MINISTRY OF NATURAL RESOURCES
CO-OPERATIVE REPUBLIC OF GUYANA

POLICY BRIEF #2

Alumina production in Guyana: feasibility considerations

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A. SCOPE

This policy brief is the second in the series of seven such documents. It assesses generally the possibility of Guyana becoming an alumina producer. Accordingly it sets out to fulfil three tasks:

i) To present the characteristics of and outlook for the world alumina industry and the implications for Guyana.

ii) To assess Guyana's comparative advantages and disadvantages in this context.

iii) To recommend a broad policy approach the government should adopt to facilitate private investments into alumina production.

First, some background on the issue.

B. BACKGROUND

(i) Policy context. Bauxite is the raw material for a range of manufactured products in the metallurgical, chemical and cement industries. Of special interest to the Guyana government is the use of bauxite for the production of alumina, the feedstock for aluminum smelting. This interest is in line with the policy goal stated in the National Mineral Sector Policy Framework and Actions of "expanding mining's contribution to national and sub-national economic development". Under this policy, Strategic Goal # 11 directly addresses the issue of using ores in value-added production: "To expand the number of businesses and economic activities that serve the mining sector (backward linkages) and that use the outputs of mining (forward linkages)."

The production of alumina in Guyana ceased in 1982. Soon after then, the restart of alumina refining has attracted active consideration. Consideration has mostly been directed at the restoration of the closed alumina operation in Linden. More lately, however, the attention has extended to the feasibility of constructing new or greenfield production facilities.

(ii) Governing economic philosophy. Since 1985, successive Guyana governments have moved the country's economy away from state-owned entities as the dominant engine of growth to an economy driven by the private sector. Privatization of state entities and the reversal of nationalization (through management contracts, leases, joint ventures and outright sales) have been the most dramatic result of this philosophical shift.

For the bauxite industry, since the early 2000s, ownership and management have been transferred from the state over to foreign-owned companies. A national consensus has now long emerged that the future of the industry will depend on maintaining and attracting overseas attention and investments. In this new dispensation, government's main role includes that of investment seeker and facilitator and minority shareholder.

The old alumina plant in Linden was owned and operated by government after the nationalization of Demba operations, the local subsidiary of Alcan, in 1971. Any establishment of alumina refining in Guyana today, however, will likely be within the prevailing free enterprise ideal.

C. POTENTIAL INVESTORS IN ALUMINA REFINING IN GUYANA

Companies willing to invest in establishing an alumina refinery in Guyana will likely count among:

i) foreign-owned bauxite mining companies in Guyana;

ii) large integrated bauxite companies not currently operating in Guyana, with their own supply chain from bauxite mining to alumina refining to aluminum smelting;

iii) Chinese-owned companies as a subset of those mentioned in (ii) above, that are seeking to supply their own local markets by investing overseas;

Whether these companies invest in Guyana depends mainly on two pivotal sets of investment factors:

i) Their assessment of the world market outlook for alumina and aluminum.

ii) Their assessment of Guyana's comparative advantages and disadvantages in this context.

D. ASSESSMENT OF INVESTMENT FACTORS

D1: World market outlook for alumina and implications for Guyana

A range of economic, geo-political/strategic, market, and technological drivers operate to shape the alumina industry. The interplay of these drivers determines the market outlook for alumina; that is, its long-term demand trend (flat; down or up; slow or rapid), and the hard limits to its potential market size.

This policy brief therefore assesses its market demand and its production, supply and use. Under market demand, we assess separately the influences that both favor and restrict growth in demand. Likewise, for production and supply, we examine the influences separately that both favor and restrict increases.

In terms of setting up an alumina refinery in Guyana, the influences that favor the growth in world demand for alumina and those that restrict growth in world production and supply point to the POSITIVE (good for Guyana). On the other hand, those influences likely to restrict the growth in demand for alumina and those that favor growth in production and supply from other countries point to the NEGATIVE (not good for Guyana).

