

Filling the Missing Middle: Ghana's Alumina Refining Prospects

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Cover image: Bauxite mining in Ghana - photo by Ghana Chamber of Mines / Ghana Bauxite Company Limited

Key messages

- Ghana rightly sees significant potential benefits in finally realizing its long-standing integrated aluminum industry ambition. Alumina refining could fill the critical "missing middle" between Ghana's existing bauxite mining and aluminum smelting, which could have significant positive economic and industrial impacts for the country.
- Rising global demand for aluminum—as well as geopolitical efforts to diversify supply chains and growing overseas investment by Chinese, Western and Gulf actors—may create new opportunities for Ghana to attract refinery investment.
- However, Natural Resource Governance Institute (NRGI) modeling suggests that a Ghanaian alumina refinery can only be commercially viable with substantial government intervention, primarily due to high bauxite feedstock, energy, caustic soda and financing costs, alongside the need for new gas, power and rail infrastructure.
- The government has several potential policy levers to improve viability, including facilitating an integrated mine-refinery project, targeted support to reduce capital and/or operating costs, carefully designed tax incentives and proactive regional cooperation. Unlocking domestic and regional capital as well as concessional finance could also materially improve viability and reduce the fiscal cost of policy support.
- These interventions differ in their effectiveness and costs. Without concessional financing, NRGI estimates that even the most promising policy support could cost the government approximately USD71–74 million annually over the 20-plus year project life, excluding infrastructure costs. Securing blended finance could reduce this annual amount by around $22 million.
- Decisions on whether and how to pursue policy support for a refinery should therefore be grounded in rigorous, transparent cost-benefit analysis that fully weighs trade-offs between approaches and alternative development priorities. This should be considered alongside environmental and social risks.

Summary

Ghana has long sought to use its bauxite resources to build an integrated aluminum industry (IAI). This ambition is understandable given rising demand across the aluminum value chain and the potential benefits for industrial development.

Aluminum demand is expected to grow strongly over the coming decades, driven by electrification, renewable energy deployment and a shift toward lighter materials in transport and manufacturing. With the country's existing bauxite mine, large undeveloped bauxite resources and the Volta Aluminium Company Limited (VALCO) smelter, alumina refining represents the "missing middle" between mining and smelting. A refinery could, in principle, generate government revenues, jobs and foreign exchange, while supporting VALCO and any future smelter in producing more affordable aluminum inputs for domestic industries. Its energy and transport needs could also anchor new infrastructure with spillover benefits for other sectors and households.

Recent proposals across mining, refining and smelting point to renewed investor interest in different parts of Ghana's bauxite value chain. However, most remain at an early stage, and considerable uncertainty remains over which projects will advance and under what conditions. The government is now revising its IAI Master Plan in response to evolving investor interest and global market shifts.

Several of these shifts may create new opportunities for Ghana. China dominates alumina and aluminum production, but domestic policy constraints are reshaping investment patterns. Chinese companies are investing in alumina refining and smelting overseas, including in Guinea and Indonesia. Western governments and companies are also seeking to diversify supply chains away from China and Russia.

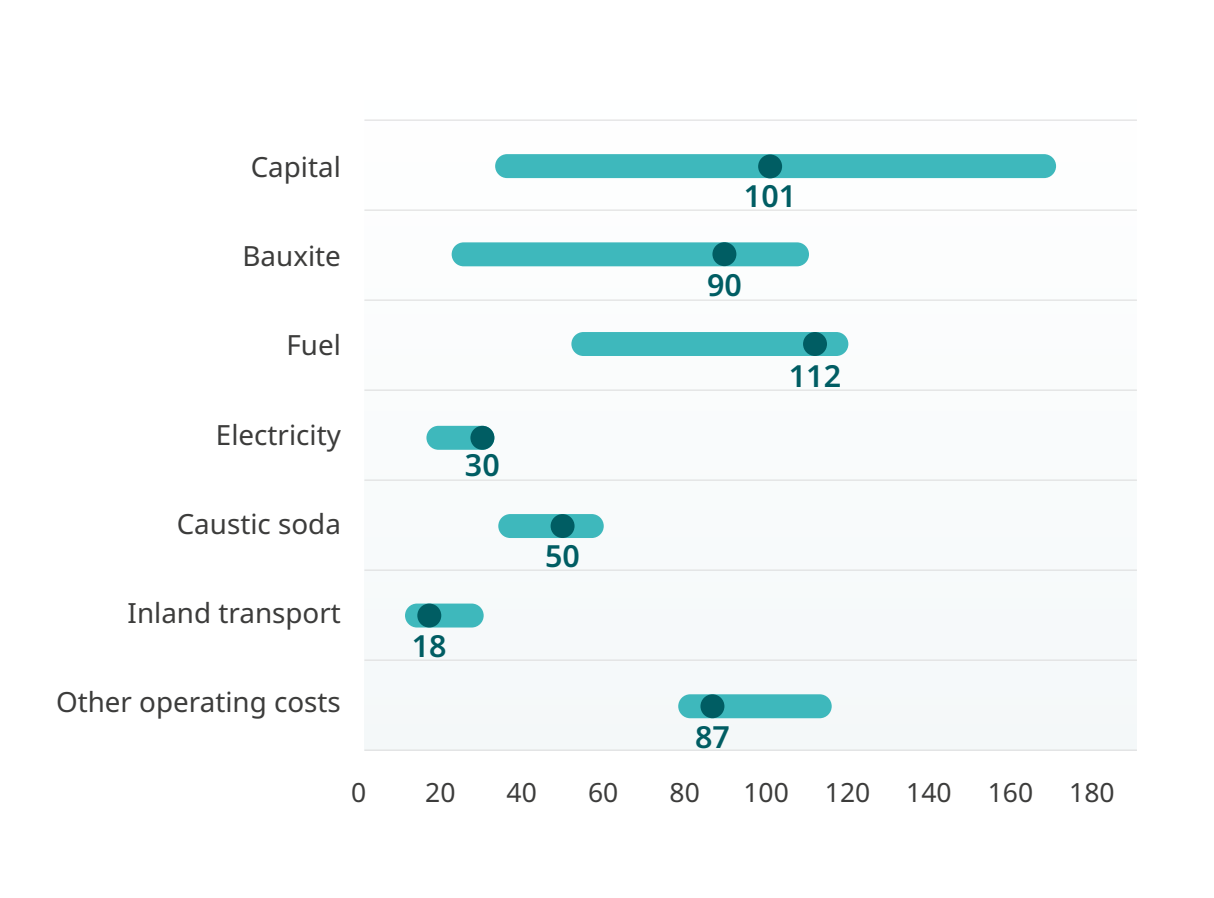
Gulf investors may also seek secure, long-term alumina supply for expanding smelting capacity, though the implications of recent tensions in the Middle East remain uncertain. Together, these shifts could increase interest from strategic investors in refining projects in countries such as Ghana.

However, opportunity does not mean viability: energy, chemical inputs, infrastructure, financing and market access often matter more than proximity to bauxite.

Our modeling suggests that an alumina refinery can only be commercially viable under current market conditions with substantial government intervention. The refinery would require major new gas, power and rail infrastructure. It may also require a volume of gas for heat generation roughly equivalent to Ghana's current non-power industrial gas consumption—a significant challenge given the country already faces a gas supply deficit.

Even assuming supportive infrastructure and sufficient gas supply are in place, the refinery generates significant losses in NRGI's base case. Its costs are high relative to expected alumina prices, primarily due to high energy, caustic soda and financing costs. A more optimistic alumina price outlook alone is unlikely to change this: lower costs would also be required.

Estimated costs of alumina refineries globally and assumed costs of a Ghanaian refinery
(2026 USD per metric ton of alumina produced)[1]

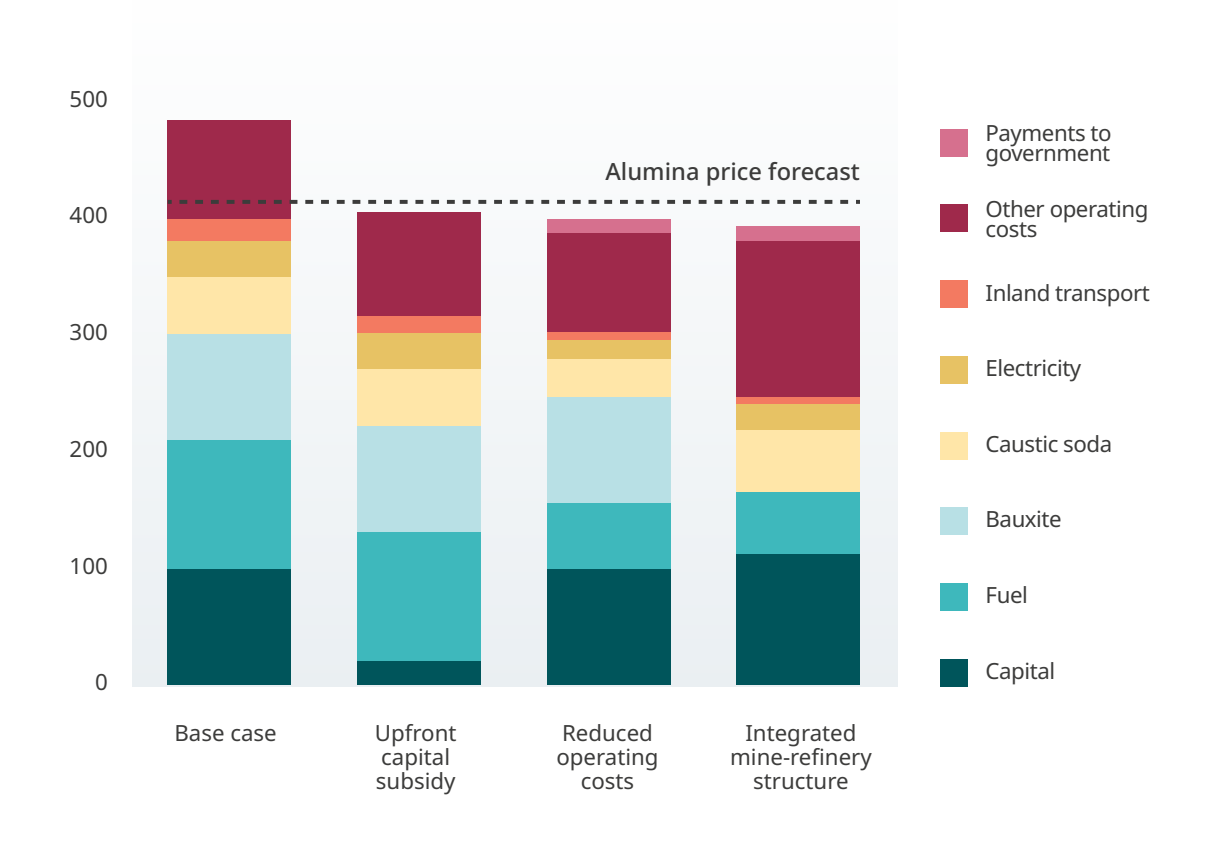


Note: Capital cost excludes investment in rail or port infrastructure, major power plants or upstream mines, but includes interest payments to lenders and required return to equity.

The government can deploy several tools to improve viability, including capital support, operating cost reductions, below-market bauxite pricing, integrated mine-refinery structures, tax incentives, alumina offtake support, export restrictions and regional cooperation. However, these interventions differ in their effectiveness and involve costs and trade-offs.

In practice, the government would likely need to combine several measures to achieve viability at the lowest possible cost, as few are sufficient on their own. We compared three illustrative packages that could enable the modeled refinery to break even: an upfront capital subsidy, reduced operating costs and an integrated mine-refinery structure.

Estimated unit costs of a Ghanaian refinery in base case vs. with illustrative policy packages
(2026 USD per metric ton of alumina produced)



Note: Capital cost includes interest payments to lenders and required return to equity.



Locomotive hauling mineral cargo in railway trucks - photo by Peter Titmuss via Shutterstock

Achieving viability at the lowest possible cost depends not only on the scale of support but also on how that support is structured.

Illustrative policy packages to achieve refinery break-even

Policy package	Description of government support	Cost to government (2026 USD)	Advantages	Disadvantages
Integrated mine-refinery structure	Mine and refinery are fully integrated into one taxable entity, combined with targeted gas and electricity price reductions, accelerated depreciation and extended loss carry-forward provisions.	Total: $1,425 million NPV(10): $452 million Annual average during operation: $71 million *(Assumes no tax avoidance in setting the bauxite price for royalty purposes.)*	Lowest-cost modeled package in discounted terms. Requires less operating cost support than a standalone refinery.	Requires government to secure investors willing to both mine and refine. Reduces government revenue from mining operations. Greater tax avoidance risks because bauxite is not sold between unrelated parties.
Reduced operating costs	Government reduces gas, electricity, rail and caustic soda costs, alongside accelerated depreciation and extended loss carry-forward provisions.	Total: $1,480 million NPV(10): $501 million Annual average during operation: $74 million *(Excludes any support needed to stimulate domestic caustic soda production.)*	Does not require a single investor to both mine and refine. Avoids a large upfront subsidy. Avoids additional tax avoidance risks linked to integration.	Creates a long-term fiscal burden. May weaken incentives for private investment in supporting infrastructure if lower tariffs depend on ongoing government support.
Upfront capital subsidy	Government provides an upfront capital subsidy of $712 million, alongside accelerated depreciation and extended loss carry-forward provisions.	Total: $718 million NPV(10): $569 million Annual average during operation: $0 million	Avoids a sustained call on public resources during operations. May make it easier to attract private investment in supporting infrastructure. Could reduce perceived sovereign and regulatory risk, lowering financing costs and the scale of subsidy required.	Most expensive modeled package in discounted terms. Requires a large fiscal commitment over a short period.

Note: An integrated mine-refinery project could take alternative forms that strike a different balance between advancing refinery development and protecting government revenue. The integrated project and reduced operating cost packages could also target different combinations of cost reductions, depending on negotiations with investors and infrastructure providers. For the upfront capital subsidy package, costs are modeled without accounting for any potential reduction in financing costs resulting from the subsidy.

Regional cooperation could help Ghana overcome domestic constraints by improving access to bauxite feedstock, gas, key inputs and regional markets for aluminum products. However, new refining capacity in Guinea or Nigeria could also reduce investor interest in Ghana if strategic investors can achieve diversification objectives elsewhere. Ghana should therefore pursue cooperation proactively, both to strengthen its own prospects and to manage emerging competition.

Financing terms are also vital. The project will only break even under the modeled policy packages if it secures substantial debt financing. Lenders would require a credible sponsor and developer; long-term energy and rail agreements; offtake arrangements; and effective mechanisms to manage sovereign, regulatory and exchange-rate risks. Government efforts to unlock underutilized domestic and regional capital pools could help meet part of the refinery's financing needs and modestly reduce financing costs.

Even so, commercial financing for a first-of-its-kind refinery in Ghana would likely remain expensive. Concessional or blended finance could therefore materially improve viability and reduce the fiscal burden of policy support. For example, with blended finance complementing the integrated project package, the government could save approximately $22 million per year in gas cost support.

Development finance institutions (DFIs), export credit agencies, sovereign investment funds and strategic partners could similarly provide loans, guarantees or support for associated infrastructure. Climate finance may also be available if the refinery incorporates low-emissions design, such as electrification of heat and renewable power. Securing such finance would depend on demonstrating that the project is commercially sound, environmentally responsible, supported by credible partners and able to deliver clear economic and social benefits for Ghana.

The government's approach will therefore be closely linked to the identity of potential commercial and concessional finance providers. As such, it will be important to account for how choices about project design, policy support and financing interact as the IAI Master Plan is revised.

Any government support for a refinery should be grounded in rigorous cost-benefit analysis. The potential benefits must be weighed against substantial opportunity costs. Without concessional finance, the most promising policy packages we modeled could cost the government approximately $71–74 million annually over the project's lifetime, excluding the cost of any supporting infrastructure. Public support could therefore divert resources from other development priorities and strategies for benefiting from Ghana's minerals.

These economic trade-offs must also be assessed alongside environmental and social risks, which may impose additional costs on communities and the government. In addition to producing large volumes of bauxite residue, hazardous wastewater and air emissions, a refinery producing around 1 million metric tons of alumina per year could consume as much water annually as around 100,000 Ghanaians. While our model factors in the project-level cost of environmental and social protection, financial provision alone is insufficient: strong regulations, rigorous impact assessments, meaningful involvement of affected communities, and robust transparency and accountability mechanisms are essential. Even with such safeguards, some impacts are unavoidable and should be incorporated into the cost-benefit analysis.

Ghana's revision of the IAI Master Plan provides an important opportunity to reassess feasibility, sequencing and trade-offs across the value chain. Transparency and citizen engagement will be essential. Proactive communication—including publishing feasibility studies, environmental and social impact assessments (ESIAs), cost-benefit analyses and policy support details—could help build public trust, improve project design and reduce corruption risks. If the government proceeds with substantial policy support for a refinery, it should do so only on the basis of a clear, transparent assessment showing that the refinery can deliver tangible, broadly shared benefits for Ghanaians.

Introduction

Amid rising global demand for aluminum driven by electrification, renewable energy deployment and the shift toward lighter materials in transport and manufacturing, Ghana has stepped up efforts to leverage its bauxite resources for industrial development. The country currently hosts one bauxite mine but, under its IAI Master Plan, the government is targeting the development of additional mines.[2] It is also pursuing the construction of alumina refineries to process part of this output, which could in turn supply the country's existing aluminum smelter operated by the state-owned VALCO as well as a new smelter.

Like many low- and middle-income countries, Ghana has historically seen mining companies extract and export minerals with little domestic processing. A government-commissioned study highlights the potential gains from developing an integrated aluminum value chain, including higher government revenues, foreign exchange, job creation and more affordable aluminum inputs for emerging domestic industries, such as automotive manufacturing. The study estimates the creation of 14,436 direct jobs and 29,321 indirect jobs in the first decade of an integrated aluminum value chain.[3]

However, realizing these benefits depends on whether moving further along the value chain is economically viable. As many countries have experienced, proximity to mineral deposits alone rarely determines where subsequent stages of the value chain are located. Instead, competitiveness depends on a range of factors, including the characteristics of the mineral, the specific stage of processing, market conditions, geopolitical dynamics and the country context.[4] For example, while bauxite is a bulk commodity and some transport savings can be achieved by refining it closer to the mine site, the cost and availability of energy and chemical inputs often play a more decisive role in determining where alumina refineries are built.

Governments can deploy various policy tools to encourage value addition. However, these interventions involve costs and trade-offs that must be carefully assessed. To ensure that value addition contributes effectively to national development goals, governments need to define clear strategic objectives specific to the mineral and stage of the value chain, grounded in rigorous cost-benefit analysis. Public resources are limited, and greater support for one industrialization pathway necessarily implies less support for others. These could include alternative mineral value chains; other ways of benefiting from mining, such as local supplier development or fiscal measures; or investments in other sectors of the economy.[5] Economic trade-offs must also be considered alongside environmental and social risks, which may impose additional costs on communities and undermine sustainable development.

In this report, we assess the economic viability of establishing an alumina refinery in Ghana—the "missing middle" between the country's existing bauxite mining and aluminum smelting—and examine the policy levers that could influence its success. We also consider the implications for a cost-benefit analysis of government intervention. The analysis aims to inform public debate and government decision-making. It draws on publicly available information about Ghana's plans and the global market, as well as discussions with government and industry stakeholders.[6] The economic model and data used in this analysis are published alongside the report on NRGI's website.

Fundamentals of alumina refining

Bauxite can be converted into metallurgical or non-metallurgical alumina.[7] Around 85–90 percent of global production is refined into metallurgical alumina and then smelted into aluminum.[8] Aluminum has high conductivity and is light weight and recyclable, making it a key material across a wide range of industries, including aerospace and automotive manufacturing; electricity transmission; renewable-energy technologies, such as solar photovoltaic (PV) systems; construction; packaging; and household appliances.

