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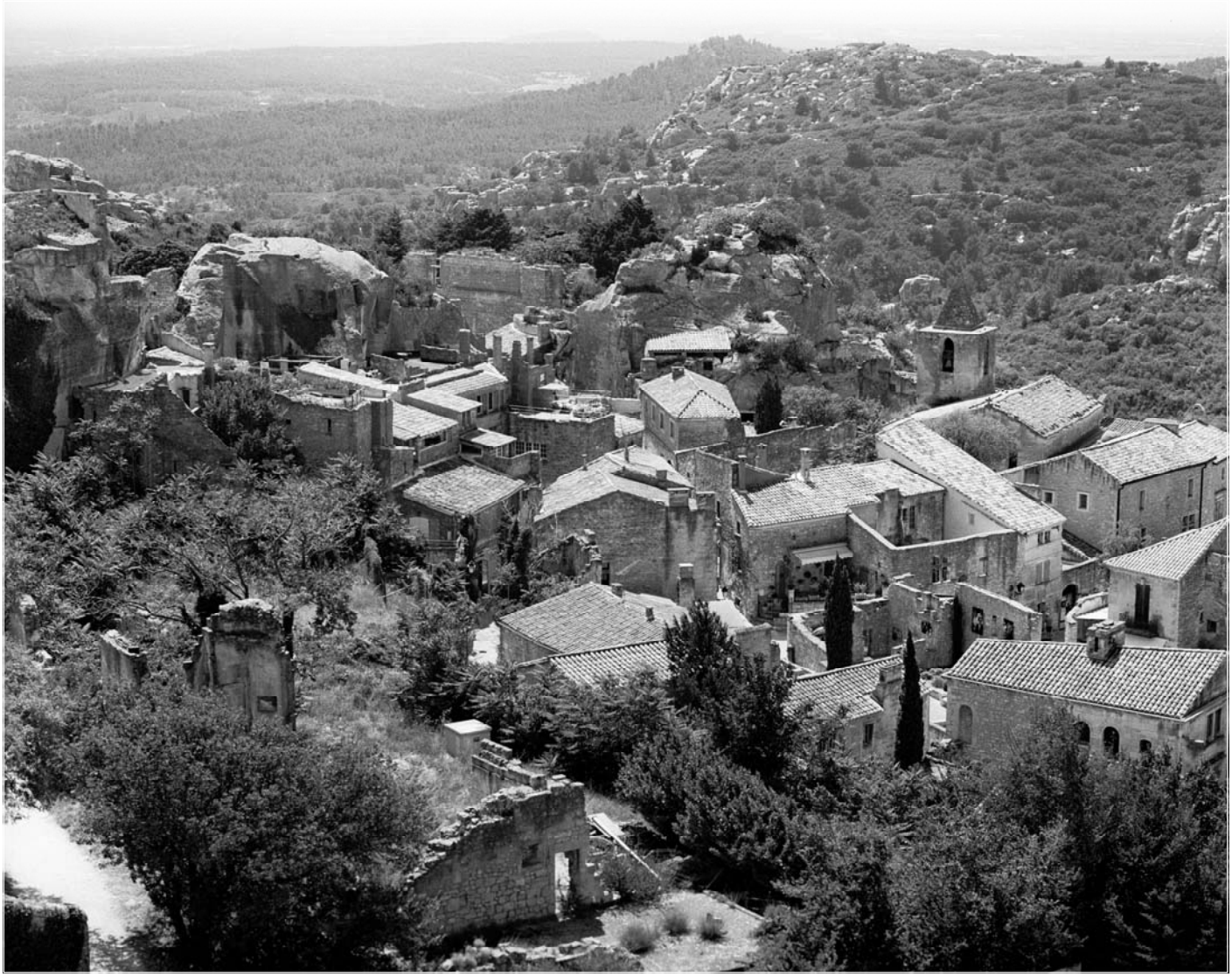

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Bauxite

Opportunities for Australian suppliers

Mining sector report, September 2015

Published by Edison Investment Research

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Bauxite

Sector Report

Opportunities for Australian suppliers

Metals & mining

There has been a structural change in the aluminium industry, which has led to a greater separation of bauxite mining, alumina refining and aluminium smelting. This has been driven by both merger and acquisition activity and the massive expansion of aluminium production in China, with the associated construction of alumina refineries dependent on high-quality bauxite imports. The ban on bauxite exports by Indonesia has led to uncertainty and created opportunities for new suppliers. Junior bauxite companies with credible projects have emerged in Australia.

27 August 2015

Companies profiled in this report

Australian Bauxite	ABX.AU
Bauxite Resources	BAU.AU
Canyon Resources	CAY.AU
Metallica Minerals	MLM.AU
Metro Mining	MMI.AU
Queensland Bauxite	QBL.AU

Growth of third-party bauxite supply

Bauxite is the raw material that is the source of aluminium (Al) metal. It is first refined into the intermediate product alumina (Al_2O_3). This is then used to produce aluminium. Depending on the grade of the bauxite, approximately 2.0-3.5 tonnes of bauxite are needed to produce one tonne of alumina and two tonnes of alumina are needed to produce one tonne of aluminium. Because of the high capital intensity of aluminium production, bauxite, alumina and aluminium production was, until comparatively recently, usually integrated within a single organisation or operated in a joint venture with specific offtake agreements. Transfer prices for bauxite were low and generally insufficient to support a standalone operation. This changed with the dramatic expansion of aluminium output in China and the creation of standalone alumina refineries dependent on imported third-party bauxite.