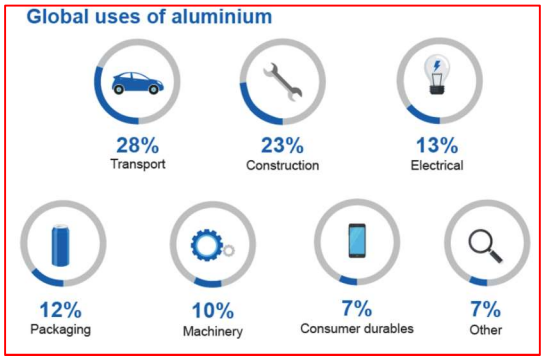
(i) World demand for alumina. Amid short-term geopolitical uncertainties and price volatility, demand for alumina is projected to grow throughout the 2020s. One estimate holds that global alumina capacity should reach 180Mt by 2024[1] from 130Mt in 2017.

[1] Metallica Minerals (2016) – Bauxite primer.

Factors favoring growth in alumina demand include:

94%
Share of alumina used to make aluminum.

- The projected growth in demand for aluminum (as the single largest end use of alumina). About 94% of alumina is smelted to produce aluminum. The remaining 6% is converted into non-metallurgical products such as abrasives and refractories. The fate of the world's alumina industries therefore is dictated by aluminum demand and supply. Aluminum is the second most used metal in the world after steel. The prosperity of aluminum manufacturing depends on the demand for the metal by several end users. As shown below, the largest of these are the transport (vehicle manufacture), construction, and the electrical sectors.



Source: Resources and Energy Quarterly December 2018. Aust gov.

Driving these end uses are factors such as increasing urbanization and industrialization foremost in China but also in emerging economies; and the increasing use (in relative and absolute terms) of aluminum in vehicle manufacturing. For example: plug-in hybrid and full battery electric vehicles use 25-27% more aluminum than the typical internal combustion engine car today. By 2030, aluminum demand from Electric Vehicles (EVs) will near 10 million tonnes, a ten-fold increase from 2017.[2]

- The projected growth of the Chinese economy, albeit at a slower rate. China is the world's largest consumer and producer of alumina and therefore is the largest market driver from a demand perspective. Meeting China's alumina demand growth will increase alumina costs, especially if insufficient capacity is approved in China. Insufficient capacity could encourage China to build or buy offshore refineries. Higher alumina imports could however reduce required bauxite imports.[3]

[2] Electric vehicles to transform aluminium demand. https://www.crugroup.com/knowledge-and-insights/insights/2018/electric-vehicles-to-transform-aluminium-demand/

[3] Wood, A. – "Bauxite and alumina fundamentals". Presentation at 33rd International Aluminum Conference, 12-14 September 2018. https://www.aluminalimited.com/database-files/view-file/?id=14275

 Factors likely to restrict growth in alumina demand include:

- While China's demand for aluminum is projected to grow, it is likely to ensue at a slower rate, as its construction and transportation industries mature and begin to plateau.
- Increased market uncertainty and reduced investor confidence following the several alumina supply shocks in 2018, triggered mainly by the US government imposition of trade sanctions and tariffs.
- The growing market share of aluminum recycling.
- macro risks, such as slowing economic growth; though commodity demand has outpaced GDP growth on average since 2000.

85%
Share of bauxite used to make alumina.

(ii) World production and supply of alumina. World production of alumina in 2017 was 130 million tonnes (Mt), and increase of 13% over 2016. Alumina capacity expanded by some 5.4Mt in 2018, after growing by 6.8 million tonne in 2017. China's output of alumina stood at about 70.3Mt in 2018, nearly triple the 24.4Mt in 2009.

 Factors favoring growth in alumina production and supply include:

- The world's largest single refinery (Alnorte in Brazil) is expected in 2019 to resume full production of 6.5 Mtpa after meeting the government's demand for higher environmental performance.
- The removal of US sanctions in December 2018 against UC Rusal, allowing the company to fully participate in the alumina market.
- Increasing alumina refining capacity. SMM[4] reported in October 2018 that China has 5.43Mt of new alumina capacity under construction. Outside of China, at least four refineries were built in the last five years and at least ten others are likely to be commissioned or recommissioned in the near future in countries such as Indonesia, Guinea and Jamaica.
- UAE and Saudi Arabia have emerged as recent alumina and aluminum producers, capitalizing on their cheap access to energy sources.

[4] SMM = Shanghai Metals Market.