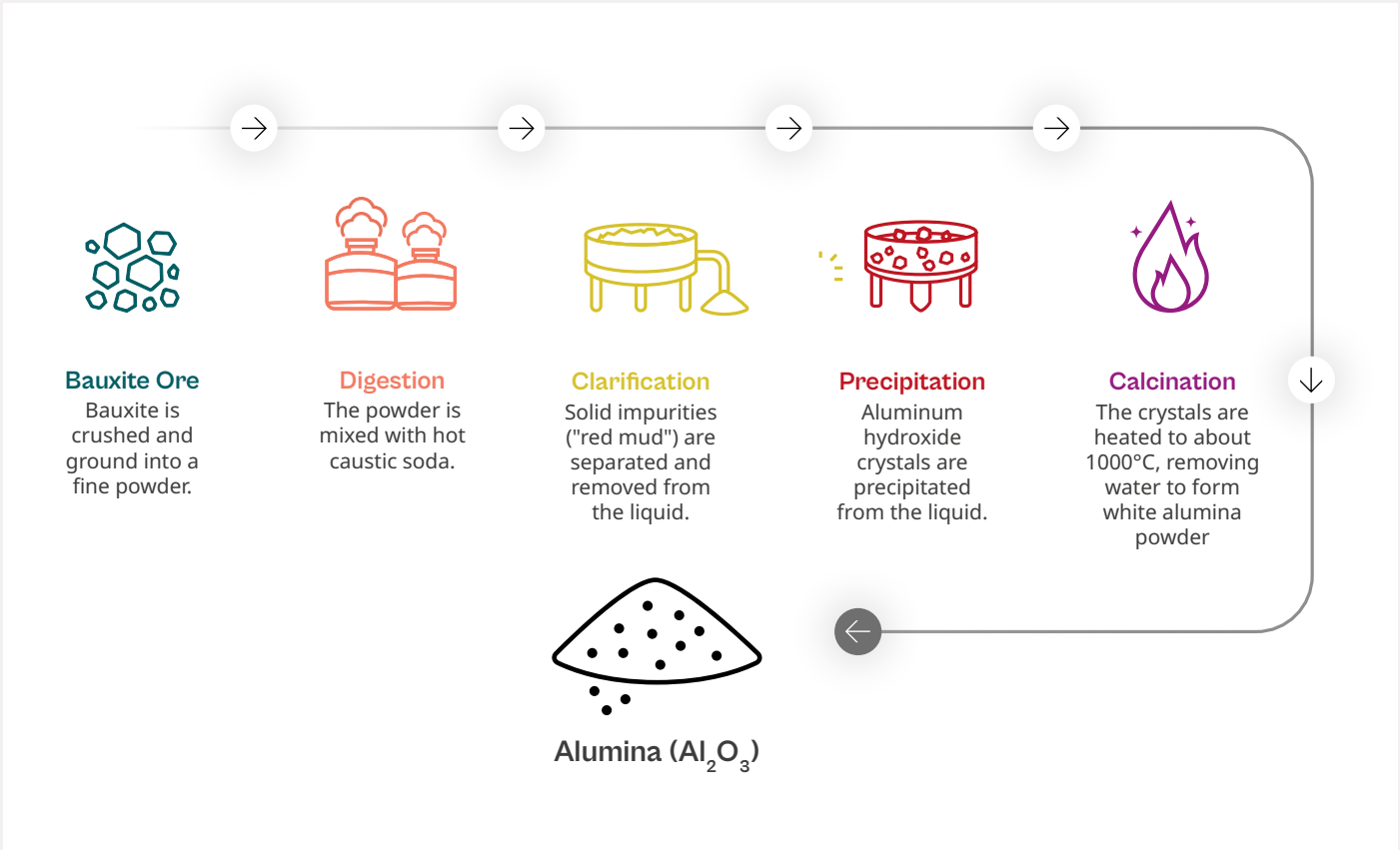
Non-metallurgical alumina is used as an input in products such as cement, refractories, abrasives and chemicals.

However, this segment of the market is relatively opaque, and publicly available data on production and trade is limited.[9]

The Bayer process

Bauxite ore is refined into alumina (aluminum oxide, Al_2O_3) through the Bayer process, summarized in figure 1. Smelter-grade alumina is then supplied to aluminum smelters to produce primary aluminum. Most non-metallurgical alumina is also produced through the Bayer process before being sent for further processing. However, alumina trihydrate (ATH)—a widely used non-metallurgical product—does not require calcination.

Figure 1. The Bayer process for refining alumina



The Bayer process requires significant energy—primarily in the form of heat, in contrast to aluminum smelting which mainly requires electricity—as well as large quantities of caustic soda (sodium hydroxide) and water.

Refineries typically generate heat for the digestion and calcination stages by burning coal or natural gas, sometimes supplemented with biomass. Some refineries are now piloting electrification of these processes, which could enable the use of renewable electricity to reduce emissions.[10] While electrification of calcination has yet to reach commercial scale, Norsk Hydro's Alunorte refinery in Brazil has begun producing steam using wind- and solar-powered electric boilers for the digestion stage.[11] In Saudi Arabia, state-owned Ma'aden is also piloting direct solar-to-steam technology at its alumina refinery.[12] The use of hydrogen as a fuel is another longer-term possibility.[13]

The characteristics of the bauxite itself play an important role in the refining process. Ore with high alumina content and low levels of silica requires lower processing temperatures and less caustic soda, reducing both energy consumption and operating costs.

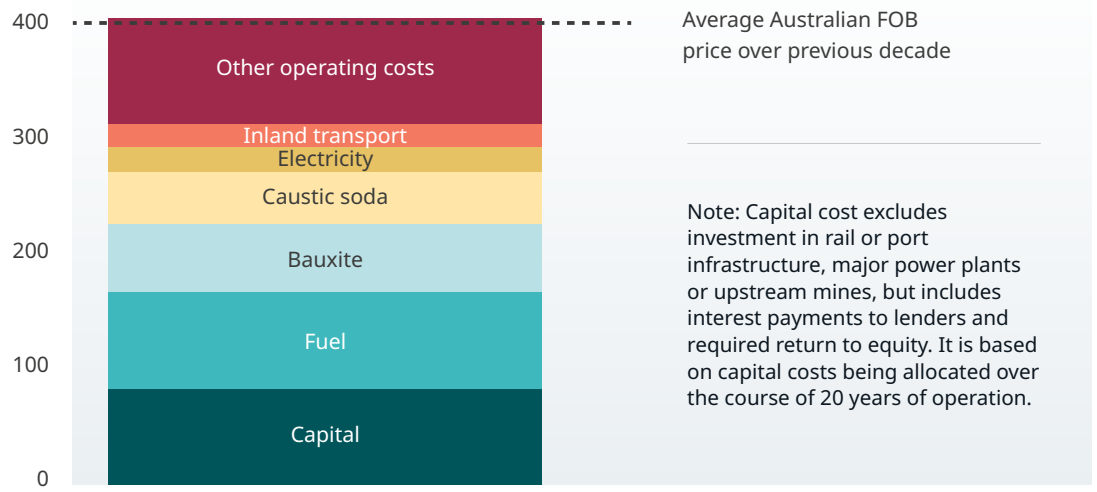
In addition to its energy and chemical requirements, alumina refining creates important environmental challenges. The Bayer process produces large volumes of bauxite residue, known as red mud.[14] This material is highly alkaline and may contain trace metals. Alumina refining can also generate hazardous wastewater and air emissions, including carbon dioxide, nitrogen oxides, sulfur dioxide and fine particulates.

Economics of refining

The economics of an alumina refinery are driven by several interrelated factors. Operating costs are dominated by energy—particularly fuel for heat—alongside the cost of bauxite feedstock, caustic soda and logistics. These costs are shaped by the location of the refinery relative to mines, infrastructure and export markets, as well as the availability and pricing of key inputs. Capital costs are also significant, meaning that financing terms play an important role in determining viability. The main drivers of capital intensity are scale, ore quality, location and environmental standards.

Costs vary widely across refineries, and profitability differs accordingly. Based on our review of alumina refineries globally, figure 2 illustrates the unit cost structure of a mid-cost refinery.[15] (The estimated range for each cost component is set out in the appendix.) A typical mid-cost refinery would have broadly broken even over the previous decade based on the inflation-adjusted average Australian free-on-board (FOB) price of $424 per metric ton, while generating a modest operating margin.[16]

Figure 2. Illustrative unit costs of a mid-cost alumina refinery vs. historical alumina price (2026 USD per metric ton of alumina produced)[17]



Ghana's long road to an integrated aluminum industry

The government estimates that Ghana has approximately 920 million metric tons of bauxite—the third largest national reserve in Africa after Guinea and Cameroon, and, if ultimately converted to proven reserves, about 3 percent of the global total.[18]

Table 1. Government estimates of Ghana's bauxite resources[19]

Deposit	Likely resources (Mt)	Alumina content	Silica content
Awaso	60	52.9%	2.0%
Kyebi	160	44.9%	2.6%
Nyinahin	700	44.5%	2.5%

Note: Mineral resource estimates across the three deposits are ongoing.

Previous attempts at establishing an integrated aluminum industry

Since gaining independence in 1957, Ghanaian governments have viewed leveraging national bauxite reserves to establish an aluminum value chain as a central component of the country's industrialization strategy.

The Ghana Bauxite Company began mining bauxite at Awaso in the 1940s, and Kwame Nkrumah's government negotiated the construction of the VALCO smelter by Kaiser Aluminum in the 1960s. Given the high electricity requirements of aluminum smelting, a key objective was to provide an anchor customer for the Akosombo hydroelectric dam.[20] More than six decades later, the dam remains a backbone of Ghana's electricity system and still accounts for roughly 18 percent of installed capacity.[21]

However, the government was less successful in using the smelter to catalyze the development of an alumina refinery. While the Akosombo dam provided a source of low-cost electricity, Ghana lacked affordable fuel to generate this heat and had limited access to other key inputs at competitive prices, including caustic soda.

Today, Ghana's bauxite deposits are considered good candidates for refining. While further verification is required, government estimates suggest an average alumina content of around 47 percent and relatively low silica levels of about 2.4 percent.[22] However, at the time, prevailing prices and available technology made these deposits less attractive to develop and refine.

Infrastructure constraints further undermined viability. Long distances to the coast—for export or supply to the VALCO smelter near Tema—and limited rail infrastructure increased transport costs. While a railway line was constructed to link the Awaso mine to the coast, projects in the Nyinahin or Kyebi areas would still have required significant additional transport by road or new rail, further raising costs.

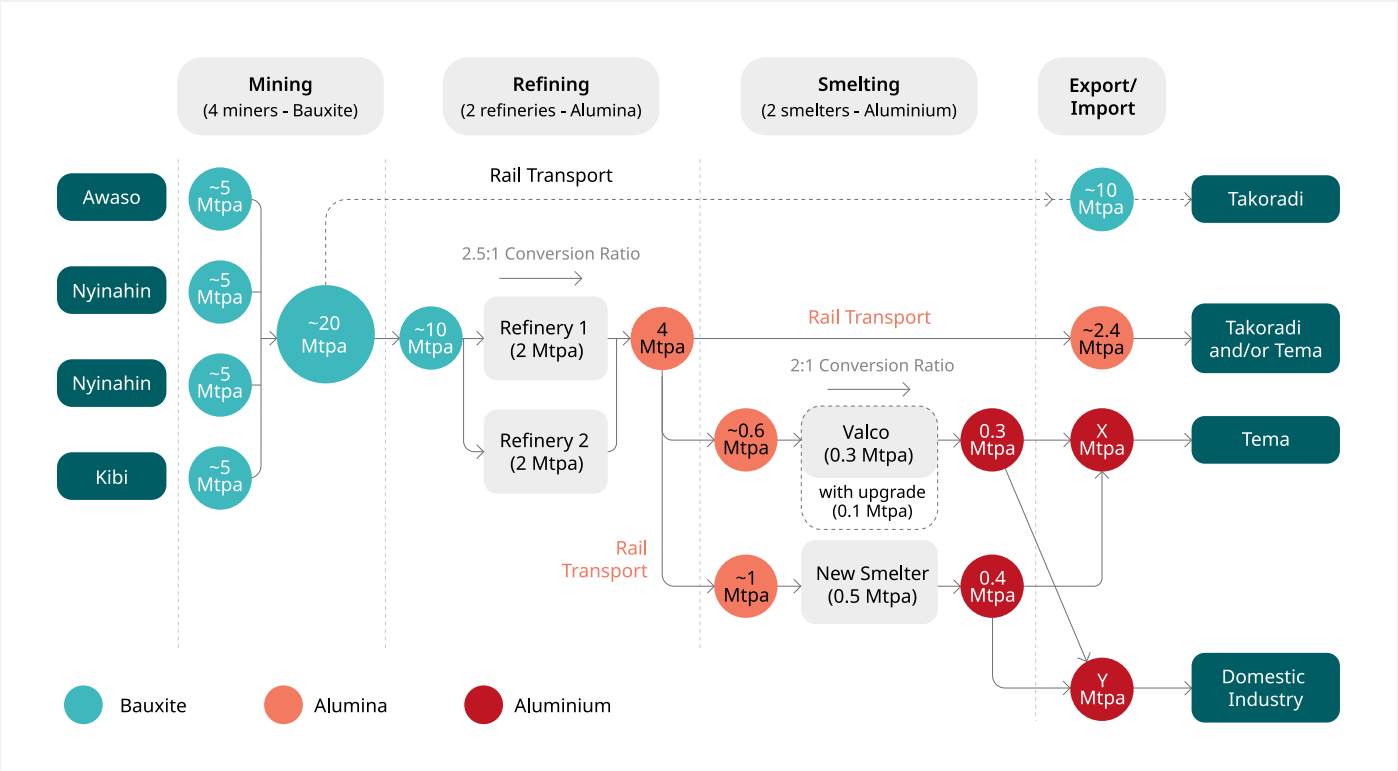
Together, these constraints meant that refining bauxite in Ghana was not commercially attractive. In addition, Kaiser Aluminum already owned refineries elsewhere and, having secured a favorable electricity supply agreement for VALCO, had little incentive to invest in refining capacity in Ghana.[23] As a result, the upstream and midstream segments of the aluminum value chain were not further developed.

Government efforts to expand bauxite mining and establish alumina refining have resurfaced periodically but not fully materialized. Persistent infrastructure constraints—exacerbated by the deterioration of the Awaso railway line—and high input costs have continued to undermine project viability.[24] For example, reported agreements with BHP Billiton in 2002 to develop a bauxite mine and an alumina refinery, and later with Bosai Minerals in 2010 to expand the Awaso mine and build a refinery, were never implemented.[25] Over the same period, the VALCO smelter has faced mounting operational challenges. The expiration of its long-term preferential electricity agreement in the 1990s was followed by Kaiser Aluminum's bankruptcy and the government taking over ownership in 2004. Since then, higher electricity prices, intermittent power supply and limited investment in modernization have left the smelter operating intermittently at around 20 percent of its capacity of 0.2 million metric tons per annum (Mtpa).[26] It has consequently operated at a financial loss and accumulated substantial debt.[27]

The Integrated Aluminum Industry Master Plan

Government interest in developing the aluminum value chain intensified again in 2018. The authorities launched an IAI Master Plan—outlined in figure 3—and established the Ghana Integrated Aluminum Development Corporation (GIADEC) to implement it.[28] The government also agreed a $2 billion resource-backed loan with the Chinese state-owned company Sinohydro to finance developmental infrastructure projects, to be repaid with future bauxite, alumina or aluminum production.[29]

Figure 3. Ghana's Integrated Aluminum Industry Master Plan 2018[30]



The plan envisions a substantial expansion of the sector. While Ghana Bauxite Company has been consistently increasing production since Ofori-Poku Company Limited took over its ownership in 2022, the Awaso mine currently produces less than 2 Mtpa.[31] The government aims to increase production at Awaso and develop new mines that utilize deposits at Nyinahin and Kyebi (with the latter being the focus of the Sinohydro deal).

The IAI Master Plan envisages total bauxite production rising approximately tenfold, to around 20 Mtpa. Roughly half would be exported, while the other half would supply two alumina refineries producing about 4 Mtpa of alumina. More than half of this alumina output would be exported, with the rest supplying a modernized VALCO smelter along with a new smelter, with combined capacity of around 0.7 Mtpa. Aluminum produced by these facilities would supply domestic industries as well as export markets.

Progress toward these ambitions has remained uneven. In 2021, for example, the government signed an agreement with the Ghanaian company Rocksure International to develop a mine at Nyinahin and construct an alumina refinery.[32] The lease was never ratified by parliament and was cancelled in July 2025, after which the government signaled it would prioritize partnerships with large international investors.[33]

Recent aluminum value chain plans

Several new proposals have emerged in recent years, though most remain at an early stage. Table 2 summarizes publicly reported plans.

Table 2. Recent aluminum value chain plans that have been publicly announced[34]

Investor	Related bauxite deposit	Value chain segments	Status
Emirates Global Aluminum[35]	Unspecified	"Bauxite-related projects", including new bauxite mines as well as collaboration on rail and port infrastructure[36]	Memorandum of understanding signed in 2025 to "explore opportunities"[37]
Ghana Bauxite Company[38]	Awaso	Expansion of mine from less than 2 Mtpa to 6 Mtpa, and alumina refinery of 0.5 Mtpa	Production expanding; refinery announced in 2025 but details limited
Madison Alumina[39]	Unspecified	2.6 Mtpa refinery; 1.0 Mtpa smelter; associated chemicals, cement and solar power	Strategic partnership discussions announced in 2025
Metaloid Resources Investment[40]	Nyinahin	New mine of unspecified size	Secured $60 million medium-term facility in 2026, in partnership with GIADEC and Ghana Integrated Bauxite Development Limited Company
Metlen Energy & Metals[41]	Nyinahin-Mpasaaso	New mine of unspecified size and alumina refinery up to 1.5 Mtpa capacity	Prospecting license granted in 2024; designated European Union Global Gateway Strategic Project in 2025
Undisclosed investor[42]	Unspecified	Alumina refinery of unspecified capacity	Strategic investor selected in January 2026
Undisclosed investor[43]	Unspecified	Modernization and expansion of VALCO	Strategic investor selected in January 2026

Taken together, these proposals point to renewed investor interest across different segments of the value chain. However, considerable uncertainty remains over which projects will advance and the conditions under which such progress will occur. Table 3 provides a consolidated view of the current state of Ghana's aluminum value chain, the ambitions set out in the IAI Master Plan and how recent announcements compare.

Table 3. State of play across Ghana's aluminum value chain

Segment	Current situation	2018 IAI Master Plan	Recent announcements
Mining	≈2 Mtpa at Awaso	Expand to ≈20 Mtpa across 3 deposits	Expansion to ≈6 Mtpa at Awaso and proposals for new mines at Nyinahin
Refining	No refinery	4 Mtpa across 2 refineries	Multiple proposed refineries totaling >4 Mtpa (early stage)
Smelting	≈20% utilization of VALCO's 0.2 Mtpa capacity	0.7 Mtpa through VALCO upgrade and new smelter	VALCO modernization and proposed new smelter

The government is currently revising the IAI Master Plan, likely in response to evolving investor interest and changing global conditions. This revision presents an opportunity to reassess the feasibility, sequencing and costs of different components of the value chain.



White alumina hydrate mineral texture - photo by Fathoni Ahmad via Shutterstock

A global context with new opportunities and challenges

Where alumina refineries are built is changing. This section sets out how Ghana's efforts to develop alumina refining and a broader aluminum value chain are taking place within a rapidly evolving global industry.