Supply destabilised by Indonesian ban

Indonesia, with substantial resources of gibbsite bauxite (for lower-cost, low-temperature refining) developed a bauxite export industry that supplied approximately 80% of China's import needs. However, in early 2014 the Indonesian government placed a ban on the export of unprocessed mineral products, which included bauxite, nickel ore and metal concentrates. Its objective was to promote the construction of value-adding facilities in Indonesia. This created a supply crunch, partly ameliorated by a build-up of stocks before the ban. A number of countries responded to Indonesia's withdrawal from the market, particularly Malaysia, which may export up to 20Mtpa in CY15. However, many alternative supply sources, particularly from Malaysia, may be unsustainable.

Market opportunity for junior bauxite companies

Continuing aluminium production growth in China and the consequent increased demand for alumina and bauxite, taken in conjunction with Indonesia's bauxite export ban, has created a market opportunity for existing and new suppliers. While only a small part of its business, Rio Tinto (RIO.LN, RIO.ASX) is in a prime position to increase its Australian bauxite exports from around 20Mtpa to up 50Mtpa, provided it can justify the capital investment. The improved market and pricing environment has also led to the emergence of a number of junior companies in Australia with bauxite projects. As alumina refineries in China need security and diversity of supply, these new entrants are likely to be strongly supported. At least two of these companies have already been offered bauxite offtake agreements.

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Contents

Overview of China bauxite demand and supply

Based on current demand of c 140mtpa, China needs to import just over 50Mtpa bauxite. Based on a range of aluminium production growth scenarios that we have carried out (see Exhibits 3-5 later in the report) import demand could increase over an approximate 20-40Mtpa range by 2020, assuming the market share of imports remains steady at around 37.5% of total demand.

For the consensus aluminium growth rate range of 6-8% CAGR over the 2015-20 period, bauxite import demand would increase by a corresponding 25-32Mtpa. Much of the aluminium demand growth in China is driven by the ongoing urbanisation of the country.

With the potential for lower aluminium growth due to a slowing Chinese economy, some industry commentators have suggested a demand increase of 20Mtpa to 2020 and a further five years to 2025 to achieve the increase of 40Mtpa.

The rate of growth in bauxite imports to supply expanded alumina capacity in China could be slowed by increased alumina imports if planned alumina refineries in Indonesia, Vietnam and Laos come to fruition.

Freight considerations for bauxite supply are important. Freight costs to China are much lower from countries like Malaysia, Australia and India (typically <US$10/t) than from countries such as Guinea (West Africa), Brazil and Jamaica, where costs can be around US$10/t higher. Currently, bauxite freight costs are depressed due to fleet overcapacity and low oil prices. The differential freight cost advantage of the bauxite producers from Asia and Australia will improve as freight costs normalise.

The Indonesian export ban has created opportunities for new suppliers. In this report, we highlight opportunities for increased Australian exports from an emerging junior bauxite sector.

- **Indonesian uncertainty:** exports ceased in early 2014 and will not resume unless there is a government policy change. There has been press coverage, not confirmed by the government, that limited exports could resume to assist funding of alumina refineries. This resumption, if it occurs, may only be temporary. The possibility that bauxite exports resume at some time in the future creates uncertainty for alternative suppliers. The cessation of exports has led to proposals for approximately seven alumina refineries in Indonesia, at least two with participation by Chinese entities. Not all are likely to be approved or financed and may have long lead times. Ultimately, Indonesian alumina exports could reduce China's bauxite imports.
- **Malaysia unlikely to be sustainable:** while Malaysia has lifted its bauxite production more than any other country to replace Indonesian bauxite, this increased capacity has been dependent on many new mine start-ups and government support, and there have also been quality and environmental issues.
- **Australia best placed:** Rio Tinto is in a prime position with bauxite reserves that would support an increase in bauxite exports from around 20Mtpa currently to 50Mtpa. Subject to financial hurdles, it could increase the capacity of its South of Embley project at Weipa and increase the capacity of export infrastructure at Gove. Alumina refineries in China need security and diversity of supply and are likely to support Australian junior companies that can deliver quality bauxite reliably, some of which can be used for blending. At least two Australian junior companies have been offered bauxite offtake agreements.
- **India production variable:** production has been volatile due to ongoing changes in government policies.
- **Vietnam output currently limited:** with large deposits, it has potential to become a much larger producer, subject to overcoming environmental objections to project proposals.
- **Guinea needs investment:** while Guinea, West Africa, has the world's largest high-grade undeveloped bauxite deposits, it needs substantial investment in mines, rail and port infrastructure to increase capacity. Political risk and security of tenure has been a constraint on

investment. Most of current capacity and capacity from planned projects is reserved for integrated refineries and is not available to third parties.

- **Brazil, Jamaica, other South/Central America:** freight costs from this region, relative to costs from Asia and Australia, are probably too high for sustained major bauxite supply flows to China because of longer shipping distances, particularly when overcapacity issues and oil prices normalise.