Factors likely to restrict growth in alumina production and supply include:

- Increased market uncertainty and reduced investor confidence following the several alumina supply shocks in 2018, triggered mainly by the US government imposition of trade sanctions and tariffs.
- Continued US sanctions on aluminum.
- Streamlining of alumina production in China. Chinese authorities raised concerns about potential excess capacity across the alumina industry at the end of 2018, citing numerous projects in the pipeline. The National Development and Reform Commission and the Ministry of Industry and Information Technology jointly issued the Notice of Promoting Orderly Development of Alumina Industry on December 28, in a bid to control excessive expansion and lower the risks of overcapacity.[5]
- A new world economic recession.
- China's ability to enter the alumina market as an exporter in the event of supply shortfalls. China is the world's largest producer of both alumina and aluminum. Historically a net importer of alumina, China has flipped to net exporter in 2018 to take advantage of high international price caused by supply shocks in the alumina market. China's ability and willingness to rebalance the global alumina market may make planning new capacity outside China problematic.
- supply shortage of domestic bauxite in China as output has been hit by environmental inspections. To compensate, China's bauxite imports are up. But internal logistics costs for imports remain high, as reported by SMM in October 2018.[6]

Implications for Guyana

Generally, as noted above, in terms of setting up an alumina refinery in Guyana, the influences that favor the growth in world demand for alumina and those likely to restrict growth in worldwide production and supply point to the POSITIVE. On the other hand, those influences likely to restrict the growth in demand for alumina and those that favor growth in production and supply point to the NEGATIVE.

On balance, the world outlook for alumina does not favor Guyana as an investment destination for a refinery. In this assessment, China sits in the centre, both as a producer and importer of alumina. As a producer, and as its own bauxite resources dwindle, China is increasingly investing in alumina capacity outside its borders in countries with massive bauxite reserves and geographic proximity. Countries much

[5] http://www.refwin.com/news/NewsDetail?id=5085&type=2

[6] SMM = Shanghai Metals Market.

closer to China than Guyana is (such as Australia, Guinea, and Indonesia) are well-poised to meet any growth in Chinese demand for alumina.

In addition, building a new plant from scratch (greenfield development) is not the only option companies have to expand alumina refining capacity. Companies can also increase utilization of existing facilities, reopen closed plants, or expand the facilities of existing plants. UC Rusal in 2018, for example, reopened its operations at Guinea's Friguia Alumina Refinery (500,000 – 600,000 tpa), which was shut down in 2012. In Jamaica, China-headquartered JISCO has reopened, modernized and expanded the 48-year-old Alpart alumina facility and plans to expand production from 1.65Mtpa to 5Mtpa.

D2: Guyana's comparative advantages and disadvantages

Even if investors were to explore the options in Guyana for erecting an alumina refinery, the additional question arises: what in this regard are the comparative advantages and disadvantages the country holds? We look at several below.

(i) Feasibility of resuscitating the old Linden alumina plant: Alumina production in Guyana started in 1961 as part of the operations of the Demerara Bauxite Company (DEMBA), a private entity owned by Alcan. Construction of the 300,000 tpa production complex started in 1956 and costed $65 million. The complex included a 15 MW power plant, an export facility of the Demerara river and a railway to bring ore to the plant. At the time, the plant was considered as the largest single construction project ever done in British Guiana, dwarfing all others in cost, in the amount of materials it absorbed and in the quantity and quality of work that have been expended in its erection.

By 1966, around 70% of the alumina plant feed consisted of dried concentrates from the tailings recovery plant, with the balance being made up of laterite and lump bauxite. Annual production in the 1960s ranged between 230,000 and 300,000 tonnes. Production was plagued by work stoppages and quality and processing issues.

In 1971, the Guyana government nationalized DEMBA and renamed it the Guyana Bauxite Company (GUYBAU). Alumina production continued for a further eleven years until the plant was closed in 1982. Foreshadowing the closure of the plant, then Vice-President of Economic Planning and Finance, Desmond Hoyte, stated in his 1982 budget speech:

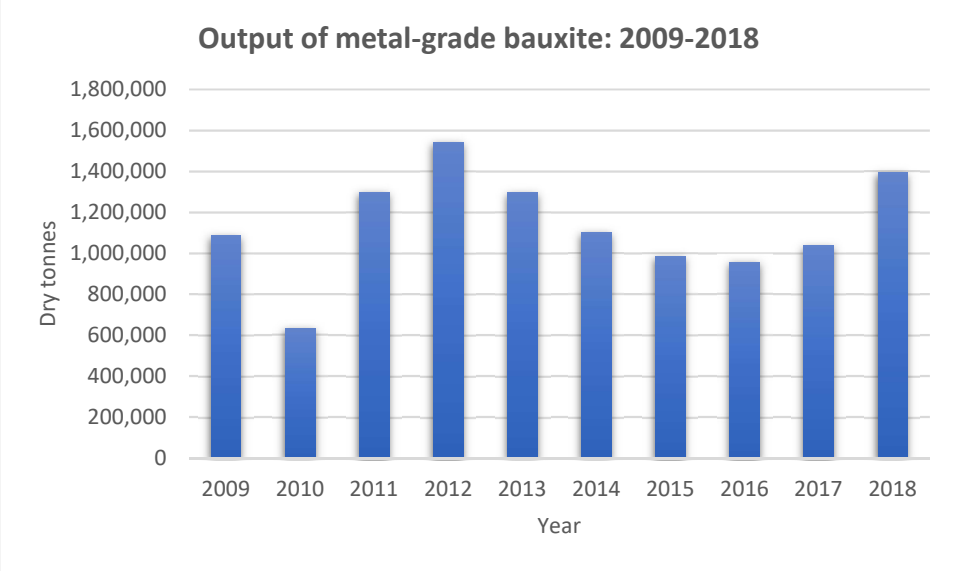
> "Because of the recession in the world market, the demand for aluminum has contracted sharply. The automobile industry, one of the largest users, is in a state of depression…The aluminum industry is said to be now experiencing the worst recession in its history. As a direct result, the demand for alumina shrunk severely…Even when the other problems of the Guymine operations are solved and production levels are restored, the marketing of the product stream will not be as easy as it used to be."

The plant was not mothballed and has lost much of its main components and systems, including the steam power plant and the Demerara Transhipment Station.

In the aftermath of its closure, opinion on possibly restarting production has been unfavorable. One early feasibility study by Norsk Hydro[7] concluded that substantial investment would be required to rehab the plant and a minimum capacity of 600,000 tpa (twice the existing capacity) would be needed for economic viability.

Accordingly, any new production of alumina in Guyana will have to be a greenfield development (starting from scratch).

(ii) Current production of MAZ in Guyana: Metal-grade bauxite is mainly mined from BCGI (Rusal) operations in Berbice. Guyana's output of metal-grade bauxite (MAZ) from 2013 to 2017 averaged 1Mt. In the same time span, MAZ accounted for 72 to 88% of total national production. In the last 20 years, the highest production of MAZ in Guyana occurred in 2000 at 2,443,404 tonnes.



Two favorable factors are noted.

- BCGI (Rusal) reports a 61% capacity utilization in its mining operations in Berbice.[8] To provide adequate feedstock for a IMt capacity alumina refinery will require annual mine output somewhere between the 2-3 Mt mark. The existence of spare capacity in the company's operations can allow it to ramp

[7] Norsk Hydro is a Norwegian aluminum and renewable energy company, headquartered in Oslo. It is one of the largest aluminum companies worldwide. It has operations in some 50 countries around the world and is active on all continents.

[8] UC RUSAL Annual report, 2017.

up production to over 2 million tonnes without massive capital expenditure, should it consider setting up a refinery.

- Guyana's metal-grade bauxite has a high alumina content and is currently used as feedstock for UC RUSAL's refineries in Ireland and Ukraine. It is still regarded as a sweetener for lower-grade ores from Guinea and other countries.

Unfavorable factors include:

- The other bauxite producers in Guyana presently focus on refractory-grade bauxite both as a result of resource limitations and corporate strategy. They therefore may not be seen as guaranteed sources of additional MAZ supplies for a refinery owned by another company.
- The low iron content of MAZ bauxite in Guyana will require investments in sourcing high-Fe bauxite or other ore.
- Rusal reports that its metal-grade reserves carry a high reactive silica content of 7%, adding that each additional % increases alumina refining cost by US$8 per Mt. Generally, the preferred silica content should be in the 4-5% range.
- RUSAL estimates its Berbice bauxite deposits to contain a total 84.7 million tonnes, of which measured reserves amount to 1.3%, indicated resources 46.5%, and inferred resources 52.2%.[9] With these numbers, for the Berbice deposits to serve as feedstock for a local alumina refinery would require significant financial investments in the expansion of ore volume and upgrade of resources to measured reserves.