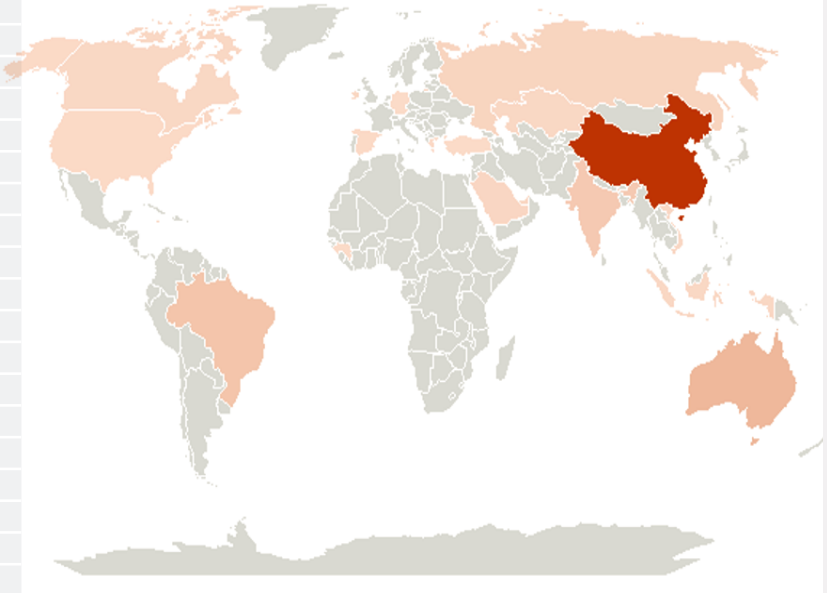
The current state of play

Global bauxite production reached roughly 440 million metric tons in 2025.[44] Australia, China and Guinea account for a large share of this output, with Brazil, India and Indonesia also important producers. While more than two dozen countries mine bauxite, fewer host alumina refining or aluminum smelting. China has emerged as the central hub of the global aluminum industry, supported by large domestic demand, relatively low-cost energy and chemical inputs, and strong government support. However, its dominance is somewhat less pronounced in the downstream of some other mineral value chains, such as lithium or rare earths.[45]

In 2025, China accounted for around 62 percent of the roughly 150 million metric tons of alumina produced globally. Other significant refining centers include Australia, Brazil and India, as well as Russia, Saudi Arabia and the United Arab Emirates (UAE).[46] Most alumina refineries are "captive", operating within integrated supply chains. Aluminum smelters run continuously, are extremely costly to stop and restart, and require a reliable supply of consistent-quality alumina. At the same time, investors and lenders typically prefer projects where refineries have secure buyers, and smelters have secure feedstock. As a result, refineries are often owned by aluminum producers or linked to smelters through long-term supply contracts. Consequently, the majority are located in countries that also host aluminum smelting. China also dominates the aluminum stage of the value chain, accounting for around 61 percent of the roughly 74 million metric tons of primary aluminum produced globally in 2025. Canada, India, Russia and countries in the Middle East (Bahrain, Oman, Qatar, Saudi Arabia and UAE) also produce significant volumes.[47]

Figure 4. Alumina refining production across the world in 2025[48]

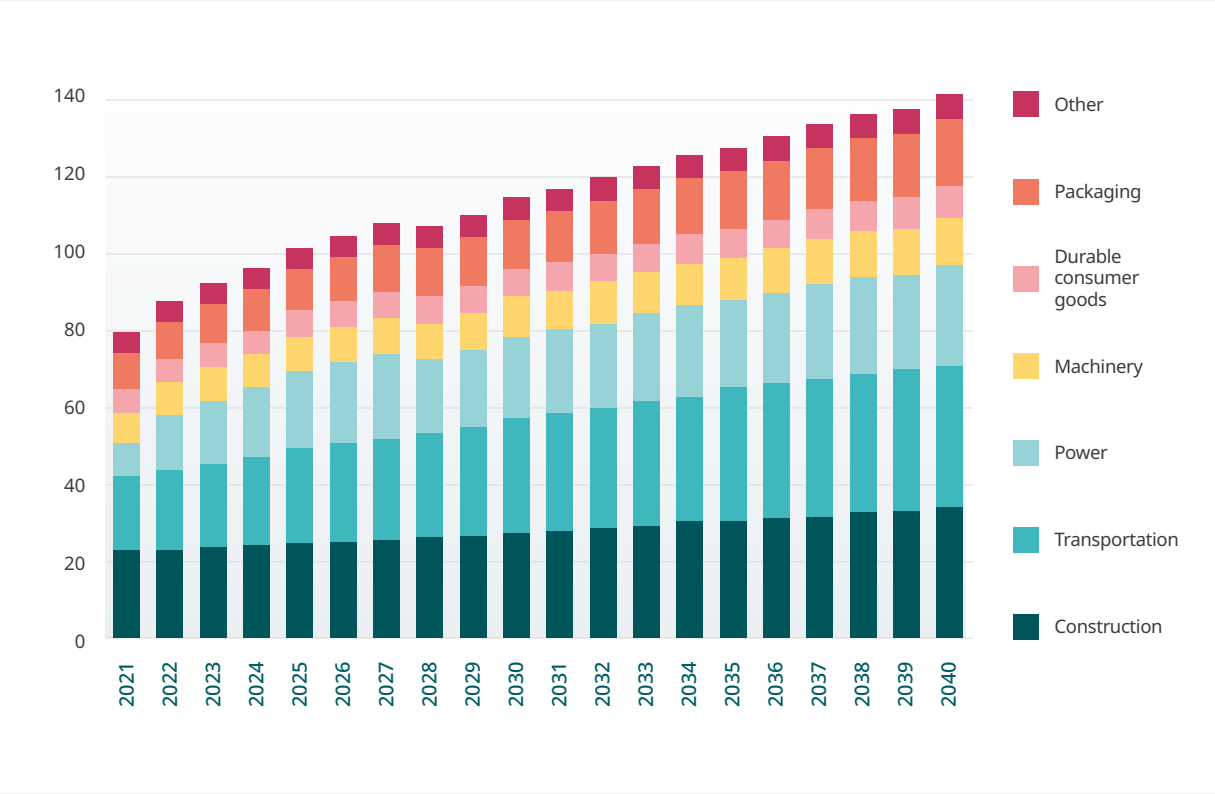
Alumina production (thousand metric tons)	
Australia	17000
Brazil	11000
Canada	1500
China	93000
Germany	460
Greece	850
Guinea	360
India	8200
Indonesia	1500
Republic of Ireland	1700
Jamaica	1500
Kazakhstan	1500
Russia	2900
Saudi Arabia	1900
Spain	810
Turkey	310
United Arab Emirates	2300
United States	710
Vietnam	1500



Increasing demand, but with a larger role for recycled aluminum

Demand for aluminum is expected to grow strongly over the coming decades, driven by electrification, renewable energy deployment and the shift toward lighter materials in transport and manufacturing.[49] While projections vary across analysts and scenarios, BloombergNEF forecasts global aluminum demand to grow by around 58 percent by 2040 in its base-case Economic Transition Scenario.[50]

Figure 5. BloombergNEF projected aluminum demand by sector to 2040 (million metric tons)[51]



Note: This projection is BloombergNEF's base-case Economic Transition Scenario.

Most of this demand is still expected to be met through primary aluminum production, but recycled aluminum will play an increasingly significant role. The pace of recycling will influence how much additional primary aluminum—and therefore alumina—will be required.[52]

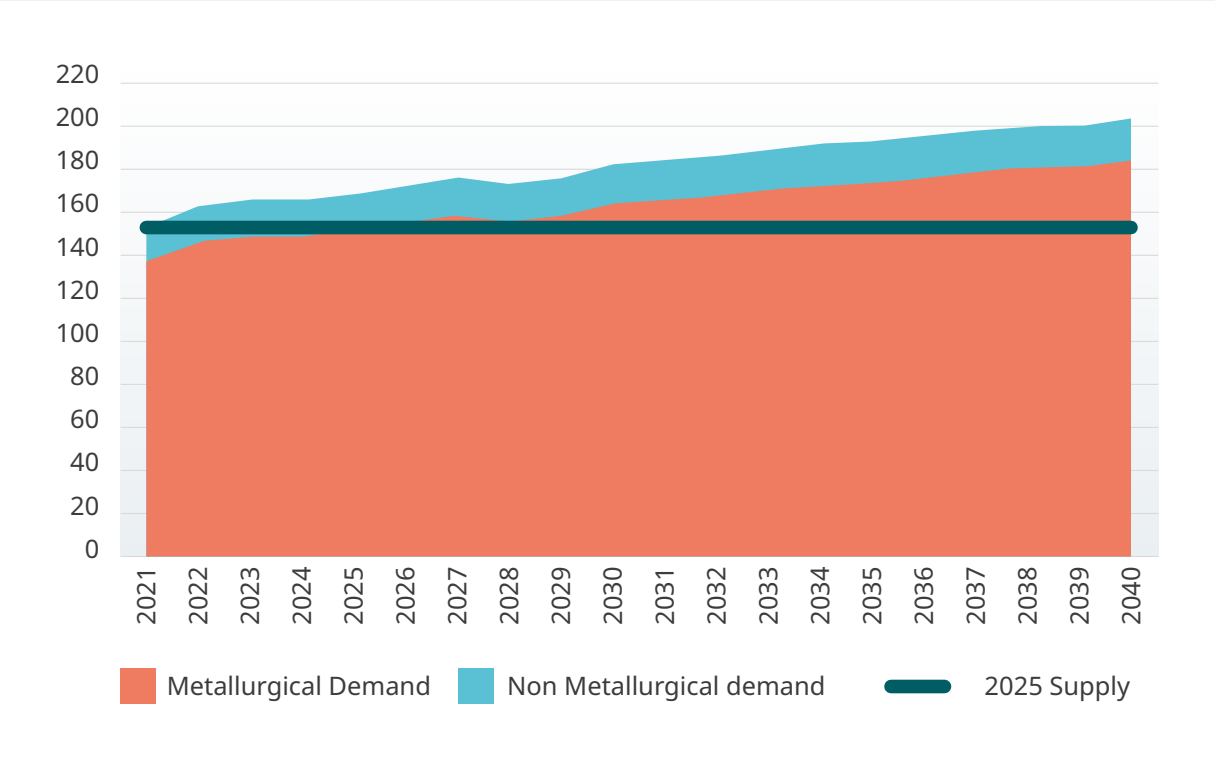
Global metallurgical alumina demand will broadly track primary aluminum production, meaning that increased recycling introduces greater uncertainty into the outlook for alumina demand. Primary production currently meets about 75 percent of aluminum demand, and BloombergNEF expects it to still supply around 64 percent by 2040 in its base case—implying an increase in primary aluminum output of roughly 21 percent, or around 16 million metric tons. The International Aluminium Institute expects primary aluminum to account for only 52 percent of total production by 2040, implying a smaller increase of around 12 percent or 9 million metric tons.[53]

In line with its primary aluminum projections, BloombergNEF expects metallurgical alumina demand to grow significantly over the coming decades, although efficiency gains in smelting may partially offset this growth. It estimates that metallurgical alumina demand could grow by around 21 percent, or 32 million metric tons, by 2040 in its base case.[54] Demand for non-metallurgical alumina is expected to increase broadly in line with wider economic trends. BloombergNEF estimates that non-metallurgical alumina demand could grow by around 2 million metric tons by 2040 in its base case.[55]

Supply sources reshaped by Chinese industrial policy, geopolitics and emission concerns

Growing global demand for alumina could significantly exceed existing supply, as figure 6 shows. However, the extent of new refining capacity required will depend not only on demand, but also on the use of existing capacity. In turn, where new capacity is built will depend on costs, government policy and geopolitics.

Figure 6. BloombergNEF's projected alumina demand to 2040 vs. 2025 supply (million metric tons)[56]



Chinese industrial policy will have a major influence on both the amount of new capacity required and where it is built. Existing refineries in China are currently operating at around 80 percent capacity. They could therefore increase production by roughly 20 million metric tons—equivalent to nearly 60 percent of the additional alumina demand that BloombergNEF expects by 2040—without the construction of new plants.[57] This spare capacity largely reflects constraints on domestic aluminum smelting. Since 2017, the government has capped smelting capacity at 45.5 million metric tons to limit emissions. While new smelters powered by renewable energy are permitted, companies must close an equivalent amount of coal-powered capacity.[58]

Chinese smelter activity may also be affected by the removal of tax rebates on aluminum product exports. [59]

One consequence of these policies could be increased alumina exports from low-cost Chinese refineries to smelters elsewhere, allowing China to capture a significant share of new demand. This, in turn, could reinforce China's longstanding model of investing in bauxite mines abroad while refining the ore domestically, making it more difficult for new refineries in other countries to compete.

At the same time, limited opportunities for domestic expansion are encouraging Chinese companies to invest in alumina refineries and aluminum smelters overseas. Indonesia has emerged as a major destination for this investment. It combines large bauxite reserves with policies that encourage domestic processing, including an export ban on raw ore, relatively low-cost energy, supportive fiscal policies and proximity to China's manufacturing base. Such a combination has already attracted significant investment in the nickel value chain. Although the aluminum sector has developed more slowly, Chinese domestic policy is now accelerating refining investment.[60]

Guinea has also benefited from the shift in Chinese investment overseas. Following years of government efforts to expand domestic processing, and despite continuing infrastructure limitations, Chinese state-owned State Power Investment Corporation (SPIC) is constructing a new alumina refinery, adding to the country's existing refinery built in the 1950s.[61]

The experience of Guinea and Indonesia illustrates the potential opportunities created by Chinese investment abroad. However, it also creates risks for other countries with similar ambitions by increasing competition for global market share. If investment in Indonesia's aluminum value chain follows a pattern similar to the country's nickel sector—where rapid capacity expansion led to prolonged low prices—new Indonesian supply could undermine the viability of refineries elsewhere.[62]

Geopolitical shifts and industrial policy in the United States, Europe and other economies are also increasing opportunities for new producers by encouraging diversification of mineral supply chains away from China and, to a lesser extent, Russia.[63] If Western governments seek alumina supplies that avoid Chinese involvement, this could create opportunities for new refining projects in countries such as Ghana. More broadly, recent tensions in the Middle East have highlighted the vulnerability of supply chain concentration in the region, and underscore the aluminum value chain's exposure to disruption, which may reinforce incentives to diversify supply geographically.[64]

However, access to low-emissions energy is likely to become increasingly important for refinery competitiveness in some markets. The European Union's Carbon Border Adjustment Mechanism (CBAM), which entered full implementation in January 2026, applies a carbon price to imports of emissions-intensive products, including aluminum.[65] The emissions associated with refining the alumina used to produce imported aluminum are not currently covered by the mechanism, but they could be included in the future as the European Commission expands its scope.[66] Similar policies may emerge elsewhere. While fully replacing fossil fuels in alumina refining is unlikely in the near term, refineries that maximize the use of low-emissions energy are likely to become more competitive in international markets as carbon costs rise.

Taken together, these trends create a complex global environment for countries seeking to refine alumina. Strong demand growth and geopolitical diversification may create opportunities, but competition among potential locations is also intensifying. Understanding how Ghana compares within this landscape is therefore critical when assessing the feasibility of establishing an alumina refinery.

The viability of an alumina refinery in Ghana

We modeled a hypothetical metallurgical alumina refinery in Ghana, assuming construction begins in 2027, to assess its economic viability and the policy levers that could influence the outcome.

While Ghana Bauxite Company is planning the development of a relatively small 0.5 Mtpa refinery as part of the expansion of the Awaso mine, this analysis focuses on a larger refinery—closer to the scale of typical greenfield projects—that would draw on Ghana's larger, untapped bauxite deposits, such as those at Nyinahin. These two approaches present different economic conditions and policy trade-offs.

As such a refinery would be unlikely to proceed without the development of additional bauxite supply, we also modeled a hypothetical bauxite mine that has a long-term offtake agreement with the refinery (i.e., a captive arrangement).

However, as mining projects are typically easier to finance and could proceed independently of refining, the mine is modeled in less detail and primarily to inform the refinery's economics rather than to assess the standalone prospects for new mining.

Modeling assumptions

The economic viability of an alumina refinery depends on a set of interrelated technical, commercial and financial assumptions. This section outlines the key parameters used in our model, with additional detail provided in the appendix.

Table 4 summarizes the key assumptions we made for the modeled refinery, while table 5 sets out the assumptions for the hypothetical bauxite mine.



Kumasi, Ghana - photo by Dave Primov via Shutterstock

Table 4. Key assumptions for modeled Ghana alumina refinery (2026 USD)

Project component	Assumption
Type of alumina	Metallurgical
Production capacity	1 Mtpa
Operating lifetime	20 years
Bauxite required to produce 1t of alumina	2.5t
Location	Close to Nyinahin deposits
Integration with bauxite mine	Not integrated
Development cost, excluding supportive infrastructure	$900 million
Operating cost	$387/t
Price of bauxite feedstock	$90/t, equivalent to $36/t of bauxite
Cost of fuel	$112/t
Cost of electricity	$30/t
Cost of caustic soda	$50/t
Cost of inland transport to domestic smelter or port	$17.5/t
Other operating costs	$87/t
Alumina price	$416/t
Corporate income tax (CIT) regime	As legislated for a manufacturing entity
CIT rate	25%
Depreciation of capital	5% per year across 20 years
Loss carry forward	Can be carried forward for 5 years
Ownership	70% private, 30% GIADEC on commercial terms
Financing	40% equity, 60% debt
Cost of capital	9.4% real, 12.7% nominal
Cost of equity	17% nominal
Cost of debt	13% nominal

Table 5. Key assumptions for hypothetical bauxite mine in Ghana (2026 USD)

Project component	Assumption
Production plateau	2.5 Mtpa
Development cost	$100 million
Operating cost	$15/t
Sustaining capex	$2/t
Mine-to-refinery transport cost	$1.5/t
Mine-to-refinery handling loss	0%
Royalty	5% on gross revenue
CIT regime	As legislated for a mining project
CIT rate	35%
Depreciation of capital	20% per year across 5 years
Loss carry forward	Can be carried forward for 5 years

Production of metallurgical alumina. We assumed that the refinery is designed to produce metallurgical alumina, given the government's longstanding focus on establishing an integrated aluminum value chain and the nature of projects proposed by investors. However, exploring the prospects for a facility producing ATH could also be useful. Because this process does not require calcination, both capital and energy costs are likely to be lower, and some ATH products have established regional markets.[67]

Production capacity of 1 Mtpa of alumina. While the IAI Master Plan sets out a plan for refineries of 2 Mtpa, and some of the current proposals involve larger refineries, government discussions indicate that Ghana is now targeting an initial refinery of 1 Mtpa. This capacity appears a reasonable target for a country's first refinery, balancing economies of scale from larger plants with their greater financing requirements and supporting infrastructure. This refinery could be expanded, and other refineries constructed, once proof of concept is confirmed.

Located at Nyinahin. Based on discussions with the government, we assumed that the refinery is located near the Nyinahin deposits. The IAI Master Plan considers locating refineries both near mines and in the coastal areas of Takoradi (close to a port) and Tema, near VALCO for domestic sales as well as a port for exports. Rather than transporting bauxite to a coastal refinery, transporting alumina from a Nyinahin refinery to Tema or Takoradi would reduce transport volumes and therefore costs. However, this would also increase the amount of supporting infrastructure that needs to be constructed.

Supportive infrastructure. A refinery located at Nyinahin would require substantial investment in new rail, gas and power infrastructure. If the refinery transports alumina to Tema, the most direct rail route would likely require construction of a line to Kumasi, connecting to the planned Central Route to Accra and Tema.[68] However, the Kumasi-Accra segment has not yet been contracted. While such infrastructure would also be required to support expanded bauxite mining, its development remains uncertain and would require substantial upfront investment.

We assumed that the refinery uses gas to generate heat for both the digestion and calcination stages, requiring approximately 36 million cubic feet per day (mmcf/d)—roughly equivalent to current non-power industrial gas consumption in Ghana.[69] Ghana already faces a gas supply deficit, with domestic production and imports from Nigeria via the West African Gas Pipeline (WAGP) insufficient to meet demand. Given this deficit is expected to worsen in the coming years, securing sufficient gas supply for the refinery would require deliberate government action.[70] The appendix outlines several possible approaches, including expanding supply and considering partial electrification to reduce refinery gas demand, despite the higher upfront costs this may entail.

Table 6. Ghana's gas supply-demand balance (million cubic feet per day)

	2025 expected[71]	2030 projected[72]
Supply		
Jubilee/TEN	97	168
Offshore Cape Three Points	240	350
WAGP	73	73
Total	**410**	**591**
Demand		
Power	519	818
Non-power	35	52
Total	**554**	**870**
Supply deficit	**144**	**279**

Note: 2025 production from the Jubilee, TEN and Offshore Cape Three Points fields is actual production, but actual supply volumes through WAGP are not yet available. The 2030 projection is based on government estimates in the Electricity Supply Plan 2025, adjusted to reflect projected non-power demand by assuming it maintains the same share of total demand as in 2025. Offshore Cape Three Points production has also been increased to reflect expanded processing capacity since publication of the plan. Planned additional production increases from the Jubilee and TEN fields are excluded due to timeline uncertainties.

Even if sufficient supply can be secured, new pipeline infrastructure would still be required to transport it to the refinery. At present, the Ghana National Gas Company (GNGC) pipeline network extends only as far as Prestea, approximately 130 kilometers south of Nyinahin. The Genser Energy network extends only as far as Kumasi, approximately 70 kilometers east.