Bauxite – the raw material for aluminium production

Bauxite is the raw material that is the source of aluminium (Al) metal. While bauxite is globally plentiful, a commercial deposit needs to satisfy both quality and logistics parameters. Bulk land transport is required, preferably by rail where distances are large, to a sea port with capacity. The seaborne transport distance to the alumina refinery needs to be viable.

Production of aluminium is carried out in two stages:

- **Stage 1:** the bauxite is processed in the Bayer process to produce alumina (Al_2O_3). The Bayer process takes advantage of the high solubility of aluminium oxide minerals in caustic soda (NaOH) solution. After precipitation of Al_2O_3, the product is calcined at about 1,000^{0}C to produce high purity alumina. To produce one tonne of alumina, 2.0-3.5 tonnes of bauxite are required, depending on the grades and composition of the bauxite. Pure Al_2O_3 contains 52.9% Al and 47.1% oxygen (O).
- **Stage 2:** the alumina is converted to aluminium metal in the Hall-Héroult Process with 2.0 tonnes alumina required to produce one tonne of aluminium. In this process, a mixture of high-purity alumina and cryolite (Na_3AlF_6) are subject to an electrolytic process in which the oxygen is eliminated to produce pure aluminium metal.

Bauxite is composed primarily of several forms of hydrated aluminium oxide minerals, as below. Of these, the trihydrate form $Al_2O_3.3H_2O$ called gibbsite is the most favoured and valuable. Bauxite containing a high proportion of gibbsite might be classified as a gibbsitic alumina with high THA (trihydrate alumina).

- **Gibbsite** ($Al_2O_3.3H_2O$): this is the most soluble aluminium oxide and therefore has a lower temperature (c 140^{o}C) and energy requirement during refining. Refineries that operate on other bauxite ores may have to operate at temperatures of up to 300^{o}C.
- **Boehmite** ($Al_2O_3.H_2O$): this is not as soluble as gibbsite. It requires more energy than gibbsite in the refining process.
- **Diaspore** ($Al_203.H_2O$): this has the same composition as boehmite but is denser and harder. It requires more energy in refining than either gibbsitic or boehmitic bauxite. A lot of the bauxite in China is of the diaspore type.

Other minerals in the ore can cause losses of NaOH in the refining process, particularly silica (SiO_2).

- **Reactive silica** (RxSi): the SiO_2 that increases NaOH consumption is the reactive silica (RxSi) component – not all SiO_2 in the bauxite is deleterious. Generally, RxSi should be <4% of the bauxite and ideally <2% of the bauxite.

Aluminium industry – the impacts of structural change

The aluminium industry is capital intensive. Because of this, ownership of aluminium industry assets was traditionally concentrated within a comparatively small number of large organisations with integration and ownership of the material flows from bauxite mine to alumina refinery and

aluminium smelter. In this integrated ownership model, assets were often held in joint ventures, particularly bauxite mines and alumina refineries. In recent years, there has been considerable rationalisation of ownership of the industry as a result of mergers and acquisitions.

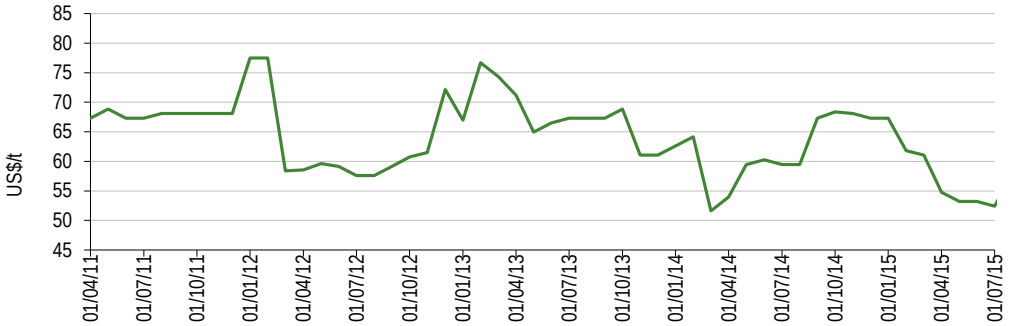
In the integrated aluminium industry, third-party sales of bauxite and alumina have traditionally been limited. When sold or transferred on an arm's-length basis, alumina was priced by LME-linked contracts at a percentage of the aluminium price. Bauxite operations were rarely operated as profit centres and prices were generally insufficient for third-party production and sale.

Many aluminium companies also operated conversion plants further downstream transforming aluminium metal into fabricated products, beverage cans and specialist automotive and aviation applications.