(iii) Quantity and quality of available local bauxite reserves: the question arises: what are the metal-grade bauxite resources available outside of those already licenced?

To achieve economies of scale, alumina plants are sized for large output. They therefore require extensive bauxite reserves of good quality and high mining rates to sustain multi-decade production.

Depending on grade, it takes 2.0 to 3.5 tonnes of bauxite to produce one tonne of alumina. An alumina refinery, therefore, aiming to produce 1 million tonnes annually would require a mining operation that can produce 2 to 3 million tonnes of bauxite annually.

[9] RUSAL Annual Report, 2017. All volumes are reported as dry weight (without moisture).

Furthermore, given the high investment cost of establishing a 1M tpa alumina refinery, and the resulting long time needed to recoup investment, the deposit would have to last well over 30 years. This arithmetic leads to a minimum deposit size (or a cluster of several smaller deposits) of over 100 million tonnes of high-quality bauxite. For a sense of scale, Rio Tinto, one of the world's largest metals and mining corporations, commissioned in March 2019 a new bauxite mine in Queensland, Australia (the Amrun mine) that will last for the next 50 years with a planned capacity of 22.8 million tonnes a year at full production.

Where in Guyana do we have comparable potential?[10] The USGS estimates that Guyana has a bauxite resources totaling 850Mt. Much of this is likely located in the underexplored Pakaraimas and in the southern and northern portions of the coastal bauxite belt. All of this potential will require large investments in development in terms of exploration/evaluation and infrastructure.

Two other important considerations should be noted. One is the presence of massive amounts high-iron deposits in Guyana. As high-iron feedstock increases the efficiency of alumina refining, the local availability of such deposits for blending with MAZ is a bonus. Secondly, that bauxite classified as RASC (based on iron content) could also be used for alumina manufacture.

(iv) Quality of geological database: Closely linked to the issue of the country's natural mineral (bauxite) endowment is the matter of the quality and availability of the information on it. The USGS estimates that Guyana has a bauxite resources totaling 850 million tonnes. Much of the country bauxite deposits, however, have not been adequately explored or assessed (see policy brief #3). As a result, several unfavorable implications arise from this information deficit:

- Potential investments in alumina refining in Guyana will have to include the costs and risks associated with the exploration for and evaluation of bauxite deposits.
- The consequent long lead time from successful exploration through mine development to alumina refinery construction[11]. This process can last over 10 years.
- The inability of the country to engage in effective investment promotion efforts.

[10] Policy Brief # 3 examines this question in more detail.

[11] An alumina refinery takes five years to build.

Bauxite freight costs to CHINA per metric tonne

From GUYANA
US$42

From BRAZIL
US$36

From WEST AFRICA
US$25

From AUSTRALIA
US$10

(v) Location of international alumina markets: Guyana is located far from the major consumers of alumina, in particular China and India. Bosai reportedly cited high freight costs as one of the reasons it decided not to build an alumina plant in Guyana.[12] If we use bauxite freight rates as a proxy for alumina freight rates, then the reported numbers are as follows:

- Bauxite freight rates from Guyana to China are US$42 a metric tonne. This compares unfavorably against freight rates to China from Brazil (US$36), West Africa (US$25), and Australia (US$10).[13]
- Chinese producers have a freight cost advantage over Guyanese producers of $10-15/tonne into the USA, $15-20/tonne in Europe. Freight to Japanese and South Korean ports is significantly more difficult in terms of the cost and availability of shipping. Chinese producers have a freight advantage currently of at least $40/tonne into main Japanese ports. This assumes individual holds can be chartered from Guyana.[14]

(vi) Inadequacy of transportation infrastructure. As measured by poorly-developed or nonexistent port facilities, paved interior highways and long-distance railways.

(vii) Energy infrastructure: Production of alumina and aluminum are energy intensive processes using approximately 2.5MWh per tonne of alumina and 15.75 MWh per tonne of aluminum.[15] In 2017, energy represented approximately 23% of the cash cost of production for alumina and 24% for aluminum.[16]

In recent years, the availability and rising cost of energy have been a driver for a shift in the geographical location of alumina/aluminum facilities. Energy rich regions such as the Middle East witnessed an increase in investment in aluminum production facilities.[17] The preferred energy sources are Liquified Natural Gas (LNG) and hydroelectricity.