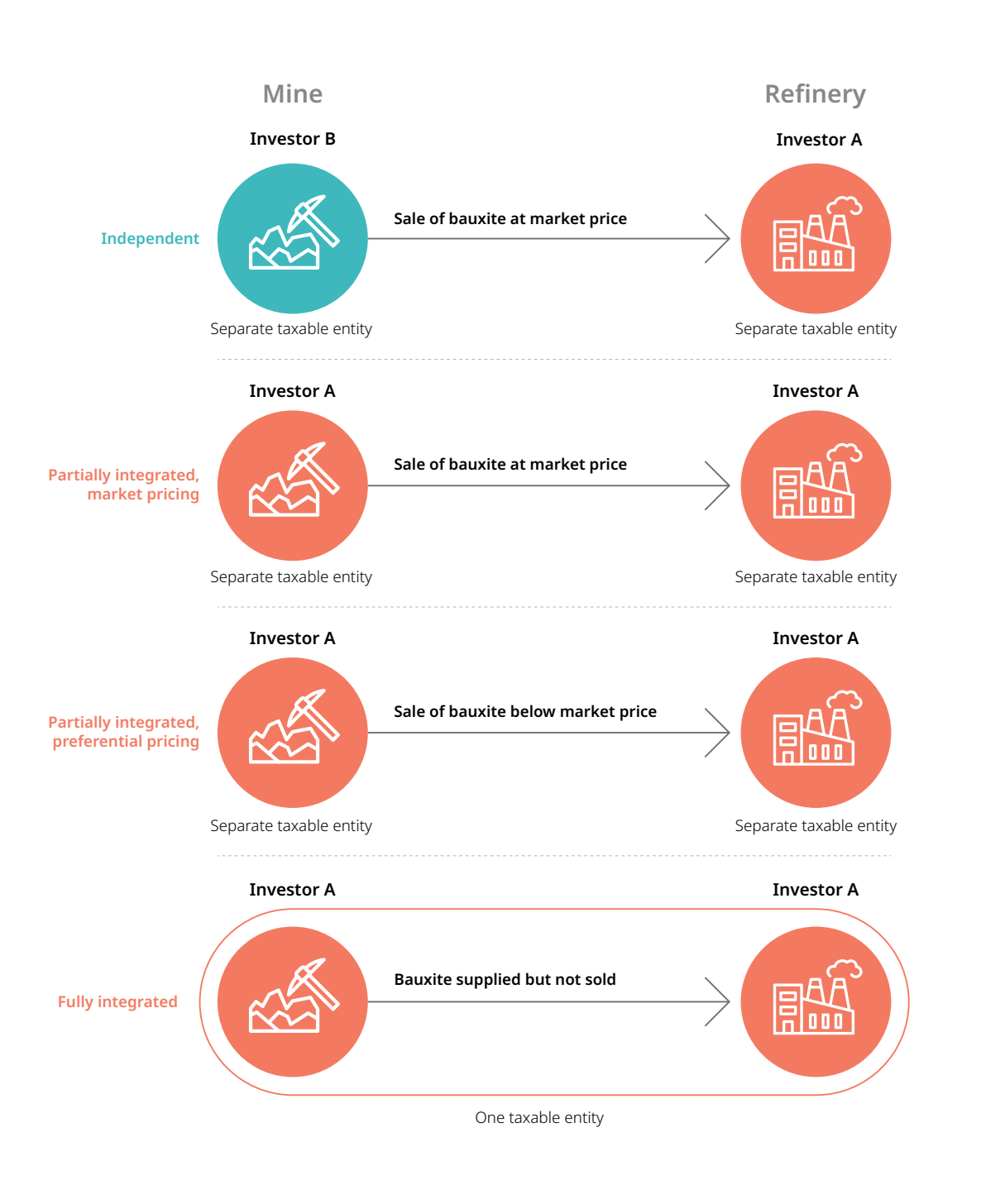
The nearest power generation is located in Kumasi and Chirano. Supplying electricity to the refinery would therefore require at least new transmission infrastructure. However, even if either of these gas-fired plants has sufficient spare capacity, the refinery may increasingly need access to low-emissions electricity to remain competitive in some markets. Power planning should therefore consider the scope for renewable generation, at least over the longer term. It should also account for the potential role of a captive cogeneration facility that can supply both electricity and process heat.[73]

We assumed that this supporting infrastructure is financed separately by the government and other investors, consistent with past practice in Ghana's oil, gas and mining sectors.[74] The government is currently seeking funding for its "Big Push" initiative, which includes major investments in expanding rail, energy and water infrastructure.[75]

As with the VALCO smelter's role in supporting the development of the Akosombo dam, a refinery in Nyinahin could act as an anchor investment for these expansions. For example, government's plans to extend the gas pipeline network require additional demand to become viable, which a refinery could help provide. Nevertheless, the need to mobilize financing for such infrastructure increases project complexity, likely raises overall costs for the government and influences the application of different policy support options.

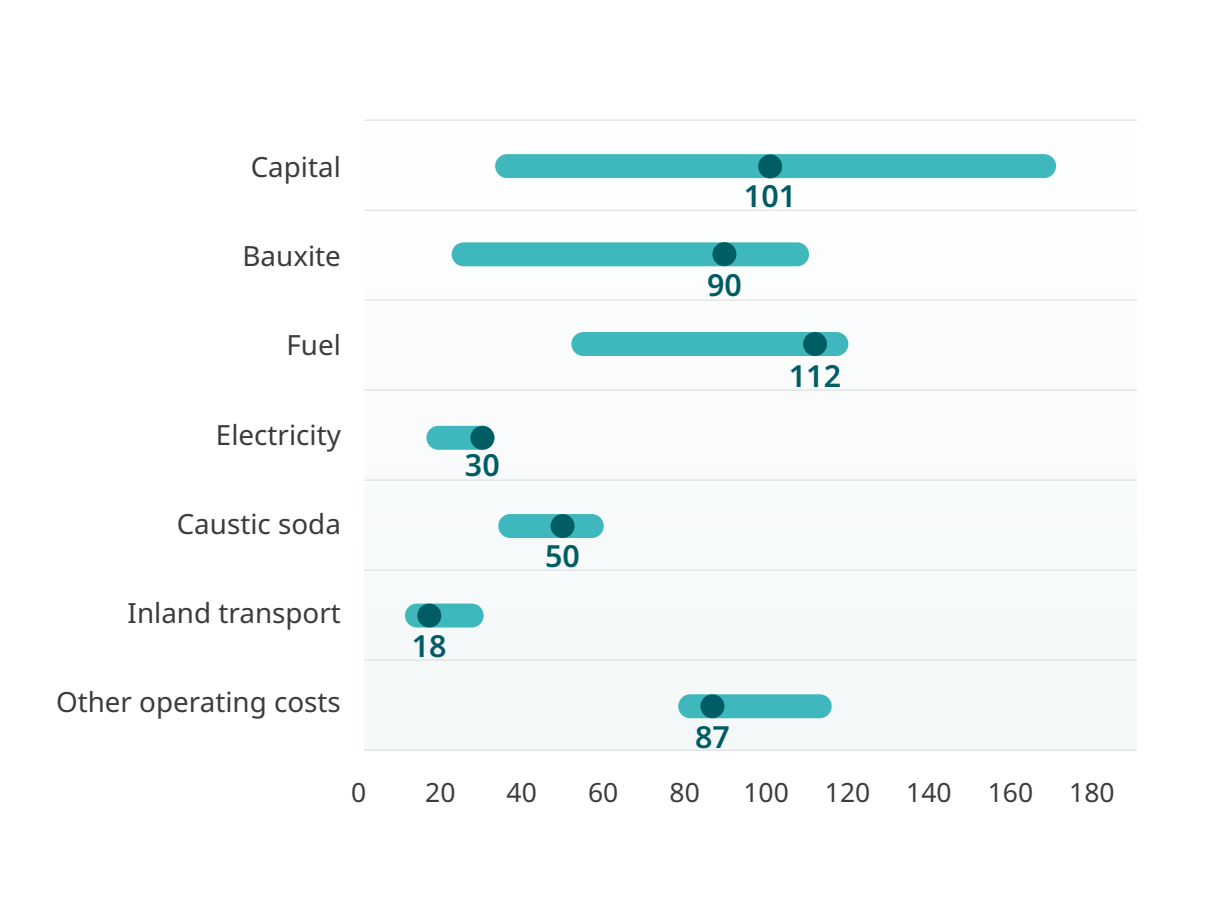
Independent to mining operations. The mine and refinery could broadly have one of four structures, as set out in figure 7. Depending on whether the government can secure an investor willing to both mine and refine, as well as on its policy approach, the mine and refinery could operate independently of each other, be partially integrated with market or preferential pricing, or be fully integrated. Given the government's selection of a strategic investor to build a standalone refinery and the IAI Master Plan's assumption that refineries pay market prices for their bauxite feedstock, we assumed that the mine and refinery are independent. We assumed that the refinery pays $36 per metric ton of bauxite, based on the pricing of Guinean bauxite and consultations with government and industry stakeholders (equivalent to $90 per metric ton of alumina produced).[76] We consider alternative project structures in the next section.

Figure 7. Possible project structures for the bauxite mine and alumina refinery



Relatively high costs. Our assumptions result in a total cost of $488 per metric ton of alumina produced. As figure 8 shows, this places the refinery toward the higher end of the global cost curve in the absence of policy support.

Figure 8. Estimated costs of alumina refineries globally and assumed costs of a Ghanaian refinery (2026 USD per metric ton of alumina produced)[77]



Note: Capital cost excludes investment in rail or port infrastructure, major power plants or upstream mines, but includes interest payments to lenders and required return to equity.

We assumed a development cost of $900 million, at the lower end of the $800 million to $1.2 billion range identified in our review of comparable 1 Mtpa refineries. This estimate reflects discussions with engineering firms and benchmarks from recent projects in Guinea. The weighted average cost of capital, at 9.4 percent in real terms, is around the midpoint of the range observed for refinery projects, based on Ghana's equity risk premium and discussions with African lenders.

Operating costs of around $387 per metric ton are at the higher end of the global range. Energy costs, particularly fuel, are the largest component, reflecting current industrial tariffs in Ghana. Given the absence of domestic caustic soda production, we assumed the refinery imports this input. Rail transport costs are based on new infrastructure and benchmarked against African tariff averages.

Alumina sold at market price. The destination of the refinery's output will depend on whether domestic smelting capacity is expanded. If smelting reaches around 0.8 Mtpa, the refinery could sell all its alumina domestically. In either case, we assumed that alumina is sold at the market price. Our assumed market price is S&P's forecast for the Australian FOB benchmark,

which is similar to the average price over the previous decade.[78] Any requirement to supply domestic smelters at below-market prices would likely reduce investor interest.

Viability threshold. We estimated a nominal weighted average cost of capital of 12.7 percent, equivalent to 9.4 percent in real terms, assuming 3 percent inflation. This implies that the refinery must achieve at least this internal rate of return (IRR) to recover the initial investment and meet the cost of capital. We therefore used this threshold as our benchmark for economic viability.

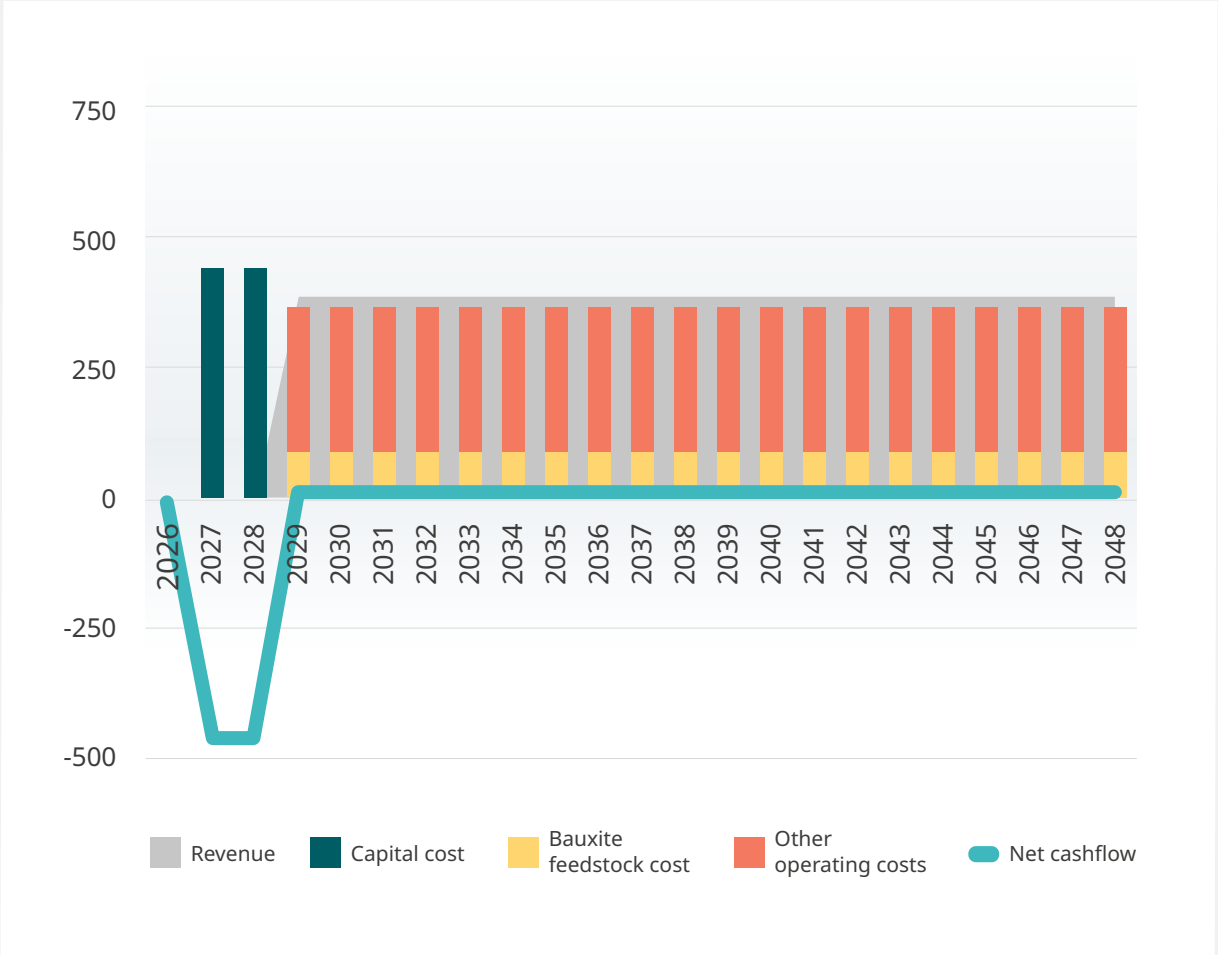
However, meeting the cost of capital may not be sufficient to attract investment. Some investors—particularly those seeking strategic benefits such as diversification away from China, access to Ghana's bauxite or expansion into African markets—may be willing to invest in a project that only meets this threshold. By contrast, investors primarily targeting financial returns are likely to require a higher IRR, potentially in the range of 15 percent or more in nominal terms.[79]

Potential viability of a Ghanaian refinery

Base-case results

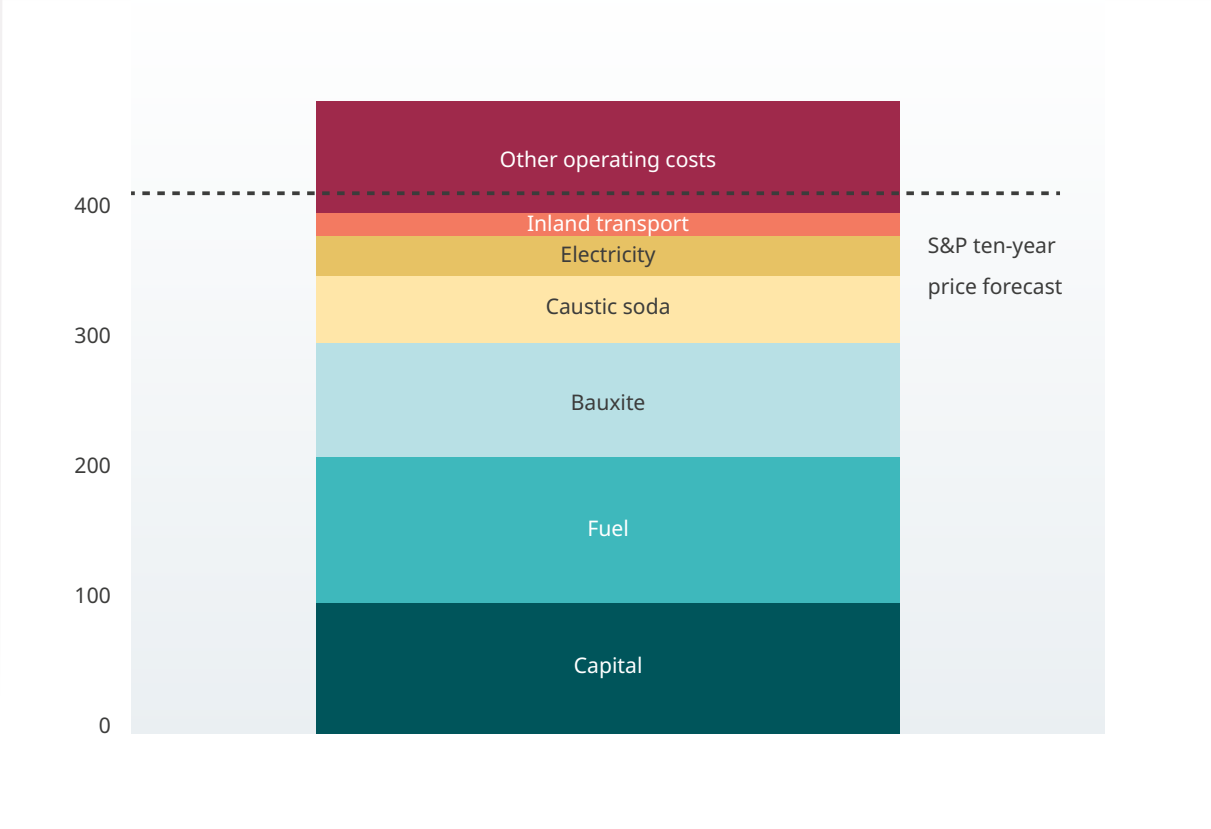
A Ghanaian refinery is not commercially viable in our base-case scenario. The project does not generate sufficient operating profit to recover its initial investment.

Figure 9. Estimated pre-tax project cash flows of a Ghanaian refinery in the base case (2026 USD millions)



As figure 10 shows, the refinery makes a loss on each metric ton of alumina produced. Total production costs are approximately $488 per ton—including financing costs—while the assumed sales price is around $416 per ton.

Figure 10. Estimated unit costs of a Ghanaian refinery vs. alumina price forecast (2026 USD per metric ton of alumina produced)



Note: Capital cost includes interest payments to lenders and required return to equity.

Across its lifetime, the refinery generates a total project loss of $615 million (net present value (NPV), discounted at 9.4 percent). While equity investors bear a smaller loss—reflecting debt financing covering 60 percent of upfront costs—they still lose $486 million (discounted at 13.6 percent).

Pre- and post-tax results are identical, as the project does not generate taxable income at any point over its lifetime. Substantial improvements would therefore be required for the project to become financially viable—particularly given that it may need to exceed the cost of capital to attract investment.

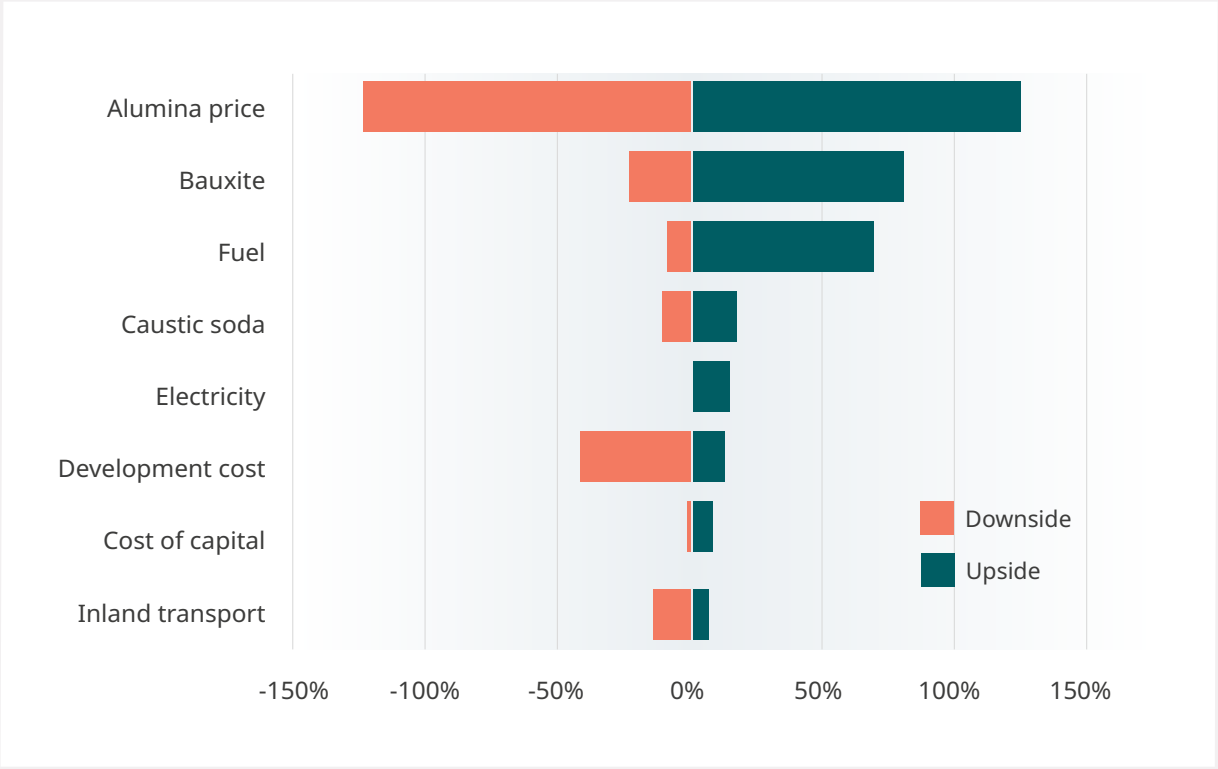
Table 7. Profitability and government revenue from the modeled mine and refinery in the base case (2026 USD)[80]

Project	Metric	Value
Mine	Project pre-tax NPV(9.4)	238 million
	Project pre-tax IRR	37%
	Project post-tax NPV(9.4)	138 million
	Project post-tax IRR	26%
	Government revenue (NPV0)	305 million[81]
	Government revenue (NPV10)	94 million
Refinery	Project pre-tax NPV(9.4)	-615 million
	Project pre-tax IRR	-5%
	Project post-tax NPV(9.4)	-615 million
	Project post-tax IRR	-5%
	Equity pre-tax NPV(13.6)	-486 million
	Equity post-tax NPV(13.6)	-486 million
	Government revenue (NPV0)	0
	Government revenue (NPV10)	0

Sensitivity analysis

Our results are sensitive to changes in several key variables. Figure 11 shows the sensitivity of refinery profitability to variations in alumina prices (± 25 percent) and key cost inputs across the range observed globally.[82]

Figure 11. Sensitivity of Ghanaian refinery pre-tax net cashflow to changes in key variables across estimated global ranges



Note: The alumina price range spans ±25 percent, equivalent to approximately $312 to $520 per metric ton. This range is centered on current prices (around $306 per ton) and extends to $520, which is aligned with the upper quartile of the global cost curve and represents tight market conditions. The bauxite price is held constant in this scenario, although it would likely move in line with alumina prices in practice.