External developments have forced structural change in the industry:

- **Divestment of conversion assets:** declining real aluminium prices reduced returns on capital, which led return-aware companies to divest lower-margin, lower rate of return conversion assets to focus on smelting and further upstream. These assets were sold to building materials, packaging and advanced manufacturing companies. This trend has been in place for at least the past two decades.
- **Chinese aluminium smelting boom:** massive Chinese investment in Chinese aluminium smelting increased aluminium capacity, preventing both global aluminium and alumina price recovery. The smelting boom was driven by the urbanisation of China involving building, construction, infrastructure and varied industrial uses, as well as increased consumption of capital goods and automobiles. During this period, there was significant progress in development of downstream fabrication capabilities including flat rolled products such as sheet, plate and foil and extruded products. From 2001 to 2015, annual Chinese aluminium production rose from 3.4Mt to over 30Mt, with actual Chinese nameplate aluminium capacity now currently around 40Mtpa following recent build. Some of the new capacity may still be in a commissioning phase.
- **Reduced investment in refining:** low aluminium prices caused alumina prices to drop. Rising costs, mainly due to higher fuel costs from 2000 onwards, lowered margins on alumina refining and reduced investment in new refining capacity, with the exception of China.
- **China refinery capacity responds:** to avoid dependency on alumina imports, China stepped up the construction of its own refineries, including a number of third-party refineries, supplied by cheap domestically mined bauxite and the establishment of major bauxite import activity, mainly centred around the high gibbsite bauxites available from Indonesia.
- **Market index prices for alumina introduced:** with many alumina refineries barely profitable, global alumina pricing began to change from an LME aluminium-linked formula to an index basis, reflecting the supply/demand fundamentals of alumina rather than those of aluminium. These new arrangements are currently being phased in as term contracts are renewed.
- **Bauxite prices now subject to market forces:** the declining quality trend of Chinese bauxite increased demand for imported bauxite. The rising demand for third-party bauxite increased bauxite prices, which has attracted new independent bauxite projects that were not previously viable. Selectively, quality bauxite operations can now be attractive businesses. While bauxite prices (see Exhibit 1) can be volatile and are lower than peak levels of over US$75/t, current prices are higher than the historical range of around US$20-30/t.

Exhibit 1: Bauxite CIF Qingdao Port



Source: Datastream

Bauxite value in use (VIU)

The CBIX is a value-in-use CFR reference price published by The Bauxite Index. The CBIX calculator is a simple tool to calculate an indicative price for any bauxite.

The value of a bauxite ore is a function of a number of variables, particularly its 'available alumina' and RxSi content. Available alumina generally applies to the proportion of gibbsite in the bauxite. An often used quality metric is the ratio of available alumina to RxSi.

- Bauxite with a high Al_2O_3 grade may not necessarily be highly valued if a large proportion of the contained Al_2O_3 is not available.
- Bauxite with high SiO_2 may not necessarily be bad if the RxSi content is low.

Traded bauxite prices are value-in-use (VIU) calculations that take into account available alumina and RxSi in the context of the design and specific requirements of refinery customers. These will reflect parameters such as logistics and processing costs.

Recently constructed 'low-temperature' merchant refineries in China were designed to operate on imported bauxite, with a focus on gibbsitic ores from Indonesia with a high THA and low RxSi.

China aluminium growth driving bauxite demand

Bauxite demand is directly related to aluminium demand and production. Most of China's aluminium demand is supplied by smelters located in China.

China's aluminium production has grown at a compound rate of 17% since 2001, increasing from 3.4Mt to a projected 30.6Mt in 2015. The annual growth rate slowed to 10-11% from 2011 with the exception of 2014. In 2014, growth was 25% due to production from new smelters in the second half. More capacity is being added in 2015. Production is lagging capacity, with capacity at the end of 2015 expected to be 40Mtpa.

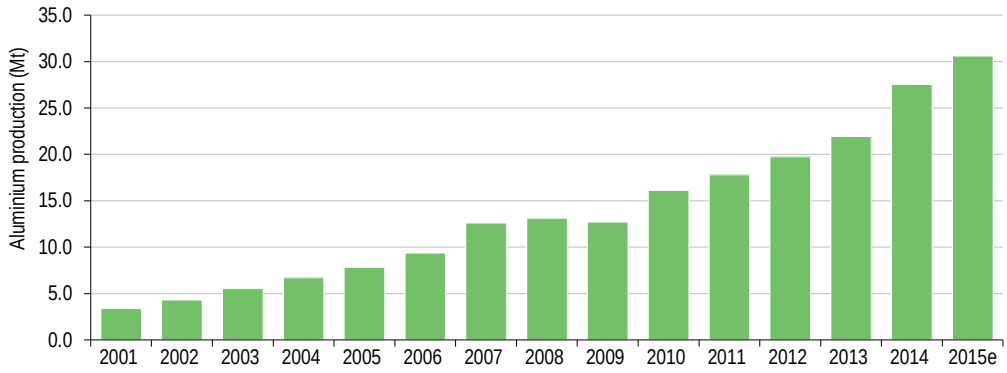
Although domestic aluminium demand weakened slightly in H1 CY15, as evidenced by increased exports, consumption in H2 CY15 has the potential to accelerate on the back of additional government stimulus. Consensus demand growth over the 2015-20 period is for growth in a 6-8% CAGR range.

The trend is for increased aluminium demand driven by the urbanisation rate and general wealth level. China has significant room for further urbanisation. As China's growth landscape undergoes a transition from infrastructure led to consumer led, aluminium consumption in the power sector

should accelerate, with China's State Grid likely to gradually shift to using more aluminium as a substitute for copper, using low-voltage aluminium alloy cables.

China is also the world's largest automotive market, with total vehicle sales expected to reach 25m units in CY15. Low oil prices have the potential to stimulate the automotive market. The aluminium content in vehicles has increased steadily in recent years and this trend is expected to continue.

