $200 million to $250 million. A five-year straight-line depreciation of the investment would range between $40 million to $50 million without accounting for interest. The resulting net taxable income would range between $26 million to $36 million. Thus, corporate income tax for bauxite production in the *segregated scenario* would amount to about $12.6 million within the capital allowance period, increasing to about $26 million thereafter.

As indicated in the previous scenario, the high capital costs for alumina production make it difficult to receive corporate income taxes for the next ten to fifteen years. Thus, the guaranteed sources from IAI to repay the Sinohydro facility in this scenario would primarily be the royalties from bauxite. Corporate income taxes from bauxite production could be an additional source after about five years of bauxite production. The cumulative yield for the *segregated scenario* is estimated at $20.6 million, increasing to about $35 million after the capital allowance period. This amount is about 16 per cent of the total annual amount required to amortise the Sinohydro $2 billion facility. Government's corporate income tax receipts from bauxite production largely depend on the cost of production and transportation infrastructure necessary for production and transportation.

[24] Bauxite export values from GHEITI report estimates price of bauxite at $31.95 per tonne; Ghana Extractive Industries Transparency Initiative. (2018). GHEITI report on the Mining Sector 2016 (Vol. 233). Retrieved from http://www.international.gc.ca/yournextmarket-vosprochainsmarches/business-entreprise/mining-minier.aspx

[25] Alcoa in its report estimated a cost between $16-$18 per tonne.
Rajendra, K. (2011). Calculation of Mining and Transportation Costs of ROM Bauxite. Retrieved December 20, 2019, from http://bauxite2aluminium.blogspot.com/2011/12/calculations-for-mining-and.html; Otto, J., Andrews, C., Cawood, F., Doggett, M., Guj, P., Stermole, F., … Tilton, J. (2006). Mining Royalties: A Global Study of Their Impact on Investors, Government, and Civil Society. Washington DC. World Bank.

Table 4: Government receivables in the segregated scenario

Item	Amount ($ million)*
Total royalties from bauxite	$8 million
Corporate income tax (within the capital allowance period)	$12.6 million
Corporate income tax from (after the capital allowance period)	$26 million

*** Assumed tax rate of 35 per cent of net profit. Taxes are not guaranteed in the medium term on account of the recovery of capital investments.**

Government's optimisation strategy: Repaying the facility

There is no clarity on the intention of the government to add value to the bauxite industry. There are questions about whether Ghana intends to refine 100 per cent of its bauxite mined or a blend of domestic refinery and exports. Available information based on Government's communication on the IAI indicates that $1 billion is expected to be invested into the refinery to process bauxite into alumina. There is also scant information on the capacity of the proposed bauxite refinery. Market analysis of bauxite refineries shows that a $1 billion investment yields refinery capacity of between 900,000 to 1 million tonnes of alumina.[26]

As part of the IAI, Government estimates that the total amount of bauxite produced per year will increase to 5 million tonnes. This requires about $2.5 billion worth of investments to build an alumina refinery. Hence, if the investment is $1 billion, it suggests that only about 40 per cent of the bauxite produced can be processed into alumina and the remaining 60 per cent exported. Clarity on these issues would ensure that the public understands the long-term strategy of the IAI.

In addition to the investments in bauxite refineries, the government plans to increase the smelter's capacity for aluminium production to 350,000 tonnes. As already analysed in earlier sections of this report, VALCO's profitability largely depends on the cost of power and the efficiency of the smelting machinery. Increasing the smelter's production capacity may increase operational costs without much addition to net revenue as they are absorbed by the inefficiency of the plants coupled with the high price of power. Cheaper power and increased smelter efficiency make the smelter project more viable. However, when the efficiency and power costs are fixed to make VALCO viable, the company would have to service its legacy debts before they become profitable. This situation makes it difficult for VALCO to contribute to the repayment of the Sinohydro facility in the short to medium term.

[26] Tuler & Scott-Taggart. (2001). Aluminium. *Encylopedia of materials: science and technology* (2nd ed), 97-100.

Economic Benefits and Challenges of the IAI

Beyond the fiscal contribution to national revenue, other economic benefits of the IAI include employment generation and expansion of the economy. The supply chain must be optimised to optimise these benefits, which suggests that inputs must be sourced locally to minimise import expenditure on the value chain. For example, caustic soda is currently imported for mine operations, although there is a potential for local production as Ghana has significant deposits of sodium chloride. However, a substantial proportion of the value of the output in the aluminium industry goes into expenditures (for example, inputs, technology and skilled labour). If the value chain fails to link local raw materials, technology and skills into the industry, the capital flight for importing these inputs reduces the impact of the integrated industry on the economy.