The alumina price has the greatest impact on profitability. If prices average around $500 per metric ton over the life of the project, our modeled project breaks even. However, this is roughly 20 percent higher than both the current forecast for the next decade and the average price over the past decade. It also does not account for the likelihood that bauxite feedstock costs would rise alongside alumina prices. The break-even price would therefore likely be higher in practice. A more optimistic price outlook alone is therefore unlikely to transform the prospects for a Ghanaian refinery. Lower costs are also required. Reductions in bauxite feedstock and fuel costs—bringing them closer to levels observed in low-cost refineries—would have the next largest impact on profitability.

The relatively limited impact of the cost of capital reflects the underlying economics of the refinery. Lower financing costs do not compensate for the combination of high upfront capital expenditure and modest operating margins. Even with cheaper financing, the project generates limited cash flow relative to its scale. As a result, improvements in input costs or capital efficiency would have a greater effect on profitability than changes in financing conditions. However, as discussed later, once such improvements are achieved, lower financing costs would have a more meaningful impact on project returns. The next section incorporates these sensitivities in assessing the policy measures that could improve viability.

Getting to break-even at least cost

In addition to facilitating—and in some cases funding—the necessary supporting infrastructure for value addition projects, governments can deploy a range of fiscal, industrial and trade instruments to promote value addition. These tools can be broadly grouped into incentives, restrictions and penalties, and enabling measures.[83] In this section, we examine the main instruments available to Ghana, assess their potential to improve the viability of an alumina refinery and the supporting infrastructure, and estimate their fiscal cost to the government.

The instruments considered are:

- Direct financial support for capital costs
- Reduced operating costs
- Below-market pricing for bauxite
- Integrated mine-refinery projects
- Tax incentives
- Above-market pricing for alumina
- A bauxite export ban
- Higher taxes on bauxite exports
- Regional cooperation

In practice, the government would likely need to combine these measures in different ways to achieve viability at minimal cost, as few are sufficient on their own.

Incentives

Direct financial support for capital costs

Some governments provide direct financial support to value addition projects through equity stakes, grants, concessional loans or sovereign guarantees.[84] Such support can improve investor returns directly by reducing the capital required from investors, or indirectly by lowering the cost of capital.

GIADEC's potential 30 percent equity stake in the refinery would reduce the upfront capital required from private investors and, by lowering perceived sovereign and regulatory risk, could also reduce financing costs. However, for this participation to directly improve investor returns, GIADEC would need to invest on concessional terms and accept lower returns than private shareholders.

Alternatively, GIADEC could finance and own the refinery outright. In this case, however, the state would assume the project's losses directly and would likely incur additional costs to bring in an experienced refining company to construct and operate the facility. Guinea is partially pursuing this approach. In 2025, it revoked the mining license of Emirates Global Aluminum's subsidiary for failing to construct an alumina refinery. Establishing a state-owned enterprise (Nimba Mining) to take over the license, it launched a tender for the construction of a refinery.[85]

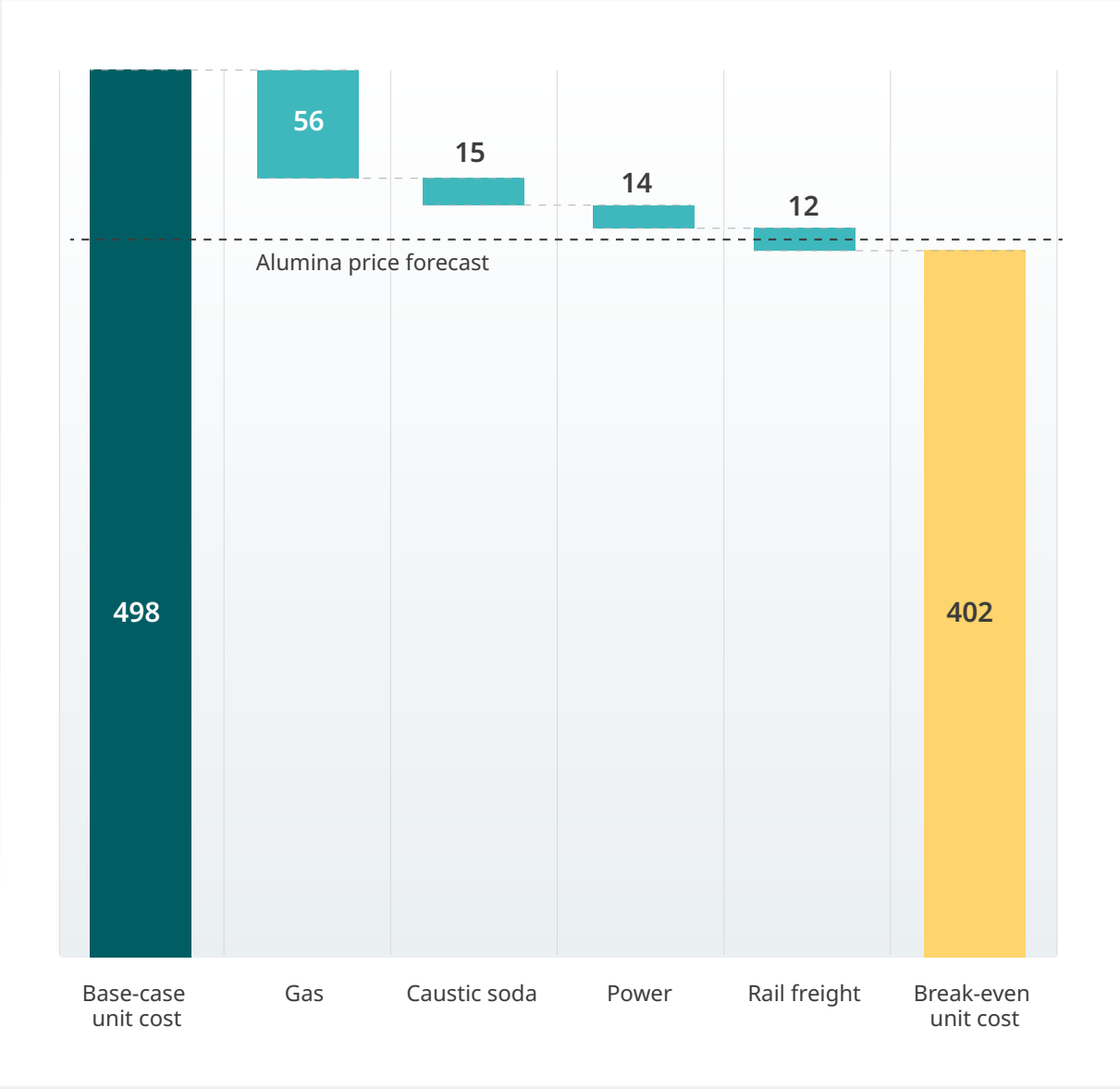
A further option is for the government to provide capital without seeking any return, effectively subsidizing the project's upfront investment costs. Given the scale of losses in the base-case scenario, our modeling suggests that the government would need to contribute approximately $720 million of the $900 million total capital cost for the refinery to break even for private investors.

Reduced operating costs

Another set of policy measures could target the main drivers of the refinery's operating costs: fuel, caustic soda, power and rail transport. (We consider reducing the cost of bauxite feedstock separately.) Figure 12 shows the potential improvement in profitability if the government reduced the cost of gas, power and rail transport costs to levels currently offered to selected industrial users (based on discussions with government and industry stakeholders), and if domestic production reduced the cost of caustic soda.

Reducing fuel costs would generate the largest improvement in refinery profitability. However, no single input cost reduction would be sufficient to make the refinery viable. Achieving break-even would require simultaneous reductions across multiple inputs.

Figure 12. Modeled reduction in key operating costs (2026 USD per metric ton of alumina produced)



These results assume that heat is generated primarily from gas. If the refinery were to electrify part of its heat demand—to reduce the risk of gas supply constraints and to access lower-emissions power— the relative importance of these levers would change. In particular, the impact of reducing gas prices would be lower, while the impact and fiscal cost of reducing electricity prices would be higher. Table 8 sets out the mechanisms for reducing these operating costs and the implications of doing so.

Table 8. Options for reducing operating costs

Policy option	Mechanism	Reduction in operating costs	Channel (how cost is absorbed)	Implication or risk	Potential cost to government over life of project (2026 USD)
Lower gas price	Supply gas at $4/gigajoule (GJ) vs. $8/GJ industrial tariff	From $112/t to $56/t alumina	GNGC absorbs reduced cost recovery— *Most likely*	Financial strain on GNGC; requires ongoing budgetary support	$1,120 million to cover GNGC foregone revenue
			Cross-subsidization to other users	Likely raises electricity prices; historically difficult to sustain; reduces infrastructure spillover benefits[86]	
			Reduced payments to domestic gas producers/importers	Increased risk of gas supply deficit	
			Reduced payments to pipeline operator	Weakens refinery's role as anchor customer for new infrastructure	
Lower electricity price	Reduce tariff to $0.108/kilowatt hours (kWh) vs. $0.20/kWh via forgone levies and taxes[87]	From $30/t to $16/t alumina	Foregone government revenue	Lower fiscal revenues; potential pressure on utility finances	$276 million
Lower rail charges	Concessional tariff of $0.017/t/km vs. $0.05/t/km commercial rate[88]	From $17.5/t to $6/t alumina	Compensation to private operator	Requires sustained subsidy or contractual payments	$231 million
			Private operator accepts lower return	Weakens refinery's role as anchor customer for new infrastructure	
			Lower tariff for state operator	Increases difficulty of repaying infrastructure financing	
Domestic caustic soda production[89]	Develop local supply to replace imports, $350/t vs. $500/t	From $50/t to $35/t alumina	Government support (coordination, energy pricing, infrastructure)	Increases public finance impact; also depends on chlorine demand	Not modeled

Reducing operating costs through these measures does not eliminate costs, but reallocates them. In particular, lowering payments to gas suppliers, power utilities or infrastructure operators would risk undermining the financial viability of these entities and could deter investment in new supply and infrastructure. Cross-subsidization—by charging higher prices to other users—may also prove to be politically and economically difficult to sustain, as illustrated by the experience of preferential electricity tariffs for the VALCO smelter.[90] It could also reduce the broader economic benefits of the refinery acting as an anchor investment for infrastructure development.

As a result, much of the burden of support would likely need to fall on the government. Whether provided directly through fiscal transfers, indirectly through state-owned enterprises or foregone levies and taxes, the combined cost of these measures could amount to around $1.6 billion over the life of the project (undiscounted, excluding any financial support required to stimulate domestic caustic soda production).

Below-market pricing for bauxite

The government could seek to improve the refinery's economics by reducing the cost of bauxite feedstock. The approach and its implications would differ depending on whether the mine and refinery are owned by different investors or whether the government can secure an investor that is willing to both mine and refine.

If the mine and refinery have different owners, lower domestic prices could reduce incentives to invest in mining. Even if investment were unaffected, lower prices would reduce government revenue from the sector. Lower revenues would translate into lower royalty payments and—given that Ghana currently taxes mining projects at 35 percent compared with the 25 percent for manufacturing activities—lower corporate income tax receipts. Alternatively, the government could allow the mine to sell bauxite at the market price while subsidizing the price paid by the refinery.

In our model, the mine must sell its bauxite at a price of around $25 per metric ton to break even—$11 per ton lower than in our base-case scenario—with a post-tax IRR of 9 percent. If the mine and refinery have different owners, it is unclear whether an investor would be willing to develop the mine with such limited returns. Government revenues would also fall substantially—by around $193 million across the lifetime of the two projects to $112 million, compared with a scenario in which the mine sells bauxite at market prices and generates government revenue of $305 million. Moreover, this price is still not low enough to make the refinery viable on either a pre- or post-tax basis. Therefore, if the mine and refinery have different owners, reducing feedstock prices alone is unlikely to be a viable policy lever unless combined with additional support for both the mine and the refinery.

An integrated mine and refinery project

If the government can secure an investor willing to both mine and refine, it could structure the relationship between these activities in different ways, striking a balance between incentivizing refining and protecting government revenue from mining. As set out earlier in figure 7, these structures differ in their treatment of legal separation, pricing between entities and the application of royalties and taxes.[91]

Table 9. Options for structuring an integrated project

Structure	Legal structure	Pricing treatment	Fiscal treatment	Implications for refining	Implications for government revenues	Country examples	Modeling of Ghana project
Partial integration with market pricing	Mining and refining are undertaken by separate legal and taxable entities, with sale of bauxite between the two.	Bauxite sales are expected to follow market (arm's-length) pricing, often supported by benchmarks or other transfer-pricing rules.[92]	Royalties apply at the mine, based on sales price. CIT is assessed separately for mining and refining entities.	Projects can be operationally integrated, supporting cost efficiencies and coordination of feedstock supply. This provides moderate support for refining but offers no tax advantages relative to independent projects.	Royalties and CIT are assessed separately for mining and refining entities, preserving the upstream tax base. This limits the risk that refinery losses erode government revenues, although transfer-pricing risks may be higher than for fully independent operations.	No examples identified for bauxite-alumina projects.	Model insufficiently detailed to show difference with base case.
Partial integration with preferential pricing	Mining and refining are undertaken by separate legal and taxable entities, with sale of bauxite between the two.	Bauxite sales may occur below market prices, but pricing is different for royalties, and possibly CIT.	Royalties apply at the mine and are protected by benchmark prices being used in the royalty base. CIT is assessed separately, with variation between whether preferential or benchmark pricing is used in the tax base.	Preferential pricing lowers feedstock costs and improves refinery cash flows. This provides stronger support for refining and may facilitate financing. Additional tax advantages arise if the refinery is taxed at a lower rate and preferential pricing is used in the tax base.	Benchmark-based royalties maintain a floor for government revenue. However, CIT payments are reduced if preferential pricing is used in the tax base, and tax avoidance risks are higher than for independent operations.	Indonesia, where recent reforms allow below-benchmark sales while maintaining benchmark-based valuation for royalties.[93]	With preferential price of $26/t, royalties being applied on market price of $36/t but CIT being applied on preferential price:[94] – Bauxite mine IRR: 9% – Refinery project post-tax NPV(9.4): -$435 million, IRR: 1% – Reduction in government revenue of $163 million to $142 million (assuming no tax avoidance)
Full integration within a single taxable entity	Mining and refining are combined within a single legal and tax entity, with no sale of bauxite between the two.	No sales price. Benchmark or formula-based pricing is used to value production for royalty purposes.	CIT is applied at the company level, allowing consolidation of mine and refinery profits and losses. Tax regime for mining projects or refining projects could be applied. Royalties are applied at extraction based on a benchmark or formula-based value.	Mining and refining are treated as a single project, allowing losses in the refinery to offset profits from mining. This provides the strongest support for refining, primarily through significant tax advantages.	Benchmark-based royalties maintain a floor for government revenue. However, CIT payments are lower and delayed, as refinery losses offset mining profits. Revenues may fall further if a lower tax rate for refining is applied.	Saudi Arabia (Ma'aden's Alcoa project).[95] Guinea also appears to be moving toward a similar model for integrated projects, though detailed tax treatment is not public.[96]	With royalties being applied on market price of $36/t, CIT rate of 25%: – Overall project post-tax NPV(9.4): -$429 million, IRR: 2% – Reduction in government revenue of $187 million to $118 million (assuming no tax avoidance)

Note: NRGI's modeling of a fully integrated project assumed that Ghana applies the 25 percent corporate income tax rate for manufacturing entities rather than the 35 percent rate applied to mining projects, to reflect the focus on improving the refinery's viability. Applying the 35 percent rate increases government revenue and reduces investor returns, but does not materially change the modeled results or the conclusion that integration alone is insufficient to make the refinery viable.

Moving from the first to the third structure increases support for refining, but it does so primarily by shifting value from the mine to the refinery and, ultimately, reducing government revenue. Further adjustments to the second and third structures could increase support for refining, but at the cost of additional government revenue—for example, by allowing royalties to be based on preferential pricing in partially integrated projects or by removing royalties altogether in fully integrated structures. However, we have not identified examples of countries adopting such approaches, and forgoing royalties would likely face significant political constraints. The choice between these structures therefore depends on how the government balances its refining objective against the need to secure stable and predictable revenues from mineral extraction.

However, our modeling suggests that even if the government can secure an investor willing to both mine and refine and facilitates a fully integrated structure, this would still be insufficient to make the refinery viable without additional policy support. Given the limited underlying cash flows, the tax advantages associated with integration are modest and do not materially change the project's overall economics.

Moreover, if the investor is primarily a mining company, it is likely to require returns above the assumed viability threshold of 9.4 percent. Given that mining projects typically deliver significantly higher returns than midstream activities, such investors are unlikely to be willing to accept considerably lower returns from an integrated project.

Tax incentives

Facilitating integrated structures can provide tax advantages, but countries such as Guinea and Indonesia also offer tax incentives more directly to reduce the cost of alumina refining and make it more attractive to investors. Ghana could consider measures such as a temporary reduction in the corporate income tax rate, accelerated capital depreciation or extended loss carry-forward provisions.

However, on their own, such incentives are unlikely to make a Ghanaian refinery viable. In the base-case scenario, the refinery does not generate taxable income at any point during its lifetime due to sustained losses. As a result, lowering or deferring corporate income tax would have no effect on project economics.

If combined with other forms of policy support, tax incentives could still play a role, but their effective design would be critical. Cost-based incentives that accelerate investor recovery of capital costs—such as accelerated depreciation or extended loss carry-forward provisions—primarily affect the timing rather than the total level of tax payments. This can reduce investor risk while limiting fiscal exposure and minimizing unintended distortions.

By contrast, profit-based incentives such as tax holidays or reduced corporate income tax rates can create greater distortions. For example, they may increase incentives for affiliated mining companies to underprice bauxite sales to the refinery, shifting profits from higher-taxed upstream operations. They may also encourage companies to overuse equipment during the tax holiday period and replace it once the incentive expires.[97]

Above-market pricing for alumina

The government could also incentivize the refinery through demand-side measures, such as guaranteeing the purchase of its output and/or the price paid for it.[98] Given that the modeled refinery is most sensitive to alumina prices, one option would be to require domestic smelters to purchase alumina at above-market prices.

However, this would reduce the cost advantage that VALCO and any other domestic smelter would gain from local alumina supply, and potentially make the products they produce less competitive in domestic and export markets. Moreover, until the performance of the VALCO smelter improves, it is unlikely that any price commitment would be seen by investors as sufficiently credible.

A more feasible option may therefore be to explore whether investors with strategic interests in the project would be willing to offtake at least a portion of the alumina at above-market prices.

Restrictions and penalties

Bauxite export ban

In early 2026, Ghana's president announced plans to end exports of unprocessed ores by 2030.[99] Such measures reflect a growing trend across Africa and other resource-rich countries.[100] For governments with limited fiscal space to offer incentives or invest in enabling infrastructure, export restrictions may appear attractive. However, they should be approached with caution. Export bans have generally succeeded only where they were narrowly targeted at a specific stage of the value chain, and where broader competitiveness factors were already in place or governments provided substantial complementary support. They can also impose significant economic costs.