Exhibit 2: Aluminium production growth in China



Source: World Aluminium, Edison Investment Research

The expansion of Chinese alumina capacity to keep pace with the rise in aluminium smelting has kept alumina imports at a low level. However, alumina imports were recently stepped up to compensate for alumina shortages, linked to the withdrawal of Indonesia from the bauxite export market. Indicative alumina imports are now approximately 5Mtpa.

The growth of aluminium demand has therefore translated to growth in demand for bauxite. Depending on bauxite grade and composition, particularly available alumina, 4-7 tonnes of bauxite are required to produce one tonne of aluminium.

Although Chinese bauxite is plentiful, the high-grade deposits have been extensively mined and many of the remaining deposits are of low grade. As bauxite demand has increased, imports have taken increased market share, with Chinese bauxite production growing at a lower rate than demand. Over the last 10 years, imports increased their share from 25-30% of demand to almost 40% of demand.

Bauxite quality has also been falling in the key alumina-producing provinces. Over the last 10 years, the average available alumina to reactive silica ratio of Chinese bauxite has fallen from around the 6.5-8.0 range to the 4.5-5.0 range. Historically, the economic process limit for Bayer process alumina refineries has been above 5.0.

China demand scenarios for bauxite

We have calculated potential bauxite demand scenarios based on annual aluminium growth rates (from 2016) of 5%, 7.5% and 10%. We assume imports have a flat 37.5% market share. There is potential for high-quality imported bauxite to capture a larger market share.

The low growth aluminium production scenario in Exhibit 3 is below the average for recent years. This rate can be achieved until 2020 in China's current nameplate capacity.

Exhibit 3: Potential China bauxite demand – low case – aluminium growth rate of 5%

	2014	2015	2016	2017	2018	2019	2020
Aluminium production (Mt)	27.7	30.6	32.1	33.7	35.4	37.2	39.1
Annual growth rate		10.5%	5.0%	5.0%	5.0%	5.0%	5.0%
Alumina required (Mt)	55.4	61.2	64.3	67.5	70.8	74.4	78.1
China production	50.4	56.2	59.3	62.5	65.8	69.4	73.1
Imported	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Bauxite required (Mt)	126.0	140.5	148.2	156.2	164.6	173.5	182.8
- China production	78.8	87.8	92.6	97.6	102.9	108.4	114.2
- Imported	47.3	52.7	55.6	58.6	61.7	65.1	68.5
Cumulative increase in bauxite demand (Mt)		14.5	22.2	30.2	38.6	47.5	56.8
- China production		9.1	13.8	18.9	24.1	29.7	35.5
- Imported		5.4	8.3	11.3	14.5	17.8	21.3
Alumina (Mt)							
- Increase in China production		5.8	3.1	3.2	3.4	3.5	3.7

Source: Edison Investment Research

In Exhibit 4, the 'mid case' aluminium growth rate of 7.5% pa would require an increase in smelting capacity of around 4Mtpa over five years relative to current nameplate capacity.

Exhibit 4: Potential China bauxite demand – mid case – aluminium growth rate of 7.5%

	2014	2015	2016	2017	2018	2019	2020
Aluminium production (Mt)	27.7	30.6	32.9	35.4	38.0	40.9	43.9
Annual growth rate		10.5%	7.5%	7.5%	7.5%	7.5%	7.5%
Alumina required (Mt)	55.4	61.2	65.8	70.7	76.0	81.7	87.9
China production	50.4	56.2	60.8	65.7	71.0	76.7	82.9
Imported	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Bauxite required (Mt)	126.0	140.5	152.0	164.3	177.6	191.8	207.2
- China production	78.8	87.8	95.0	102.7	111.0	119.9	129.5
- Imported	47.3	52.7	57.0	61.6	66.6	71.9	77.7
Cumulative increase in bauxite demand (Mt)		14.5	26.0	38.3	51.6	65.8	81.2
- China production		9.1	16.2	23.9	32.2	41.1	50.7
- Imported		5.4	9.7	14.4	19.3	24.7	30.4
Alumina (Mt)							
- Increase in China production		5.8	4.6	4.9	5.3	5.7	6.1

Source: Edison Investment Research

In Exhibit 5, the 'upper case' assumes that the recent annual aluminium production growth rate of around 10% is sustained. This would require an increase in smelting capacity of around 10Mtpa over five years relative to current nameplate capacity.

Exhibit 5: Potential China bauxite demand – upper case – aluminium growth rate of 10.0%

	2014	2015	2016	2017	2018	2019	2020
Aluminium production (Mt)	27.7	30.6	33.7	37.0	40.7	44.8	49.3
Annual growth rate		10.5%	10.0%	10.0%	10.0%	10.0%	10.0%
Alumina required (Mt)	55.4	61.2	67.3	74.1	81.5	89.6	98.6
China production	50.4	56.2	62.3	69.1	76.5	84.6	93.6
Imported	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Bauxite required (Mt)	126.0	140.5	155.8	172.6	191.1	211.5	233.9
- China production	78.8	87.8	97.4	107.9	119.5	132.2	146.2
- Imported	47.3	52.7	58.4	64.7	71.7	79.3	87.7
Cumulative increase in bauxite demand (Mt)		14.5	29.8	46.6	65.1	85.5	107.9
- China production		9.1	18.6	29.1	40.7	53.4	67.4
- Imported		5.4	11.2	17.5	24.4	32.1	40.5
Alumina (Mt)							
- Increase in China production		5.8	6.1	6.7	7.4	8.1	9.0

Source: Edison Investment Research

Dynamics of third-party bauxite supply to China

With a shortage of domestic bauxite of the appropriate quality, some Chinese alumina refineries are dependent on imported bauxite. Based on current demand, China needs to import just over 50Mtpa of bauxite.