Therefore, to a large extent, localisation and value addition benefit a country in the aluminium industry. Consequently, an Act of Parliament was passed giving the Ghana Integrated Aluminium Development Corporation the mandate to ensure equity participation and development of a policy for local participation in the industry. The minimum equity participation prescribed in the law is at least 30 per cent of the total equity held by the Corporation and local investors. This is in addition to any carried interest held on behalf of the state (Section 4 (d), (e) and (f)).

This provision requires significant investment from local partners and the Government. For example, a total investment of $1 billion in bauxite refinery alone suggests that investment by Government or local investors must be at least $300 million. Moreover, this amount must be raised through debt or equity, translating to a minimum of $75 million equity based on the debt-to-equity ratio prescriptions in the Income Tax Act (Act 896, 2015), which raises the question of the ease or difficulty in raising such an amount by local businesses.

The law also provides avenues for the integration into the downstream sector by facilitating the establishment of industrial parks, which is set to promote the manufacture of aluminium related products and services in the integration aluminium industry. The downstream aluminium industry consists of metal supplies, roofing sheets, glassworks, utensils and the like. This effort can reduce the importation of finished aluminium products into the country. Despite the potential benefits, actualising the integrated aluminium industry dream faces several challenges.

Power

The aluminium value chain is energy-intensive, requiring cheap and available power to justify investments. The Ghana Integrated Aluminium Development Corporation Act, 2018 (Act 976) recognises this fact and therefore prescribes assurance of cheap and reliable power from the state. The Act stipulates that the state shall ensure the availability of power which shall be provided at globally competitive rates (Section 22 (1) and (2)). Generally, power is expensive in Ghana as industrial consumers pay about 18 US cents per kwh. VALCO, a major consumer, receives a concessionary rate of 5 US cents per kwh which is still argued to be expensive and above the global industry average of approximately 3.5 US cents per kwh.

Environmental concerns

The exploitation of minerals is generally a big contributor to environmental degradation, of which bauxite mining is no exception. The main processes for bauxite mining include topsoil removal, extraction and washing. These processes impact the environment, including soil erosion, noise pollution arising from the explosion and the release of impurities into the environment.[27] Residue formed after the Bayer Process (extraction and refinery of bauxite from the ore) contain high amounts of iron and other oxides, which form a red coloured muddy structure, generally known as red mud.[28] Red mud must be contained and properly treated to prevent it from spreading to other agricultural lands and seeping into water bodies.

The Act does not explicitly mention guidelines for environmental conservation in the IAI. However, it stipulates the collaboration of the Corporation with relevant public institutions on the development of the integrated aluminium industry. There has been advocacy on the need for Government to conduct a Strategic Environmental Assessment (SEA) of the IAI to assess the costs, benefits and measures to mitigate environmental impacts. The wide range of assessments of SEA makes it relevant for such an assessment to be done for the integrated aluminium industry.[29] However, accessing $2 billion ahead of SEA ties the odd to extraction by any means possible. This notwithstanding, proper environmental assessment and mitigation strategies could help reduce the impact of the mine activities.

Recyclable Aluminium: A threat to taking from the earth

Although the demand for aluminium, in general, is growing, there are competing efforts from secondary aluminium. Secondary aluminium is obtained from recycling scraps of aluminium products. According to the Aluminium Association, aluminium is the most recyclable material of all materials. It is thus described as the "most valuable material in the recycling bin." Aluminium can be recycled several times without losing its properties. Recycling is generally a waste preventive approach and activity that is beneficial to the environment. Aluminium recycling, therefore, has more ecological benefits than primary aluminium production.

Therefore, the demand for primary aluminium is likely to decline due to an increased affinity for recycled aluminium. This continual occurrence has the potential to reduce the level of extraction of bauxite needed for aluminium production. The demand for secondary aluminium is also heightened by an increased need for recycled aluminium by multinational companies. For instance, Apple seeks to chart a new path towards environmental sustainability through advanced recycling. The global technology company currently has robots that disassemble and recycle used apple devices. Currently, iPads, MacBooks and Apple watches are produced from recycled aluminium as part of the company's plan to contribute to environmental sustainability. These efforts led to the company winning the 2019 UN Climate Action award.

Beyond environmental sustainability, the process of recycling aluminium consumes less power than primary aluminium production. According to the US Department of Energy,[30] secondary aluminium production consumes about 6 per cent of the energy required to produce aluminium from primary sources. This significant power difference presents opportunities for aluminium recycling companies to operate at a cheaper production cost without compromising the quality of recycled aluminium produced. It is, however, important for the IAI to embrace the new developments in the global aluminium industry to avoid the crushing impact of falling aluminium prices .