The current unavailability of a cheap and reliable energy source in Guyana is a deterrent to the development of large energy intensive industries. This puts Guyana at a comparative disadvantage.

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[12] Economist and former MP Lance Carberry, in a letter dated 16 February, 2011, titled "The Bosai alumina refinery feasibility study" wrote: "… since BOSAI promised to build a 500,000 tonne per year Aluminum Smelter, there would be no need to ship alumina once the smelter becomes a reality." One can contend, however, that freight cost would still be an issue in shipping aluminum overseas, as there is no local market for the metal.

[13] BCGI Prospectus, 2019.

[14] FBX (2011). NI 43-101 Technical Report Bankable Feasibility Study Update of the Bonasika Project, Guyana.

[15] Sustainability Update 2017. https://www.aluminalimited.com/energy/

[16] Ibid

[17] Ibid

	GUYANA'S POSITION	
Energy sources	**Favorable**	**Unfavorable**
Existing hydroelectric facilities		
Hydroelectric potential		
Natural gas facilities		
Natural gas potential		
Other energy sources (geothermal, coal, nuclear)		
Potential of other energy sources		

(viii) Environment and land use considerations: Disposal of the residue from alumina manufacturing significantly implicates the need for environmental management and land use planning. The production of alumina in Bayer refineries requires substantial land mass for lagoon storage of processing waste and residue. The large Red Mud pond in Linden is testimony to this. One estimate concludes that for each tonne of alumina produced, 0.9-1.5 tonnes of solid residue is generated, depending on the initial bauxite-ore grade and the alumina's extraction efficiency. One other source puts the waste produced for each tonne of alumina as high as 2.0 to 2.5 tonnes.

The country has well-developed land use and environmental management frameworks that can help to foster investor confidence.

Implications for Guyana and policy approach

On this scorecard, the comparative disadvantages outweigh the advantages both in terms of their numbers and relative potential financial costs. The government will have to implement policies to create or reinforce comparative advantages that can hopefully outweigh the disadvantages over which it has no control, such as Guyana's geographic location. This will require a total investment-climate approach that focuses not only on fiscal incentives, but also on the development of transportation infrastructure (roads, rails and ports), cheap and reliable local sources of energy, country-wide bauxite exploration and evaluation, and investment promotion.

E. CONCLUSION

There is no stated and evident interest shown by the three foreign-owned bauxite companies in Guyana in setting up an alumina refinery here. Bosai Minerals Group Inc. is reported to be planning or building alumina plants elsewhere. UC Rusal has signaled its own disinterest in using Guyana's MAZ as the main feedstock for an alumina plant here because of its high silica content.

An alumina refinery is unlikely to be established in Guyana in the foreseeable future.

There is also no projected shortfall in existing and planned alumina refining capacity worldwide.

Given also the superior comparative advantages of several other countries, an alumina refinery is unlikely to be established in Guyana in the foreseeable future.

F. A RELOOK AT THE ALUMINA REFINERY QUESTION

The call for establishing an alumina refinery in Linden is, one suspects, based on the fact that alumina was once produced there and the bauxite resources are available in the vicinity. But if discussed within a national and regional development strategy, alumina refining does not bring any special advantages over other possible economic activities. While employment of several hundred persons and other economic benefits could be expected, alumina refining does bring several serious downsides. It has a huge environmental and health hazard footprint, especially as regards tailings disposal and its use of caustic soda. Its large power requirements can amount to an opportunity cost, especially if it sources electricity from a hydropower-driven national grid with little excess capacity. Such power could be directed to other development initiatives. Moreover, the massive investment costs to set up a refinery will require very generous government fiscal incentives (including tax holidays), which will mean little or no government revenues for an extended period.

A refinery, even if established, will not be the economic salvation for Linden and the wider region. Economic development there could probably be more effectively realized through the encouragement of a range of small to medium-sized businesses detached from bauxite mining. In addition, the opportunities exist now for the bauxite communities to benefit more from corporate social responsibility efforts of the current mining companies, and from direct revenue sharing of bauxite tax and royalty proceeds between the regional and central governments.