Introduced in 2014, Indonesia's export ban on unprocessed nickel, bauxite and copper illustrates both the potential and the risks. Although the ban was effective in attracting investment in nickel processing, it was heavily supported by the country's strong market position (currently accounting for about 44 percent of global reserves and 67 percent of production), regulated energy prices, tax incentives and active engagement with anchor investors in special economic zones.[101] Indonesia's experience with bauxite has been more mixed. The country lacks the same degree of market power in bauxite (around 10 percent of global reserves), and alumina refining economics are more challenging. While the aluminum value chain is gradually developing, bauxite production fell sharply following the ban and at the time of writing it remains below pre-ban levels.[102]

Guinea has not imposed an export ban, but in 2022 it required all mining companies to submit plans to construct alumina refineries. As noted earlier, Guinea transferred the license of Emirates Global Aluminum to a state-owned enterprise in 2025 for failing to do so, and has warned SPIC of similar consequences if its refinery is not operational by 2028 (construction is currently expected to be completed by the end of 2027).[103] Whether this approach leads to the development of additional refineries remains uncertain. Guinea's high-quality bauxite, dominant market position—particularly following Indonesia's export ban—and shifting global investment dynamics may support such an outcome (the country currently accounts for about 26 percent of global reserves and 34 percent of production). However, whether it reduces investment in the bauxite sector and therefore entails broader economic trade-offs remains to be seen.[104]

In Ghana's case, caution is particularly warranted. Expanding bauxite production will require substantial new investment. With limited sunk capital in the sector, companies may respond to an export ban by scaling back mining plans rather than investing in refining capacity. While geopolitical competition may increase the willingness of companies to develop refineries to secure bauxite supply, such investments would still need to be economically viable. An export ban—without additional policy support that improves refining economics—could therefore reduce government revenue and employment from mining, while also limiting feedstock availability for any future refinery. For example, if a ban discouraged investment in the hypothetical mine modeled in this analysis, the government would lose at least $305 million in revenue over the project's lifetime under the base-case scenario.[105]

Higher taxes on bauxite exports

Some countries do not restrict the volume of unprocessed exports but instead impose higher taxes on them relative to processed exports.[106] The logic is similar to that of an export ban: to discourage raw mineral exports and encourage domestic processing. However, if the tax regime is not carefully calibrated, similar risks arise. If higher export taxes significantly reduce the profitability of bauxite mining while alumina refining remains unviable, the result may be lower bauxite production rather than increased investment in refining. Governments may, however, face fewer challenges under World Trade Organization rules than with export bans.[107]

Enablers

Regional cooperation

Regional cooperation can serve as an important enabler where it helps countries overcome domestic constraints. However, such cooperation must navigate a range of economic and political dynamics, including the inherent tension between collaboration and competition among participating countries. Starting with small, targeted initiatives—for instance, by building coalitions of willing governments around specific value chain opportunities—can increase the chances of success.[108]

For example, Ghana could agree with Guinea or Sierra Leone to supply part of their bauxite output to a refinery in Ghana. This could enable the construction of a larger facility that would benefit from economies of scale, particularly while Ghana continues to ramp up its own bauxite production. Although imported bauxite would be more expensive than domestically produced ore due to transport costs, it could still be cheaper than sourcing from more distant suppliers. Access to additional feedstock could therefore support a larger refinery and improve project economics.

Ghana could also cooperate with its neighbors to overcome input constraints. As noted earlier, Ghana may need to secure additional gas from Nigeria to ensure sufficient supply for the refinery. The government could also play a role in reducing trade barriers within ECOWAS and across the continent. Given that the Secretariat of the African Continental Free Trade Area is headquartered in Accra, Ghana is well placed to support such efforts.

Stronger regional trade links could make it easier to source critical inputs such as caustic soda from producers in countries like Egypt and South Africa, while also expanding regional demand for Ghanaian aluminum and aluminum-based products. This, in turn, could strengthen the performance of VALCO and any future domestic smelters, while increasing investor confidence in refinery offtake opportunities.

However, the region may also be a source of competition. New alumina refining capacity in Guinea, and a possible refinery in Nigeria, could reduce investor perceptions of regional risk, but also reduce interest in a Ghanaian refinery if strategic investors can achieve objectives such as supply diversification elsewhere.[109] These developments could also reduce regional demand for Ghanaian alumina.

In this context, Ghana could engage with neighboring countries to explore cooperative arrangements. If its own prospects appear to be weakening, for example, it could negotiate for its bauxite to be processed in regional refineries in exchange for a share of alumina output for domestic smelting, as well as participation in refinery revenues, employment and supplier opportunities.[110]

Regional cooperation can therefore either strengthen Ghana's position—or substitute for domestic refining—depending on how proactively it is pursued.

Comparing and combining policy support

These policy measures differ in both their effectiveness and their fiscal cost. In this subsection, we focus on the most promising types:

- Direct financial support for capital costs (focusing on an upfront subsidy, though other variants are possible)
- Reduced operating costs
- An integrated mine-refinery project (focusing on full integration, while recognizing that the government may choose alternative structures to balance refinery development and revenue protection)
- Tax incentives

The government will need to combine some of these measures. As noted above, facilitating an integrated project—even with full integration—would not be sufficient on its own to make the refinery viable. Given that the project is unprofitable even before tax, lowering or deferring corporate income tax would also be insufficient to attract investment. This would remain the case even if the government took the politically challenging step of reducing royalties on bauxite. We therefore assumed that, in addition to facilitating an integrated project, the government provides targeted operating cost reductions to bring the project to break-even.

In practice, these measures can be combined in different ways. For example, a smaller upfront capital subsidy could be paired with a more limited package of operating cost reductions. This could reduce the risk of these reductions undermining the government's ability to secure investment in new supply and infrastructure. Similarly, tax incentives could reduce the scale of support required through other channels. However, as discussed above, income tax holidays or temporary rate reductions can create distortions and lead to greater-than-expected revenue losses. We therefore focused on measures such as aligning capital depreciation with the accelerated schedules applied to mining projects and extending the loss carry-forward provision, which defer rather than eliminate tax payments.



Bauxite clay open-cut mining - photo by Alexey Rezvykh via Shutterstock

Table 10 presents three illustrative policy packages centered on upfront capital subsidy, reduced operating costs and a fully integrated mine-refinery structure. Each is combined with other measures to achieve viability at the lowest possible cost.

Table 10. Illustrative policy packages to achieve refinery break-even

Policy package	Description	Fiscal cost (2026 USD)
Upfront capital subsidy	Upfront capital subsidy of $712 million. Capital depreciation accelerated from 20 years to 5 years. Loss carry-forward limit extended from 5 to 10 years.	Total: $718 million. NPV(10): $569 million. Annual average during operation years: $0 million.
Reduced operating costs	Gas price reduced from $8/GJ to $4/GJ. Electricity price reduced from $0.20/kWh to $0.108/kWh. Rail tariff reduced from $0.05/t/km to $0.042/t/km. Caustic soda price reduced from $500/t to $350/t. Capital depreciation accelerated from 20 years to 5 years. Loss carry-forward limit extended from 5 to 10 years.	Total: $1,480 million. NPV(10): $501 million. Annual average during operation years: $74 million. (Excludes any cost of policy support to stimulate domestic caustic soda production.)
Integrated mine-refinery structure	Mine and refinery fully integrated. Capital depreciation accelerated from 20 years to 5 years. Loss carry-forward limit extended from 5 to 10 years. Gas price reduced from $8/GJ to $4/GJ. Electricity price reduced from $0.20/kWh to $0.169/kWh.	Total: $1,425 million. NPV(10): $452 million. Annual average during operation years: $71 million. (Assumes no tax avoidance in setting of bauxite price for royalty.)

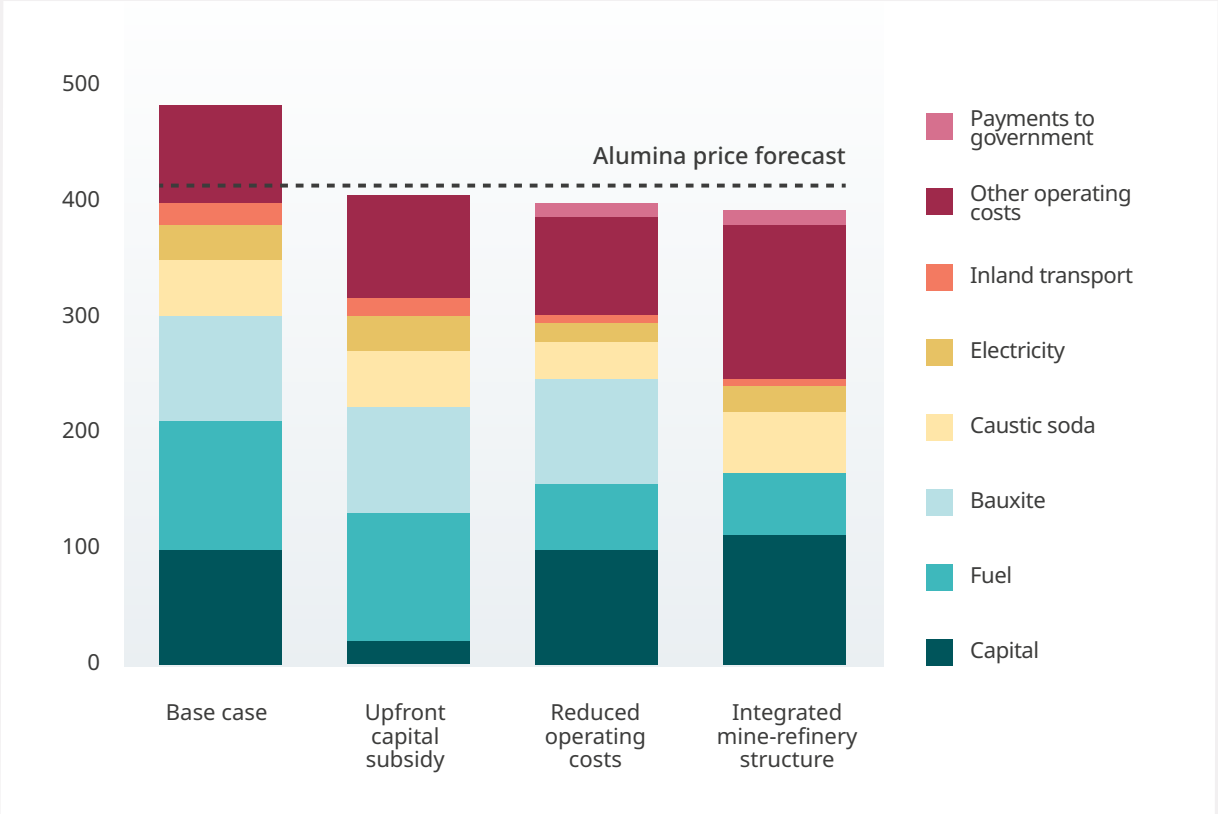
Note: For simplicity, the potential effect of an upfront capital subsidy on the cost of capital is not modeled. In practice, such a subsidy could reduce perceived sovereign and regulatory risk, lowering financing costs and, in turn, the scale of subsidy required in this scenario. In the reduced operating cost package, tax incentives are assumed to limit the extent of rail tariff reductions, reflecting the likely need to attract a private operator and the potential impact of concessional tariffs on project viability. However, similar tax measures could be used to limit reductions in other operating costs. In the integrated project package, gas and electricity prices are reduced, although other operating costs could be targeted instead.

If the government can secure investors willing to both mine and refine, facilitating an integrated project combined with tax incentives that defer rather than reduce tax payments as well as targeted operating-cost reductions appears to be the most cost-effective way to improve refinery viability, provided tax avoidance risks are effectively mitigated. In this scenario, the combined cost of foregone government revenue and operating-cost support is $452 million (discounted at 10 percent), equivalent to around $71 million per year over the project's lifetime.

If the government cannot secure investors willing to both mine and refine, the next most cost-effective option appears to be a package of further operating-cost reductions combined with some tax incentives. This approach also reduces tax avoidance risks and limits the need for the government to commit a large upfront subsidy. With this package, the support costs the government a total of $501 million (discounted at 10 percent), equivalent to around $74 million per year during the project's lifetime.

An upfront capital subsidy, combined with tax incentives, appears to be the most expensive option; due to budget constraints, the government would likely struggle to make such a large contribution over a relatively short period. However, this approach avoids a more sustained call on public resources and may increase the likelihood of private investment in input supply and infrastructure, as investors would not rely on continued government support to offset lower tariffs. The extent of this effect will depend on how operating-cost reductions are structured, as well as on investor confidence in the government's ability to sustain any support over the refinery's lifetime. As noted earlier, an upfront subsidy could also reduce the cost of capital and, in turn, the scale of subsidy required under this package.

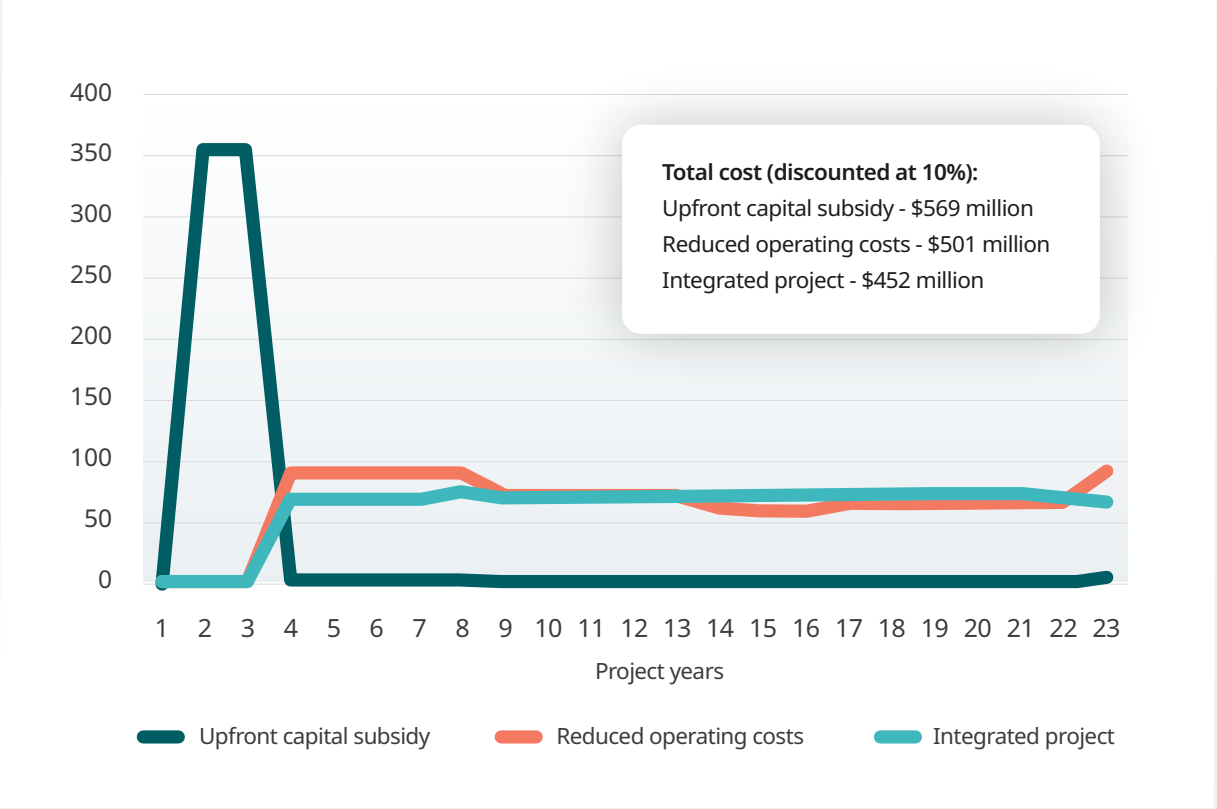
Figure 13. Estimated unit costs of a Ghanaian refinery in base case vs. with illustrative policy packages (2026 USD per metric ton of alumina produced)



Note: Capital cost includes interest payments to lenders and required return to equity.

These results highlight that achieving viability at minimal cost depends not only on the scale of support, but also on how that support is structured.

Figure 14. Cost of policy support options over the life of the project (2026 USD millions)



Securing debt financing

Even if input cost reductions and incentives are combined in the ways described above, the project only breaks even if it also secures substantial debt financing. Unless the government provides even greater policy support, the viability of the refinery therefore depends not only on these measures but also on whether the project can be structured to meet lenders' bankability requirements.

Several factors are particularly important in securing debt financing:

A credible sponsor and developer. Lenders typically require experienced operators with a track record of delivering and operating large industrial projects. A reputable developer reduces perceived construction and operational risks, particularly for a first-of-its-kind project in a country.

Long-term energy and rail agreements. Given the importance of fuel, electricity and rail charges to refinery economics, lenders will require predictable costs over the duration of the loan period (and preferably beyond). Long-term agreements can therefore play an important role in improving the project's risk profile, particularly if the government has intervened to reduce these costs.

Long-term offtake agreements. Alumina refineries that are linked to aluminum smelters through long-term supply contracts are typically easier to finance. Securing such agreements provides lenders with confidence in stable revenues and reduces exposure to short-term commodity price volatility. However, lenders

may discount agreements with financially weak smelters, given the risk of delayed payments or default. The larger the share of production intended for Ghanaian smelters, the more important it will be that these facilities are on a sound financial footing. If this cannot be ensured, the government may need to provide risk-mitigation mechanisms such as guarantees or prepayment arrangements.

Participation by government or DFIs. The involvement of public institutions—through equity participation, guarantees or financing from DFIs—can reduce perceived sovereign and regulatory risks. This can be particularly important for large industrial projects in countries with limited experience hosting such facilities. As noted earlier, GIADEC's planned participation in any refinery, or other forms of support to its capital costs, could be an important factor for lenders.

Foreign-currency revenues. Alumina is traded internationally in U.S. dollars. Selling to domestic smelters under dollar-linked contracts can therefore provide a natural hedge against exchange-rate risks and strengthen the project's credit profile.

More broadly, the government could accelerate implementation of its Capital Market Master Plan to make it easier for the refinery and similar large industrial projects to tap into underused domestic and regional capital pools.[111] While Africa's capital markets now exceed $4 trillion, much of this capital remains concentrated in low-risk government bonds and offshore assets.[112]

For example, Ghana's pension funds hold approximately $6 billion in assets. Although regulations permit up to 25 percent of these assets to be allocated to alternative investments—including infrastructure and project finance vehicles, equivalent to roughly $1.5 billion—actual exposure currently stands at only around 1 percent.[113]

If appropriate regulatory reforms, de-risking mechanisms and investable structures were developed—including, potentially, partial listing on the Ghana Stock Exchange—accessing domestic and regional capital could modestly reduce financing costs. These investors may apply somewhat lower risk premiums than purely international commercial lenders. Domestic participation could also reduce perceived political and regulatory risk, as a broader local investor base may increase the government's incentives to maintain a stable investment environment.

However, even with these elements in place, commercial debt financing for a first-of-its-kind refinery in Ghana would likely still carry relatively high interest rates, whether sourced domestically, regionally or internationally. As a result, our modeling suggests that, under purely commercial financing, returns on equity could remain slightly negative even if the project breaks even overall.

As discussed earlier, the cost of capital has a relatively limited impact on profitability in the base-case scenario, reflecting the weak underlying economics of the refinery. However, as policy measures improve operating margins, financing terms become more important. Access to concessional financing could therefore play an important role in improving project viability—particularly for investors primarily seeking financial returns. It could also reduce the scale of costly government support required.

Concessional financing

Concessional financing could further improve the viability of a Ghanaian alumina refinery by lowering the cost of capital. DFIs, export credit agencies and sovereign investment funds can provide financing on terms that are more favorable than purely commercial loans, reducing debt servicing costs and improving project returns.[114]

A useful precedent is the Mozal aluminum smelter project in Mozambique, one of the largest industrial investments in Africa. The project was financed through a consortium of strong equity partners—including BHP, Mitsubishi, the Industrial Development Corporation of South Africa and the

Mozambique government—alongside a diversified group of lenders. These included DFIs, such as the International Finance Corporation (IFC), as well as export credit agencies (ECAs) and commercial banks. This blended financing structure helped reduce perceived project risks and resulted in borrowing costs that were significantly lower than would otherwise have been possible (around the London Interbank Offered Rate (LIBOR) plus 150 to 300 basis points).

Table 11: Indicative final debt composition of Mozambique's MOZAL aluminum smelter

Debt tranche	Indicative amount	Indicative rate	Example of lenders
ECA-backed bank loans	$300 million	≈5.5%	Export Credit Insurance Corporation of South Africa-backed loans from Nedbank, Standard Bank and Absa
DFI senior loans	$200 million	≈6.5%	IFC and Development Bank of South Africa
Commercial bank loans	$170 million	≈8.5%	BNP Paribas and Société Générale
Subordinated DFI loans	$150 million	≈9.5%	Commonwealth Development Corporation, Deutsche Investitions- und Entwicklungsgesellschaft and Proparco
Total debt	**$820 million**	**≈6.5%**	

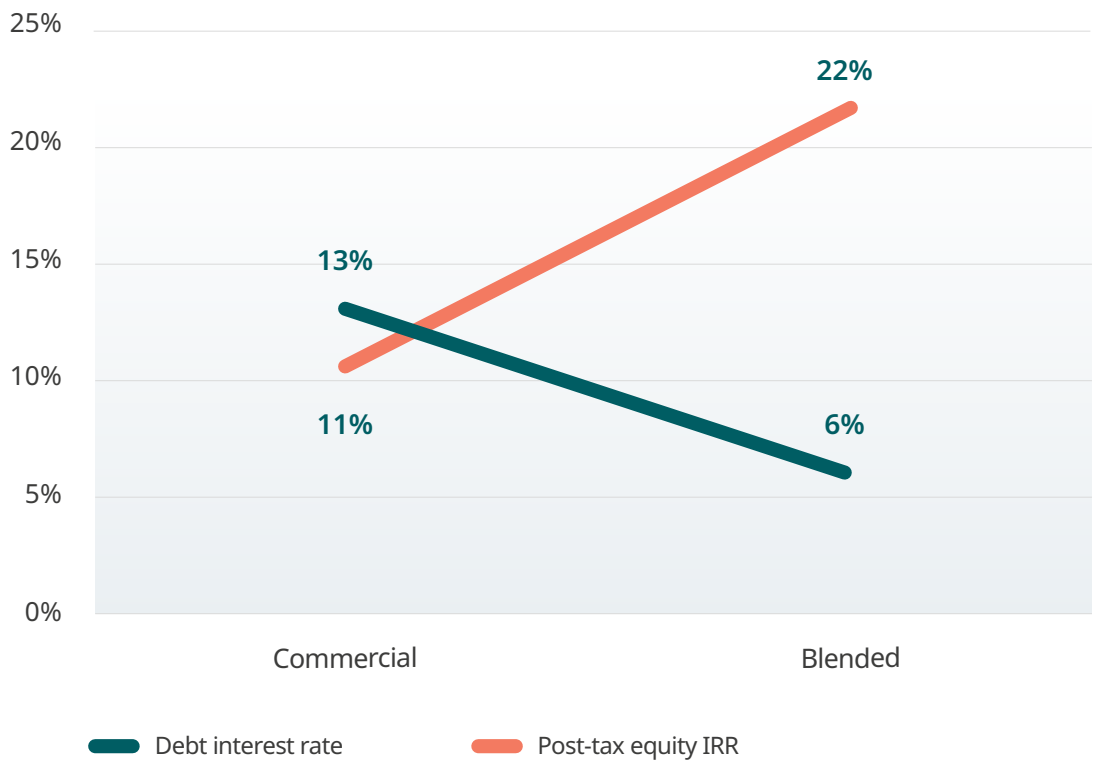
The Ghanaian government could pursue a similar approach for an alumina refinery. If development partners are convinced of the project's economic and development benefits, they could participate directly through concessional loans or guarantees, or indirectly by supporting associated gas, power or rail infrastructure. Export credit agencies may also provide support where equipment or engineering services are sourced from their home countries.