Based on a range of aluminium production growth rates (Exhibits 3-5), import demand could increase over an approximate 20-40Mtpa range by 2020, assuming the market share of imports remains flat around 37.5% of total demand.

For the consensus aluminium growth rate range of 6-8% CAGR over the 2015-20 period, bauxite import demand would increase by a corresponding 25-32Mtpa. Much of the aluminium demand growth in China is driven by the ongoing urbanisation of the country.

With the potential for a lower aluminium growth run rate due to a slowing China economy, some industry commentators have suggested demand would increase by 20Mtpa by 2020 and take until 2025 to increase by 40Mtpa.

The rate of increase of bauxite imports to supply expanded alumina capacity in China could be slowed by increased alumina imports if planned alumina refineries in Indonesia, Vietnam and Laos come to fruition.

Bauxite freight costs to China are much lower from countries like Malaysia, Australia and India than countries such as Guinea, Brazil and Jamaica, where costs can be in the order of US$10/t higher. At the current time, bauxite freight costs are low because of fleet overcapacity and low oil prices. The differential freight cost advantage of the bauxite producers from Asia and Australia will improve as freight costs normalise.

China – bauxite imports now essential

China began to import bauxite in a meaningful way from around 2005. Bauxite imports were directed to new alumina refineries, some of which were built specifically to operate on imported bauxite. The rise in alumina production allowed aluminium smelting capacity to be increased to meet rising domestic demand.

Around 33% of alumina refining capacity in China is based on imported bauxite and is unable to use Chinese bauxite due to quality issues. China has large bauxite resources (c 3.5-4bn tonnes), but only about 25% of the bauxite can be classified as reasonable quality, with the balance low quality. Bauxite quality is deteriorating over time, driving cost increases in mining and processing.

This strategy of importing what was then cheap bauxite to boost alumina production in China avoided an escalation of alumina imports. In fact, alumina imports peaked at around 5Mt in 2005.

Indonesia supplied the bulk of China's bauxite imports. Australia provided most of the balance with minor imports from India and elsewhere.

Indonesia bauxite exports ceased early in 2014

Indonesia provided almost 80% of China's annual import requirement of 45-50Mt bauxite. An attraction of Indonesian bauxite was its high gibbsite content and low reactive silica, allowing low-temperature operation of the refineries with low caustic soda consumption.

For some time, Indonesia had canvassed intentions to reduce or eradicate exports of unprocessed mineral products to promote the construction of value adding processing plants in Indonesia to grow the economy and create jobs. Unprocessed minerals included bauxite, nickel ore and metal concentrates.

The export ban started at the beginning of 2014. While there was scepticism that it would last, the ban is continuing and appears to have strong support in Indonesia. It could therefore become permanent.

Unconfirmed reports in the Indonesian press suggest that consideration is being given to allowing bauxite producers with an alumina refinery project that is at least 30% complete to apply for a licence to resume exports. The reason for the possible relaxation of the ban would be to provide cash flow to assist with the completion of refinery construction, with several bauxite miners apparently having difficulties financing the refineries. According to the press articles, there would be an export tax of 7.5% and miners would need to pay a deposit to the government as evidence of their serious commitment to construct the refineries.

The possible relaxation would not restore the previous level of exports, as not all bauxite producers have an alumina refinery proposal. Also, there is no suggestion that bauxite exports would continue after completion of the refineries. The export of some copper concentrates has continued to be conditional on the construction of smelting facilities in Indonesia. There have been suggestions that the full implementation of a ban on copper concentrate and other concentrates may be delayed beyond the 2017 timeline because of delays to smelter construction. These suggestions only imply a delay to the total ban, rather than a withdrawal of the ban. If the same model applies to bauxite, any relaxation of the ban would only be temporary. At this stage, we are not aware of any official government confirmation of the press articles.

The possibility that Indonesia resumes bauxite exports at some time in the future creates uncertainty for alternative suppliers. However, it is possible that Indonesian exports would be at a diminished rate for a limited period only before ceasing again. For those new entrants with projects that will produce gibbsite bauxite suitable for low-temperature refineries, such as the Australian junior companies, their bauxite would be expected to remain in strong demand for blending with lower-quality bauxites.

Ahead of the Indonesian ban, China increased its bauxite inventories by 20Mt from around 15Mt to 35Mt. After the Indonesian export ban, bauxite imports virtually halved. Bauxite inventories fell throughout 2014 and the first half of 2015.

The cessation of exports has led to proposals for approximately seven alumina refineries in Indonesia, at least two with participation by Chinese entities. Not all are likely to be approved or financed and may have long lead times. Ultimately, alumina exports from Indonesia may reduce China's level of bauxite imports.