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[27] Abdullah, N. H., Mohamed, N., Sulaiman, L. H., Zakaria, T. A., & Abdul Rahim, D. (2016). Potential health impacts of bauxite mining in Kuantan. Malaysian Journal of Medical Sciences, 23(3), 1–8.

[28] Jamieson, E. J., Penna, B., van Riessen, A., & Nikraz, H. (2017). The development of Bayer derived geopolymers as artificial aggregates. Hydrometallurgy, 170, 74–81. https://doi.org/10.1016/j.hydromet.2016.05.001

[29] Neal, T. (2019). Strategic Environmental Assessment and the Sustainable Development of a Ghanaian Integrated Aluminium Industry. Retrieved September 18, 2019, from https://apj.hkspublications.org/ghanabauxite/

[30] U.S. Department of Energy. (2007). U.S. Energy Requirements for Aluminium Production: Historical Perspective, Theoretical Limits and Current Practices. Retrieved from http://www1.eere.energy.gov/industry/aluminum/pdfs/al_theoretical.pdf

Conclusion and Recommendation

The objective of Ghana's integrated aluminium industry is to ensure maximum benefits of bauxite production across the entire value chain from bauxite extraction to aluminium production. A successful IAI will ensure that Ghana reaps economic benefits from the country's bauxite deposits, including fiscal gains by the Government, capacity building, employment generation, and overall economic and industrial development. However, a fundamental difficulty arises with front-loading the benefits through the Sinohydro facility, which requires that the government makes payments in alumina to the value of over $200 million per annum over the loan repayment period.

The analysis in this paper shows that the government's revenue from taxes and royalties are not sufficient to repay the $2 billion facility. The possible, guaranteed Government take from the projected production under various scenarios show a maximum of about $48 million within the repayment period from private investment, compared with the annual repayment amount of over $200 million.

Given the risks highlighted, Government must clarify how it intends to repay the barter deal. If proceeds from IAI are insufficient, the Government may have to buy alumina with hard currency from the industry to trade barter with Sinohydro or pay the equivalent cash amount to Sinohydro. This highlights the importance of the requirement on the government to provide alternative payment options in the MPSA. Therefore, the summary provided in Box 2 is worthy of note.

Box 2: Summary of findings

01 Royalties and taxes from the IAI may not be enough to repay the $2 billion Sinohydro facility.

02 VALCO requires substantial subsidies to be profitable. The smelter is less efficient and operate with relatively expensive power. This cocktail of challenges makes it difficult for VALCO to be profitable. Government will have to provide subsidy on power for VALCO to improve on its operational health and make it profitable.

03 There is limited and outdated information on reserves. This makes it difficult to progress to production of bauxite in the other deposits in Nyinahin and Kibi. Any new company will have to independently access the reserve potential of the deposits to make a case for investment. It is therefore difficult to project short term production of bauxite from the sites.

04 The importance of SEA ignored before the barter deal was concluded. The environmental and social impact assessments for the bauxite mining are important but unfortunately deferred in the context of the barter arrangement. Mitigation strategies therefore become the only available option if the IAI progresses.

05 Risk that bauxite will not be refined in Ghana. The decision to build a refinery will take time, especially given the lack of up-to-date reserve data. In order to start repaying the $2 billion facility, GIADEC may be forced to export raw bauxite to be refined into Alumina in China. This will lead to substantial production to depletions ratio and an inability to leverage domestic smelting capacity.

In the light of the above conclusions, it is recommended that;

1. Government should find other sources of financing development projects in the country. The bauxite barter deal introduces complexities that will delay disbursement as a result of the likely repayment problems.
2. Government should pursue the IAI agenda with deep reflection on the global situation of the aluminium industry. An option is for Government to start processes to refine the output of the Awaso mine, which is enough to feed VALCO.
3. Cost benefits studies should be conducted to justify subsidies in electricity to VALCO. If justified, this will require a strong commitment from the government to pay for the subsidy amount. If a subsidy regime is introduced, it should be done to incentivise further investment in electricity generation, including leveraging domestic gas.
4. Independent and robust SEA is required for the bauxite mining in the new prospects. The impact of crushing down the hills of the prospective areas should be justified by properly estimating associated benefits and mitigation plans.
5. Government should be transparent in its IAI agenda and exhaust public engagement on the need for integrated aluminium industry. There has been little engagement on the IAI with relevant stakeholders beyond the government agencies. Therefore, the government should recognise the citizenry's knowledge to contribute to the success of the IAI.
6. Recycling of Aluminium must form an integral part of the integrated aluminium industry.

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