Beyond traditional DFIs, other strategic partners may also play a role. Chinese financial institutions have increasingly invested in alumina refineries overseas as China's domestic refining capacity approaches policy limits, though how this would interact with the existing Sinohydro arrangement is unclear.

Investors from the Gulf—where aluminum smelting capacity had been expanding prior to recent tensions in the Middle East—may also seek secure long-term alumina supply and could be willing to provide concessional financing in exchange. Meanwhile, Western governments and institutions are increasingly supporting efforts to diversify mineral supply chains, as illustrated by the European Union's designation of the Metlen bauxite and alumina project in Ghana as a Global Gateway strategic project. The refinery could also potentially access climate finance if part of its heat demand is electrified and supplied by renewable energy.

The approach that the government takes to the refinery will therefore be closely linked to the identity of potential finance providers, while the preferences of commercial investors will shape how concessional financing can be mobilized—and vice versa. Accounting for how choices about project design, policy support and financing interact will therefore be important during the government's revision of the IAI Master Plan.

Figure 15. Impact of concessional financing on Ghanaian refinery post-tax equity internal rate of return with the integrated project policy package



To assess the potential impact of concessional financing, we modeled a scenario in which the refinery secures a blended interest rate of 6 percent. This assumption reflects a Secured Overnight Financing Rate of 3–4 percent and a margin of 2–3 percent, broadly consistent with financing structures supported by development partners.

Access to concessional financing could significantly improve the refinery's overall viability and reduce the level of policy support required from the Ghanaian government.

For example, with blended finance complementing the integrated project package, the government could save approximately $22 million per year in gas subsidies.

However, securing such financing will depend on demonstrating that the project is commercially sound, environmentally responsible and supported by credible partners. DFIs would also expect it to deliver clear economic and social benefits for Ghana.

Weighing up the costs of government intervention

The government will need to weigh the costs of supporting an alumina refinery against the potential benefits it could generate for Ghanaians. This assessment should consider not only fiscal and economic impacts, but also environmental and social outcomes.

The full study commissioned by GIADEC outlining the potential economic gains from developing an integrated aluminum value chain—including higher government revenues, foreign exchange earnings, job creation and more affordable aluminum inputs for domestic industries—is not publicly available. The summary released to date does not provide sufficient detail to isolate the specific contribution of an alumina refinery.

Potential benefits

Our modeling provides an indication of some of the potential benefits, which vary in scale:

Government revenue. Under the operating cost reduction package, the refinery directly generates approximately $62 million in government revenue over its lifetime (discounted at 10 percent), equivalent to only around 16 percent of the estimated cost of reducing gas and power prices to make the project viable.

Jobs. We estimate that the refinery could create approximately 411 direct jobs during its operational phase, based on discussions with government and industry stakeholders, contributing to tax revenues and supporting livelihoods. We did not model indirect employment effects.

Support for VALCO. A domestic refinery could also support the performance of the VALCO aluminum smelter. VALCO currently imports alumina at global prices that include freight and insurance costs. Domestic supply could reduce these costs and allow the smelter to secure longer-term supply agreements, improving resilience to volatility in global alumina markets. However, a refinery would not be a complete solution to VALCO's challenges. Improvements in electricity supply reliability, electricity prices and energy efficiency would have a larger impact on the smelter's competitiveness.

Infrastructure spillovers. Additional benefits could arise from the infrastructure developed to support the refinery. Investments in gas, power and rail infrastructure in the Nyinahin area could improve access for other industries and communities—though, as discussed earlier, care will be needed to ensure that these users are not priced out. Improved power and gas supply along the corridor could also reduce the cost of bauxite mining, thereby increasing government revenues from the sector.

Such infrastructure could also support the development of an industrial ecosystem around the refinery, including production of key inputs such as reagents, lime, filters and grinding media. More broadly, improved infrastructure could benefit existing sectors such as agriculture—for example, by reducing post-harvest losses—and expand energy access for rural communities. Domestic production of caustic soda, if developed alongside the refinery, could also support downstream activities such as polyvinyl chloride manufacturing and water treatment.[115]

Opportunity costs of policy support

At the same time, the government must consider the opportunity costs of providing policy support to a refinery:

Trade-offs with other development priorities. The estimated $71–74 million annual cost of support under the integrated project and reduced operating cost packages—excluding any additional public financing for supporting infrastructure—is equivalent to around 40 percent of the government's 2025 budget for primary education and approximately 75 percent of the allocation to the agriculture sector.[116] Public support for a refinery could therefore divert substantial resources from other value chains and development priorities.

Trade-offs with other mineral benefit strategies. The government must also consider the trade-offs between supporting alumina refining and pursuing other strategies for benefiting from Ghana's mineral resources. For example, policy support for an alumina refinery may need to be balanced with the investments required to improve the performance of VALCO. If fiscal constraints prevent both from proceeding simultaneously, the government may need to sequence these investments. In the interim, Ghana could potentially cooperate with Guinea to secure alumina supply for VALCO, while still reducing transport costs relative to imports from more distant sources.

The government should also consider whether some of these resources could generate greater benefits if directed toward supporting local suppliers—for example, through investments in skills development or enabling infrastructure; or targeted financial support, such as grants or concessional loans to help Ghanaian firms provide goods and services to mining operations.[117]

Trade-offs with other mineral value chains. Similarly, the government must assess whether comparable resources should instead be directed toward other mineral value chains, based on feasibility, potential benefits and associated risks.

Previous NRGI analysis suggests that establishing lithium refining capacity could also require considerable public support.[118] Given Ghana's fiscal constraints, the government may only be able to support one such value chain.

The case for pursuing an alumina refinery appears stronger than for a lithium refinery. While this analysis highlights the challenging economics of alumina refining, lithium refining faces even greater headwinds. The dominance of low-cost Chinese lithium refineries has been reinforced by recent closures of refineries in Australia, leaving only one refinery in South Korea that profitably processes hard-rock lithium into lithium carbonate or hydroxide outside China.[119] Given these dynamics, the planned acquisition of Atlantic Lithium and its Ghanaian mine by Zhejiang Huayou Cobalt is unlikely, on its own, to materially improve Ghana's prospects for domestic lithium refining.[120] Huayou's global strategy will ultimately determine whether it sees strategic value in developing refining capacity in Ghana. Its substantial, existing refining capacity in China, combined with current market conditions, suggests such prospects will remain challenging.

Although access to the full GIADEC study would be needed for a definitive comparison, an alumina refinery is also likely to generate broader domestic benefits. Unlike the potential for an alumina refinery to support downstream smelting, the scope for a lithium refinery to catalyze further value addition—such as battery cathode manufacturing—appears more limited. Moreover, while the higher energy and transport requirements of alumina refining increase project complexity, they also increase the likelihood that the refinery could act as an anchor for infrastructure investment, with potential spillover benefits if well managed.

These economic trade-offs must be assessed alongside environmental and social risks, which may impose additional costs on communities as well as the government.

Managing environmental and social impacts

The government must place the management of environmental and social impacts at the core of any decision to develop an alumina refinery. These impacts are a central component of the cost-benefit analysis and, in some cases, may imply that certain locations or projects should not proceed.

Alumina refining is resource-intensive and can generate significant environmental and social risks. A refinery producing around 1 million metric tons of alumina per year could consume up to approximately 900 million litres of water annually—equivalent to the average annual consumption of around 100,000 people—placing pressure on local water supplies.[121]

Refineries also generate large volumes of bauxite residue (also called "red mud"). Historically, this has been stored in large tailings ponds, which carry risks of leaks or dam failures that can contaminate soil and water systems, damage vegetation and harm aquatic life. While safer practices, such as dry stacking, are increasingly being adopted, they can still generate dust that affects air quality and may cause irritation to people, animals and crops.

In addition, alumina refining can produce hazardous wastewater and air emissions, which can affect human health and local ecosystems if not properly managed. Ghana's experience with other forms of mining illustrates the potential scale of such impacts: one study found that between 1997 and 2005, farms located near mines were nearly 40 percent less productive than comparable farms further away, and farming households were 18 percent more likely to be poor.[122]

The government can take several steps to limit these environmental and social impacts:

First, the government should conduct a strategic environmental assessment of its aluminum value chain plans—in line with the Environmental Protection (Environmental Assessment) Regulations 2025—to inform its revision of the IAI masterplan.[123]

Second, it should prohibit mining and value addition in areas of particularly high environmental and social sensitivity. Ghana's Environmental Guidelines for Mining in Production Forest Reserves already prohibit exploration—and therefore mining—in protected forest reserves, including areas of globally significant biodiversity and cultural sites.[124] The government recently repealed regulations that enabled the President to grant exceptions to this ban, though the pending decision of whether to approve mining of the Kyebi deposits in the Atewa Forest is a key test case for its adherence to these guidelines.[125] The government should place similar restrictions on value-addition activities, such as alumina refining, informed by the strategic environmental assessment.

Third, even where projects are located outside no-go zones, the government must ensure that environmental and social risks are rigorously assessed and managed. This could include delinking the procurement and financing of ESIAs from the companies developing the projects. When companies directly commission and pay for these assessments, it creates potential conflicts of interest that may bias findings or undermine public confidence in the process.[126]

To strengthen accountability, the government should also require disclosure of final ESIAs, associated environmental management plans and reports against these, including summaries or key metrics to allow public understanding of what are often lengthy and complex documents.[127]

Fourth, the government should not proceed with mining or refining projects where local communities have not been meaningfully involved in decision-making.[128] The Environmental Protection (Environmental Assessment) Regulations require stakeholder engagement during the environmental impact assessment process. However, communities have raised concerns about limited engagement prior to permitting decisions, as well as shortcomings in resettlement and compensation arrangements where projects have proceeded.[129] There is already precedent for these challenges in Ghana's aluminum value chain. The construction of the Akosombo dam and the VALCO smelter resulted in the resettlement of approximately 80,000 people into 52 villages to make way for Lake Volta. A 2006 survey found that 69 percent of those resettled had not received compensation for lost property.[130] The regulations provide for public hearings on plans that the Environmental Protection Authority considers will have extensive and far-reaching environmental impacts. Such hearings would be appropriate in the case of any mining or refining projects.[131]

Fifth, the government should establish robust systems to manage red mud and other refinery wastes before any project proceeds. This could include setting clear national standards for residue storage and treatment, extending financial assurance mechanisms to ensure companies—rather than the state—bear cleanup and closure costs, and exploring opportunities to reuse red mud or recover valuable minerals over time.[132] Strong systems will also be needed to manage hazardous wastewater, including recycling and neutralization prior to discharge.

Adhering to high environmental and social standards is critical not only for protecting people and ecosystems in Ghana, but also for attracting investment. Increasingly, international investors and industrial buyers require minerals to be produced in accordance with robust environmental and social standards. For example, Mercedes-Benz now requires suppliers to source minerals from mines audited by the Initiative for Responsible Mining Assurance and to comply with the Organisation for Economic Co-operation and Development's (OECD) due diligence guidelines.[133]

Nevertheless, even with strong safeguards, some environmental and social impacts are unavoidable—such as high water use. The government must therefore explicitly incorporate these impacts into a rigorous cost-benefit analysis that weighs economic, fiscal, environmental and social outcomes before deciding whether to support the development of an alumina refinery, including whether the project should proceed at all.[134]

A transparent and participatory process

The government should prioritize transparency in decisions related to the development of Ghana's IAI Master Plan and involve citizens throughout the process. A transparent and participatory approach is essential for building trust, enabling public scrutiny which improves policy design and implementation, and reducing risks of corruption.

Given the broad public support for developing an integrated aluminum value chain, the government faces significant pressure to deliver. Establishing or facilitating value-addition projects is also becoming increasingly important for mining companies seeking to maintain their social license to operate in Ghana. However, as this report has shown, a Ghanaian alumina refinery would face challenging economics, and would likely require costly policy support involving significant trade-offs. Transparency will therefore be essential to build trust, manage public expectations and avoid either pursuing refining at any cost or provoking a backlash if a refinery does not ultimately materialize.

The complexity of the policy support required further strengthens the case for transparency. Public scrutiny increases the likelihood that problems are identified early and addressed, reducing the risk of costly mistakes and leading to more robust and credible policy. This credibility will also be important for securing investment, as it gives investors confidence in the durability of policy support and the predictability of the broader business environment.

Transparency is also critical, as strong public support for developing an integrated aluminum industry creates the potential for "state enchantment," where narrow private interests are presented as serving the national interest without adequate scrutiny of the underlying commercial realities or corruption risks.[135] For example, civil society organizations have raised questions about the beneficial ownership of a Ghanaian gold refinery that received a permit to refine gold purchased by the Bank of Ghana.[136] Experiences with value addition projects in countries such as Chile, the Democratic Republic of Congo, Indonesia and Mongolia also highlight governance risks related to policy design, licensing and contracting processes; the allocation of incentives; and the management of environmental and social impacts.[137] Without adequate transparency and oversight, political pressure to advance a refinery project could increase opportunities for corruption.

As a first step, the government should disclose in full the Economic and Social Impact Analyses of the Ghana Integrated Aluminium Industry Project commissioned by GIADEC, as well as the updated IAI Master Plan once completed.

Going forward, Ghana should continue to strengthen implementation of the Extractive Industries Transparency Initiative (EITI). It should address the gaps identified in the most recent validation—including in relation to beneficial ownership, state participation, infrastructure provision and resource-backed loans (such as the Sinohydro agreement)—and fully implement the requirements of the 2023 EITI Standard.[138] Ghana EITI could also explore piloting additional disclosures to inform the design and implementation of value addition policies and projects, such as any feasibility studies, ESIAs and cost-benefit analyses.[139] In this way, Ghana can leverage EITI to enable informed, constructive and realistic public debate, including on the trade-offs involved in pursuing a refinery.

Accountability institutions—including parliament, civil society organizations and the media— will also be essential in scrutinizing any plans to establish an alumina refinery. Such oversight will help ensure that, rather than a narrow group of interests, any project ultimately benefits all Ghanaians.

Conclusion

Ghana's ambitions to build an integrated aluminum value chain are understandable, especially given rising global demand for aluminum and alumina, and the potential to generate jobs, fiscal revenues and inputs for domestic industrial development. Yet this report finds that an alumina refinery—the "missing middle"—is unlikely to be commercially viable in Ghana under current market conditions without substantial government intervention.

A refinery would likely require government action to alleviate Ghana's worsening gas supply deficit. If constructed near potential new bauxite mines in Nyinahin, it would also require significant new gas pipeline, power and rail infrastructure, increasing both the cost and complexity of the project. Even with such gas supply and supporting infrastructure in place, a refinery generates significant losses over its lifetime in our base case. A more optimistic alumina price outlook alone is unlikely to change this, as profitability is constrained primarily by high input costs—particularly bauxite, fuel, electricity and caustic soda—as well as the financing terms available for a first-of-its-kind industrial project.

The central policy challenge is therefore to break even at the lowest possible cost, while maintaining fiscal sustainability, minimizing distortions, avoiding undermining the viability of the necessary new infrastructure and ensuring political feasibility. Our analysis suggests that, if the government can secure investors willing to both mine and refine, an integrated mine-refinery project, alongside reductions in key operating costs and targeted tax incentives, could offer a plausible pathway to viability. If not, a more extensive package of support to reduce capital and/or operating costs would likely be required.

Government efforts to unlock underused domestic and regional capital pools could help the refinery meet part of its debt financing needs and modestly reduce financing costs. Similarly, concessional or blended finance could materially improve viability and further reduce the fiscal burden of policy support, but would still depend on a bankable project with credible sponsors, durable energy and transport agreements, and secure offtake arrangements. Given that the approach the government takes will be closely linked to the identity of potential finance providers, it will be important to account for how choices about project design, policy support and financing interact as the government revises the IAI Master Plan.

In this context, incorporating low-emissions design—such as electrification of heat and the use of renewable energy—could offer several advantages, despite having potentially higher upfront costs. It could reduce exposure to gas supply constraints, improve the refinery's long-term competitiveness and further strengthen access to concessional and climate finance.

These decisions are not being made in isolation. The government is also considering how to improve the performance of Ghana's VALCO smelter and secure investment in a new smelter. Given the scale of investment required across these segments, sequencing will be critical. In the interim—or potentially over the longer term—regional cooperation could help fill gaps in the value chain.

Ultimately, any decision to proceed should be grounded in a rigorous and transparent cost-benefit analysis that accounts not only for direct revenues and jobs, but also for whether the refinery represents the best use of public resources compared to alternative development priorities, as well as its environmental and social risks. Embedding transparency and strong accountability mechanisms into the revised IAI Master Plan will be essential to ensure that any future refinery delivers tangible benefits for Ghanaians and earns public trust.

Appendix

Global alumina refinery costs

Table 12. Estimated costs of alumina refineries globally[140]

Cost Component	Estimated range
Development cost	
1.0 Mtpa capacity	$0.8–1.2 billion
1.5 Mtpa capacity	$1.0–1.5 billion
2.0 Mtpa capacity	$1.2–1.8 billion
3.0 Mtpa capacity	$1.7–2.6 billion
4.0 Mtpa capacity	$2.0–4.0 billion
Cost of capital	**6–16%, nominal**
Operating cost	**$218–475/t**
Bauxite feedstock	$23–110/t, equivalent to $9–44/t of bauxite
Fuel	$53–120/t
Electricity	$17–30/t
Caustic soda	$35–60/t
Labor	$25–30/t
Maintenance	$20–30/t
Environmental management	$20–30/t
Inland transport	$12–30/t
Other operating costs	$13–25/t

Note: Most company filings do not disaggregate fuel and electricity costs. To enable comparison with Ghana's cost structure, energy costs are disaggregated using an indicative split of 75 percent fuel and 25 percent electricity.

Modeling assumptions

Production capacity of 1Mtpa of alumina. While the IAI Master Plan sets out ambitions for refineries of 2 Mtpa, and some of the current proposals involve larger refineries, government discussions indicate Ghana is now targeting an initial refinery of 1 Mtpa. The optimal capacity of a refinery depends on several factors. Larger plants benefit from economies of scale, but they also have larger overall financing requirements and require greater supporting infrastructure, including power generation. A capacity of 1 Mtpa is therefore a reasonable aim for a country's first refinery, balancing scale with financing needs and infrastructure requirements.

We assumed that the refinery operates for at least 20 years, which is approximately the timeframe before significant reinvestment might be needed to replace equipment. This is a typical project life for modeling purposes.

A bauxite-to-alumina conversion ratio of 2.5. We assumed that 2.5 metric tons of bauxite are required to produce one ton of alumina, consistent with the IAI Master Plan. The refinery will therefore require 2.5 Mtpa of bauxite feedstock, or 50 million metric tons over its lifetime.

Located at Nyinahin. Government estimates suggest Nyinahin contains significantly larger reserves than Awaso or Kyebi (see table 1). Although Awaso's bauxite has higher alumina content and lower silica—making it more suitable for refining—its relatively small reserves limit expansion potential. Kyebi is closer to VALCO and the port at Tema for exports, but the ore quality is lower than Nyinahin and the government is yet to approve mining activity due to environmental sensitivities. Kyebi is home to the Atewa forest, which is a critical biodiversity hotspot and a water source for millions of people.[141]

Alternatively, instead of the refinery being located by the mine producing the bauxite feedstock, it could be located in the Takoradi area, close to a port for exports, or it could be constructed in the Tema area, which would place it near to both VALCO for domestic sales and a port for exports. Of the two coastal locations, Tema would offer greater transport efficiencies. However, Tema's growing population and expanding urban footprint may make it difficult to accommodate an industrial facility of this scale and obtain the necessary environmental permits. Table 13 summarizes the advantages and disadvantages of locating the refinery in either Nyinahin or Tema.