Malaysia steps up exports, but capacity and quality issues

The Indonesian ban induced Malaysia to dramatically increase bauxite production from a token 100-200,000t in 2013 to 3.3Mt in 2014 and a possible 15-20Mt in 2015. The Malaysian supply has provided some relief, but cannot replace all of Indonesia's exports.

To accomplish the increase in Malaysian capacity, there have been many new mine start-ups. Government support has been needed for aspects such as roads, land use, environmental issues and port restrictions. We understand costs have been rising. This increased capacity may not be sustainable.

Malaysian bauxite is a gibbsite bauxite, but the quality varies with high moisture and high iron in some instances. There have been liquefaction issues due to the high moisture, which can be dangerous when transporting the bauxite by sea.

India – government policies a constraint on exports

India increased its bauxite exports from <1Mtpa to >5Mtpa from 2013 onwards. However, historically, exports from India have fluctuated due to changes in country policies. In 2014, the export duty on Indian bauxite exports was increased from 10% to 20% with the objective of improving the availability of bauxite to Indian alumina refineries. With a number of new alumina projects in the country and both Hindalco and Verdante looking to expand aluminium production, domestic demand for bauxite is increasing.

Although India has very extensive resources of bauxite, environmental concerns are inhibiting new developments. Also, not all of this is high quality.

Vietnam – extensive bauxite deposits, limited production

Vietnam has extensive bauxite deposits, but only a small production capacity. Exports to China have been limited. It has potential to become a much larger producer and exporter, subject to overcoming environmental objections to project proposals.

Guinea – limited capacity for third-party exports

Guinea, West Africa, has some of the largest, high-grade undeveloped bauxite deposits in the world. However, the high capital cost for both mines and infrastructure (rail and port) plus political and resource security risk has been a limiting factor on their development. Most of current capacity and capacity from planned projects is reserved for integrated refineries and is not available to third parties.

- **CBG Sangaredi:** bauxite mining commenced in 1973. Bauxite exports were 15.2Mt in 2014. A US$1bn expansion to increase capacity to 23.5Mtpa is planned with completion in 2018. CBG is 49% owned by the Government of Guinea with the remaining 51% owned by Halco Mining consortium. The shareholders of Halco are Alcoa (AA.NYSE) (45%), Rio Tinto (45%) and Dadco Investments (10%). Dadco Investments is part of a privately owned investment, manufacturing and trading group, which has aluminium interests that include a 0.9Mtpa alumina refinery in Germany. Most of CBG's bauxite production is exported to the non-government shareholders of Halco. CBG has signed supply deals for the expansion. This includes a 10Mtpa contract with Abu Dhabi state-owned investment fund Mubadala and Dubai Aluminium, starting at 5Mtpa. It does not appear that there will be any surplus that can be exported to China.
- **Guinea Alumina Corporation (GAC)** is proposing to develop the GAC bauxite mine and an associated alumina refinery, with potential bauxite exports in 2017. However, there has been no recent confirmation of the status of its plans. GAC is a mining development company that is wholly owned by Emirates Global Aluminium (EGA).
- **United Company Rusal (HKG.486):** Rusal is planning the first stage of its Dian-Dian bauxite development for first production by 2016 at 3Mtpa with the potential for expansion to 9Mtpa. We understand a major motivation for the mine is to increase the company's self-sufficiency in bauxite. Therefore, available bauxite for third-party customers may be limited.

South America – extensive resources, high freight costs

A number of South American countries such as Brazil and Jamaica have extensive bauxite resources and significant production facilities. However, the higher costs of freight to China from South America, with an additional cost differential of at least US$10/t, put them at a competitive disadvantage to bauxite producers in Asia and Australia, especially when shipping charter costs and fuel costs revert to expected higher levels.

Australia – well placed to plug the bauxite supply gap

Bauxite suppliers in Australia comprise incumbent major companies and the emergence of a number of junior companies with planned projects and active exploration activities targeting export markets. Lower freight costs to China compared to producers in Africa and South America is a competitive advantage for Australian producers.

There are currently five major bauxite mines in Australia. These mines were primarily established to supply integrated alumina refineries. They are operated by RIO, Alcoa World Alumina and Chemicals (AWAC) and South32 (S32.ASX)

Of the juniors, Australian Bauxite (ABX.ASX) is the first to establish a mining operation and its first export shipment is expected later in 2015. A number of the other juniors are planning to commence production in the near term, with most targeting production in 2016.

Rio Tinto

The RIO bauxite mines at Weipa (north Queensland) and Gove (Northern Territory) export bauxite, but this was a secondary and generally marginal business until about five years ago.

Following industry consolidation, the bauxite mining centres at Weipa and Gove are operated by Rio Tinto. Rio Tinto's bauxite exports have increased from around 12Mtpa in 2011 to a current level of 20Mtpa as a result of production creep at Weipa and restructuring at Gove, where the refinery has been placed on care and maintenance.

- **Weipa:** bauxite mining commenced in 1963. There are currently three operating mines at East Weipa, Andoom and Ely north of the Embley River. Current production is approximately 26Mtpa bauxite with around 18Mtpa allocated to exports and 8Mtpa dispatched to its alumina interests at Queensland Alumina (RIO 80%, Rusal 20%) and Yarwun (RIO 100%), both at Gladstone, Queensland. These northern bauxite reserves are gradually depleting and will be replaced by the South of Embley (SOE) project to the south of the river. Initial SOE production at around 22.8Mtpa will substitute depleted East Weipa bauxite (approximately 12Mtpa) and allow bauxite exports to third parties to increase. Depending on market demand, production could be expanded to 50Mtpa. Proven and probable reserves are 1,485Mt at 49.4% Al_2O_3. Weipa has high available Al_20_3 at close to 50% and low RxSi.
- **Gove:** bauxite mining commenced in 1970 with the objective of supplying the Gove alumina refinery, which had a capacity of 2.3Mtpa alumina. The bauxite mining rate was approximately 8Mtpa, with around 6Mtpa consumed by the refinery and exports capped at 2Mtpa. Alumina production from the Gove refinery ceased in Q3 CY14 due to a combination of low alumina prices and high energy costs as its power is generated from fuel oil. Bauxite exports at around 2Mtpa are continuing, but infrastructure constraints prevent a significant increase in exports. Mine capacity is approximately 10Mtpa, implying exports could be increased if the infrastructure constraint was removed. Proven and probable reserves are 146Mt at 52.5% Al_2O_3. Gove has high available Al_20_3 at close to 50% and low reactive SiO_2 at around 3%, giving a relative ratio of around 16.0.

Alcoa World Alumina and Chemicals (AWAC)

Located in Western Australia (WA), AWAC operates two mining complexes at Huntly and Willowdale. These supply bauxite for its Kwinana, Pinjarra and Wagerup alumina refineries. Ownership of the AWAC operated bauxite and alumina assets is Alcoa (AA.NYSE) (60%) and Alumina (AWC.ASX).

AWAC's mines have large resources and reserves, but grades of 31-33% Al_20_3 are much lower than those at Weipa or Gove. These mines were built solely to provide bauxite to its integrated

alumina refineries. The mines are located in close proximity to the refineries they serve and are connected by conveyors or a rail link.

Although alumina grades are low, most of the contained alumina is available alumina and reactive silica is low. They therefore have good refining characteristics with low caustic soda consumption. The low cost to transport the bauxite from mine to refinery compensates for the low grades.

The low grades of WA bauxite result in a lower value per tonne, despite attractive refining characteristics. As a result, it has not been commercially attractive to export. With the recent increase in bauxite prices, it may now be viable to export WA bauxite. We are not aware of any proposals for exports.

AWAC operates two mines as follows:

- **Huntly and Willowdale:** available Al_2O_3 averages 32.9% and reactive silica is <1%.

South32 (S32)

Located in WA, S32 operates the Boddington mine, which supplies the Worsley alumina refinery. Ownership of the Boddington/Worsley assets is S32 (86%), Japan Alumina Associates (Australia) Pty (10%) and Sojitz Alumina Pty (4%).

The S32 ore grades and processing characteristics are similar to the mines operated by AWAC. The S32 assets were previously operated by BHP Billiton.

- **Boddington:** available Al_2O_3 is 31.9% and reactive silica is 2.3%

Junior companies

With the rise in demand for world traded bauxite and higher bauxite prices, a junior bauxite sector has emerged, comprising a number of companies with bauxite projects.

Alumina refineries in China need security and diversity of supply and are likely to support Australian junior companies that can deliver quality bauxite reliably. In addition, Australian bauxite, being largely gibbsite bauxite, can be usefully deployed for blending with lower-quality bauxites. As an indication of the interest in new bauxite capacity shown by alumina refiners, offtake agreements have been offered to at least two of these companies.

- **Australian Bauxite (ABX.ASX):** the first junior company to establish an Australian bauxite mine. The company is expecting to make its first export shipment from its operation in Tasmania later this year. The company also has resources in NSW and Queensland. It has been offered a long-term offtake agreement with the preferred customer.
- **Bauxite Resources (BAU.ASX):** currently, the only junior bauxite company in WA. It is planning to develop a pipeline of projects that are close to existing rail links and port facilities
- **Metallica Minerals (MLM.ASX):** has lodged a mining lease application (MLA) for its Urquhart project (MLM 60%), located near Weipa in northern Queensland, with a late 2016 production target
- **Metro Mining (MMI.ASX):** currently conducting a definitive feasibility study (DFS) for its Bauxite Hills project in northern Queensland with production targeted for late 2016. MMI has signed a bauxite offtake non-binding Memorandum of Understanding (MOU) with the Xinfa Group, one of the largest integrated aluminium companies in China. Xinfa is currently a 7.2% shareholder in MMI.
- **Queensland Bauxite (QBL.ASX):** planning to develop the South Johnston bauxite project in northern Queensland with the goal of commencing production in late 2015.

Another Australia-listed company plans to develop a bauxite project in Cameroon, Central Africa:

- **Canyon Resources (CAY.ASX):** CAY is earning 75% of the Birsok Bauxite Project in Cameroon. Its licences are contiguous with the substantial Minim Martap project. CAY is currently conducting exploration to prove up a resource. Capital expenditure for an initial 2-

3Mtpa DSO operation is expected to be low. An existing rail line, located approximately 10km from the project area, provides a link to the Doula port.