Bauxite ore stockpiled for transport ahead of export - photo by Igor Grochev via Shutterstock

Table 13. Considerations for refinery location decision

Factor	By Nyinahin mine	By VALCO/Tema port
Transport cost to VALCO/Port	Lower: Transporting alumina rather than bauxite will mean 60 percent less volume being transported.	Higher: Transporting bauxite rather than alumina will mean more volume being transported.
Infrastructure cost	Higher: Nyinahin is industrial greenfield with limited infrastructure to support a refinery.	Lower: Tema is already an industrial area, and the refinery will be able to leverage some of VALCO's existing infrastructure.
Power generation	More challenging: A new power plant will be required.	Less challenging: Existing infrastructure and demand makes it easier to increase power generation.
Gas pipeline cost	Higher: If the refinery is to use gas as the fuel, extending the existing pipeline network will be relatively costly.	Lower: Transporting gas to Tema would require less pipeline, and therefore less cost.
Water facilities	Higher cost: New industrial-scale water facilities suitable for refining will be required.	Lower cost: Existing water infrastructure in Tema can be leveraged.
Specialized skills	Harder to attract: Nyinahin is remote with limited amenities.	Easier to attract: Proximity to Accra and co-location with VALCO will make location relatively appealing.
Imported raw materials	Harder and higher cost: Raw materials will need to be transported to Nyinahin from the port.	Easier and lower cost: Refinery will be close to the port where the raw materials arrive.
Infrastructure spillover benefits	Higher: Can be anchor customer for new infrastructure that then benefits underserved area.	Lower: Area already relatively well served with infrastructure.

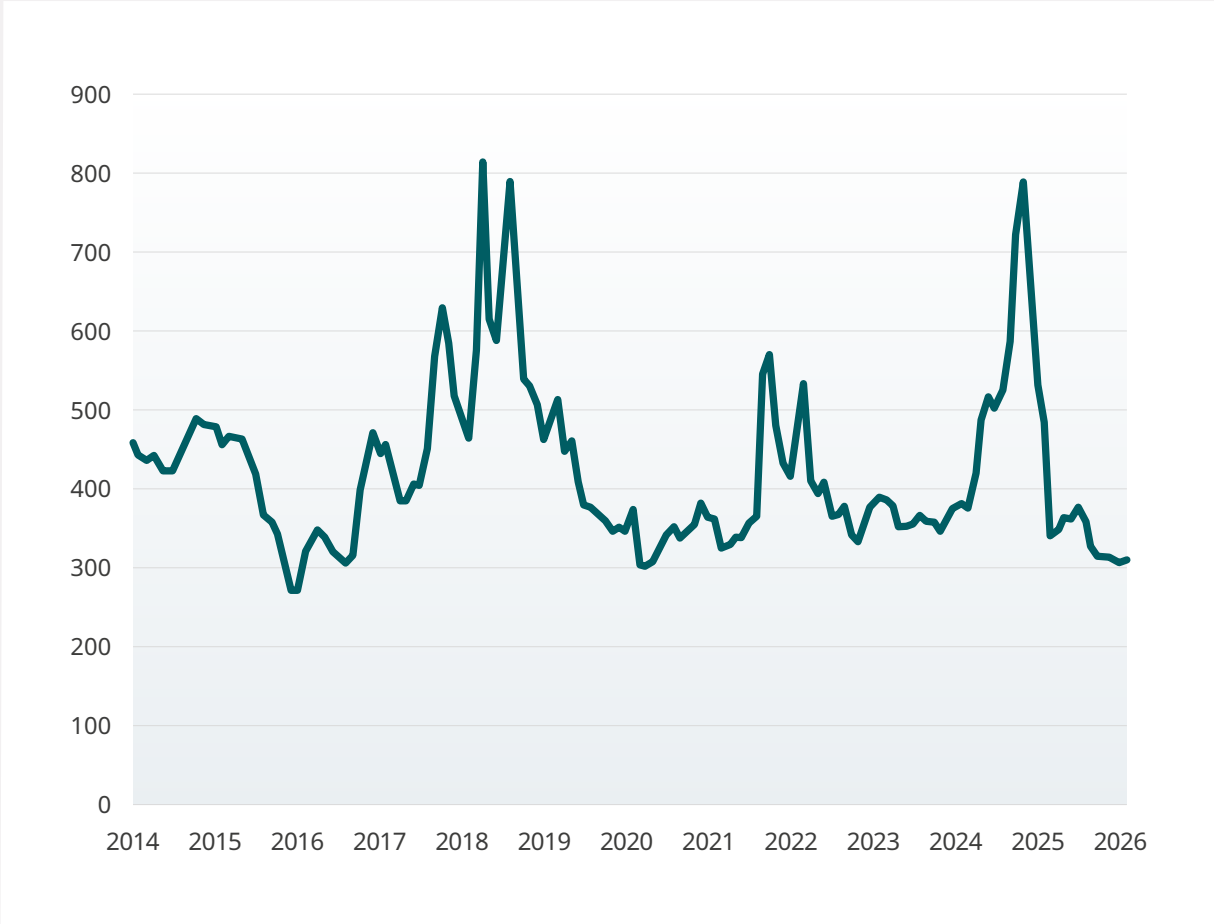
Relatively low construction costs. We assumed a development cost at the lower end of the range for 1 Mtpa refineries—$900 per metric ton of annual capacity (tpa)—based on discussions with engineering companies and on the expected cost of Guinea's new refinery. SPIC expects its 1.2 Mtpa refinery to cost $1.03 billion, translating to a capex intensity of $858/tpa. Its refinery is slightly larger and will benefit from higher ore quality, but must overcome weaker existing infrastructure, less public and private experience of delivering large projects and a more challenging regulatory environment.[142]

High operating costs. We assume the refinery purchases its bauxite feedstock at the FOB price net of inland freight, shipping or insurance costs. A price of $36 per metric ton is based on the pricing of Guinean bauxite and consultations with government and industry stakeholders. CIF prices in China for Guinean bauxite were $61 per metric ton on 24 March 2026, similar to the most recent long-term contract price agreed for Guinean bauxite of $62 per metric ton. Our assumed FOB price is therefore around 60 percent of these CIF prices.[143]

We assumed a gas price of $8 per gigajoule and an electricity price of $0.20 per kilowatt-hour, based on industrial tariffs published by the Ghana Public Utilities Regulatory Commission for the fourth quarter of 2025.[144] Given the lack of caustic soda production in Ghana, we assumed that the refinery imports caustic soda at $500 per metric ton. This estimate is based on a benchmark FOB price in Saudi Arabia of around $350 per ton in 2025, plus approximately $150 per ton for freight, insurance and port handling. We estimated the cost of rail transport to VALCO or the port based on new railway infrastructure being constructed and the project company charging the African average tariff of $0.05 per metric ton per kilometer.[145] Other related assumptions are primarily based on discussions with government and industry officials.

Alumina sold at market price. We take S&P's forecast of the average Australian FOB price over the next decade of $416 per metric ton as our base case. Australia's alumina FOB price is widely treated as a benchmark for long-term contracts, hedging strategies and spot trade. This price forecast is broadly similar to the inflation-adjusted average price of $424 per metric ton over the previous decade.[146]

Figure 16. Historical Australian free-on-board price for alumina (2026 USD per metric ton)[147]



Legislated corporate tax regime: We assumed that the government applies the legislated corporate income tax for a manufacturing entity. The refinery will therefore pay a tax rate of 25 percent, depreciate capital on a straight-line basis over 20 years and be able to carry forward losses for up to five years. For simplification purposes, we did not model any other taxes for a standalone refinery—such as withholding taxes on interest or dividends—but we consider the applicability of royalties in relation to an integrated mine and refinery project in the "Getting to break-even at least cost" section.

Privately owned: We assumed that the refinery is majority privately owned, but with GIADEC holding an equity stake of 30 percent, in line with the GIADEC Act.[148] However, we assumed that GIADEC acts as a commercial entity, contributing its share of capital under the same conditions and receiving the same returns as any private investor. We consider the implications of GIADEC operating differently to a private investor as a policy lever in the "Getting to break-even at least cost" section.

Debt financing: We assumed the refinery secures 60 percent debt financing. Alumina refinery projects often involve significant equity financing due to the large upfront capital expenditure and the high risks resulting from the exposure to bauxite and alumina price movements, as well as the significant impact of any energy price changes. However, with a credible sponsor as a developer, long-term energy agreements and long-term offtake agreements, among other things, refineries tend to be able to secure debt financing of 60–70 percent of total capital. Given this is Ghana's first alumina project, we assumed debt financing at the lower end of this range.

Medium cost of capital: We estimated a nominal weighted average cost of capital of 12.7 percent, equivalent to 9.4 percent in real terms, assuming 3 percent inflation. This falls within the 6 to 16 percent nominal range observed for alumina projects elsewhere.[149]

Our assumed cost of equity of 17 percent is based on a risk-free rate of 3 percent and a Ghana-specific equity risk premium of around 14 percent.[150] We assumed lenders provide debt on a fully commercial basis, though we consider the implications of the refinery securing concessional financing in the "Concessional Financing" section. Our assumed interest rate of 13 percent is based on a Secured Overnight Financing Rate of 3–4 percent and a margin of 9–10 percent, based on discussions with a range of lenders to African industrial projects.

Table 14. Estimated weighted average cost of capital for a Ghanaian refinery[151]

Cost of equity	17%
Cost of debt	13%
Nominal weighted average cost of capital	12.7%
Real weighted average cost of capital	9.4%

Hypothetical bauxite mine. There is limited public information on the broader economics of the Awaso mine or potential new Ghanaian mines. For simplicity, we assumed the mine produces 2.5 million metric tons of bauxite per year—the feedstock requirement for a 1 Mtpa refinery—and supplies all its output to the refinery. Our cost assumptions are based on consultations with industry stakeholders. Also for simplicity, we assumed that the mine only pays royalties and corporate income tax—for example, it does not pay the Growth and Sustainability Levy, contributions to a community development fund or withholding taxes.

Government options for increasing gas availability for the refinery

Ghana is already struggling to meet existing gas demand through domestic production and imports from Nigeria via the WAGP. Government projections suggest that this supply deficit will further increase in the coming years.[152] There are several ways the government could seek to address this deficit and ensure sufficient supply for a refinery, though each carries different levels of certainty, cost and trade-offs.

Supply-side measures

Incentivize new domestic production. Ghana has potential new gas production in the pipeline. For example, Eni made a commercial discovery in a new block in 2025.[153] However, as with all upstream oil and gas projects, investment decisions remain uncertain, particularly given global energy transition pressures.

The government could explore ways to further incentivize domestic production, but any such approach should be rigorously assessed to ensure fiscal concessions do not excessively reduce public benefits; environmental and social costs are properly considered; state investment does not expose public finances to undue risk;[154] and Ghana does not become locked into long-term gas dependence beyond clearly defined strategic needs when superior alternatives may emerge.[155]

Increase WAGP imports. Ghana currently imports only around 73 mmcf/d through the WAGP, well below both its contracted volumes of 120 mmcf/d and the pipeline's physical capacity of 474 mmcf/d.

Utilizing this spare capacity is constrained by both financial and structural factors. Ghana's accumulation of payment arrears has periodically led WAGP to reduce deliveries.[156] More fundamentally, gas supply challenges within Nigeria—including insufficient upstream production—have also constrained available export volumes.[157]

The Ghanaian government is making progress in reducing arrears.[158] However, it is uncertain whether Nigeria will generate sufficiently large and reliable production increases to materially expand long-term gas flows to Ghana, particularly given increasing domestic demand for gas.[159] As a result, expanding WAGP imports could help narrow supply deficits, but it may not provide a fully reliable standalone solution for refinery demand.

Commence liquefied natural gas (LNG) imports. A long-anticipated LNG import terminal, with potential supply capacity of around 400 mmcf/d, could significantly improve Ghana's gas supply balance. Although the terminal is physically ready to operate, it has yet to begin receiving LNG cargo due to contract disputes and market uncertainties.[160] The government now expects operations to commence by the end of 2026.[161]

However, LNG would likely be substantially more expensive than existing domestic or pipeline gas supplies, increasing the weighted average gas price.[162] This would either require greater government subsidies to make gas affordable for the refinery or increase prices for other users. Higher costs may also constrain LNG affordability across the broader economy. Because the government will likely have needed to commit to long-term take-or-pay agreements to secure investment in this infrastructure, this approach to increasing supply could expose Ghana to renewed penalties, rising public arrears and additional long-term fossil fuel lock-in risks.[163]

Demand-side measures

Increase the role of renewables. As the cost competitiveness and reliability of renewable energy continue to improve, the government could reassess the scale of planned new gas-fired power generation and instead accelerate investment in solar, wind and other lower-emissions power sources where feasible.

By reducing the power sector's future gas demand, this could help free up gas supply for higher-value industrial uses, such as alumina refining. However, achieving this would require careful power system planning, including investment in grid infrastructure, storage and backup capacity to ensure reliability.

Reduce refinery gas demand. The government and investors could also explore reducing refinery gas demand by incorporating electrification into parts of the refining process, particularly the digestion stage, where pilot projects are already emerging globally.

However, electrification would likely increase upfront capital costs and electricity demand, while its economic viability would depend heavily on access to competitively priced, reliable and ideally low-emissions power. This refinery configuration was not modeled in this analysis.

Endnotes

1 Estimated global costs of alumina refineries are primarily from BloombergNEF's Aluminum Valuation Model, which is based on filings by companies owning alumina refineries. BloombergNEF, *Aluminum Valuation Model,* last accessed 28 March 2026.

2 The IAI Master Plan is not publicly available, but the overarching ambition is set out here: GIADEC, "Future State of the Integrated Aluminium Industry," n.d., giadec.com/wp-content/uploads/Master%20Plan%20Schematic.pdf.

3 The full study is not publicly available but a summary is online. GIADEC, "Economic and Social Impact Analyses of the Ghana Integrated Aluminium Industry (IAI) Project," Technical presentation, 2-3 October 2024, giadec.com/wp-content/uploads/2024/12/Economic-Social-Impact-Analyses-of-the-Ghana-Integrated-Aluminium-Industry.pdf.

4 Thomas Scurfield, Matthieu Salomon and Silas Olan'g, *Six Keys to Unlocking Equitable Value Addition in Mining* (NRGI, 2024), resourcegovernance.org/publications/six-keys-unlocking-equitable-value-addition-mining.

5 See, for example: Peter Quartey, Festus Ebo Turkson, Emmanuel Abbey, Daniel Chachu, Mawuenyega Makafui Butu and Brad Wong, *Cost-benefit analysis of interventions in the industrial sector of Ghana* (Ghana National Development Planning Commission and Copenhagen Consensus Center, 2020), copenhagenconsensus.com/publication/ghana-priorities-industrial-policy.

6 We had a meeting with government and industry representatives to collect feedback on our initial modeling of a Ghana alumina refinery on 23 January 2026, and a follow-up meeting on our draft analysis on 24 March 2026.

7 A very small share of bauxite is used directly or with minimal processing, including as an input into cement production and in refractories (materials designed to withstand very high temperatures, such as the lining of furnaces and kilns used in heavy industry).

8 *Fastmarkets,* "Bauxite and alumina: A comprehensive market guide," n.d., www.fastmarkets.com/industrial-minerals/bauxite-alumina/.

9 China is the world's biggest consumer of non-metallurgical bauxite and alumina, which it produces domestically and imports from Guyana. *Fastmarkets,* "Bauxite and alumina."

10 See, for example: Australian Renewable Energy Agency, "Alcoa – Renewable Powered Electric Calcination Pilot," last updated 30 April 2025, arena.gov.au/projects/alcoa-renewable-powered-electric-calcination-pilot/.

11 Prerana Pradhan, "Case Study: Hydro Alunorte's electric boilers push alumina towards low-carbon steam," *Al Circle,* 23 November 2025, www.alcircle.com/blog/hydro-alunortes-electric-boilers-push-alumina-towards-low-carbon-steam-2.

12 *Mining.com, "*Next phase of development underway for world's largest solar thermal project – MA'ADEN I," 29 November 2024, www.mining.com/next-phase-of-development-underway-for-worlds-largest-solar-thermal-project-maaden-i/.

13 Australian Renewable Energy Agency, "Yarwun Hydrogen Calcination Pilot Demonstration Project," last updated 30 April 2025, arena.gov.au/projects/yarwun-hydrogen-calcination-pilot-demonstration-program/.

14 A refinery typically generates one to two metric tons of red mud for every ton of alumina.

15 This review utilized BloombergNEF's Aluminum Valuation Model, which is based on filings by companies owning alumina refineries. BloombergNEF, *Aluminum Valuation Model.*

16 Australia's alumina FOB price is widely treated as a benchmark for long-term contracts, hedging strategies and spot trade. S&P Global, "Global Metals & Mining," no date, www.spglobal.com/market-intelligence/en/solutions/products/resources/capital-iq-pro-metals.

17 BloombergNEF, *Aluminum Valuation Model.*

18 GIADEC, "Economic and Social Impact Analyses of the Ghana Integrated Aluminium Industry (IAI) Project." The U.S. Geological Survey currently estimates global reserves of 29 billion metric tons. U.S. Geological Survey, *Mineral Commodity Summaries 2026: Bauxite and Alumina* (2026), pubs.usgs.gov/periodicals/mcs2026/mcs2026-bauxite-alumina.pdf.

19 GIADEC, "Economic and Social Impact Analyses of the Ghana Integrated Aluminium Industry (IAI) Project."

20 The average aluminum smelter currently consumes around 14,000 kWh of electricity per metric ton of aluminum produced, with electricity accounting for 30–50 percent of production costs. The VALCO smelter consumes more electricity, possibly around 15,000 kWh per ton of aluminum produced, due to its older technology. International Aluminium, "Primary Aluminium Average Smelting Energy Intensity for 2024," international-aluminium.org/statistics/primary-aluminium-smelting-energy-intensity/; Aranya Mondal, "How is electricity reshaping the future of aluminium smelters - and what does it mean for global aluminium production?" *Al Circle,* 22 January 2026, www.alcircle.com/news/how-is-electricity-reshaping-the-future-of-aluminium-smelters-and-what-does-it-mean-for-global-aluminium-production-117021; Theophilus Acheampong and Mathew Tyce, *Navigating the energy transition and industrial decarbonisation: Ghana's latest bid to develop an integrated bauxite-to-aluminium industry* (Energy Research and Social Science, 2024), www.sciencedirect.com/science/article/pii/S2214629623003973.

21 The Akosombo hydroelectric dam has an installed capacity of 1,020 megawatts (MW), with total installed capacity in Ghana at 5,749 MW in 2024. Ghana Energy Commission, *National Energy Statistical Bulletin 2025* (2025), www.energycom.gov.gh/index.php/planning/energy-statistics?download=774:2025-energy-statistics.

22 GIADEC, "Economic and Social Impact Analyses of the Ghana Integrated Aluminium Industry (IAI) Project."

23 The government offered large bauxite mining concessions to Kaiser Aluminum and Reynolds Metals Corporation (who initially owned 10 percent of VALCO) to incentivize them to establish an integrated value chain, but the agreement did not place any obligations on them to exploit the concessions. The incentives that they received for the smelter included "duty-free status for the company's alumina imports and aluminum exports." Paul Kuruk, *Renegotiating Transnational Investment Agreements: Lessons for Developing Countries from the Ghana-Valco Experience* (Michigan Journal of International Law, 1991), 47, repository.law.umich.edu/cgi/viewcontent.cgi?params=/context/mjil/article/1607/&path_info=.

24 When the railway linking the Awaso mine to Takoradi port fell into disrepair in 2007 and bauxite began moving by road, transport costs increased by around 50 percent. Oxford Business Group, *The Report: Ghana 2017* (2017), oxfordbusinessgroup.com/overview/digging-deep-government-taking-steps-address-recent-decline.

25 *Modern Ghana,* "$1bn Bauxite refinery plant in the offing," 4 December 2002, www.modernghana.com/news/28673/1bn-bauxite-refinery-plant-in-the-offing.html; *All Ghana Data,* "US$1.2 bn To Be Invested In Alumina Refinery Plant In Ghana," 23 September 2010, www.allghanadata.com/business/news/usd1.2-bn-to-be-invested-in-alumina-refinery-plant-in-ghana-china/.

26 The original electricity supply contract between the government's Volta River Authority and VALCO ended in 1997 after nearly 40 years. The base rate was increased in the 1980s from the original $0.006265/kWh to $0.011 cents/kWh and remained so going into the early 2000s. The electricity price that VALCO currently pays is not publicly known, but it is understood to be higher than the $0.05/kWh typically needed for a smelter to be competitive. Acheampong and Tyce, *Navigating the energy transition and industrial decarbonisation: Ghana's latest bid to develop an integrated bauxite-to-aluminium industry.*

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