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Evolution of the Aluminium Supply Chain

*A presentation prepared by CM Group for the Australian Stewardship Initiative (ASI)
Annual Conference May 2018*

The CM Group



the
BAUXITE INDEX
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A privately owned, independent, global non-ferrous metals research boutique. CM specialises across a range of base and other non-ferrous metals industries, including Al, Zn, Cu, Mo, W, Ni, Mg, Mn and mineral sands.

CM is the developer and publisher of the CBIX Value-in-use bauxite price index.

ALUMINA
LIMITED

bhpbilliton

UBS

RUSAL

ALCOA

ILUKA

HYDRO

noranda

RioTinto

GLENCORE

Votorantim
Metais

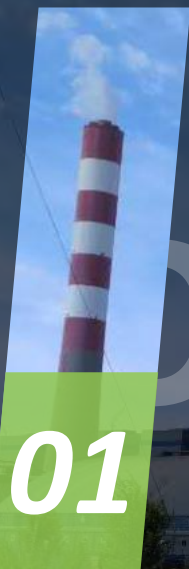
Deutsche Bank

MITSUBISHI

ANGLO
AMERICAN

MACQUARIE

DAEWOO



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***The Bauxite
Revolution***

Shifts in Alumina Supply

02



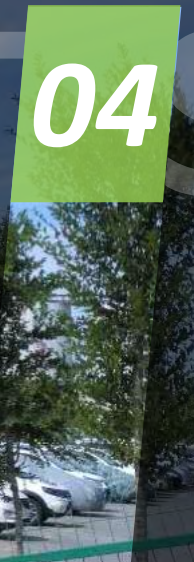
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** SSSR - Structural Supply-Side Reform*



Picture: Bauxite Loading Facility Construction, Guinea, March 2018

Bauxite Industry - Summary

*Bauxite is **plentiful**, although recently bauxite **mining and export patterns** have shifted significantly with **availability**.*

*Historically, refineries have been designed to treat **specific bauxites**. More recently, a new model has emerged whereby refiners have some **choice between bauxites**, based mostly on **availability** and **processing costs**. Grade and distance are the key cost drivers.*

*Over the past three years, **Guinea** has emerged as a major **bauxite exporting country**. Capacity has **tripled** and is forecast to double again to over 100 MTPY by end 2020.*

Bauxite – main mineral from which alumina is extracted



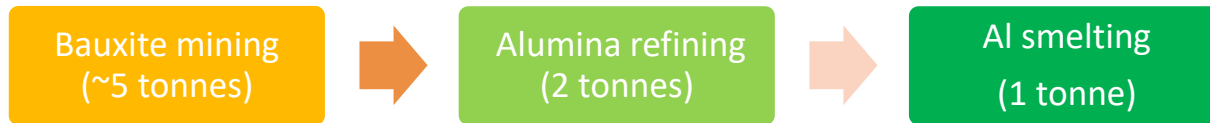
Indonesian Bauxite



North Chinese Bauxite

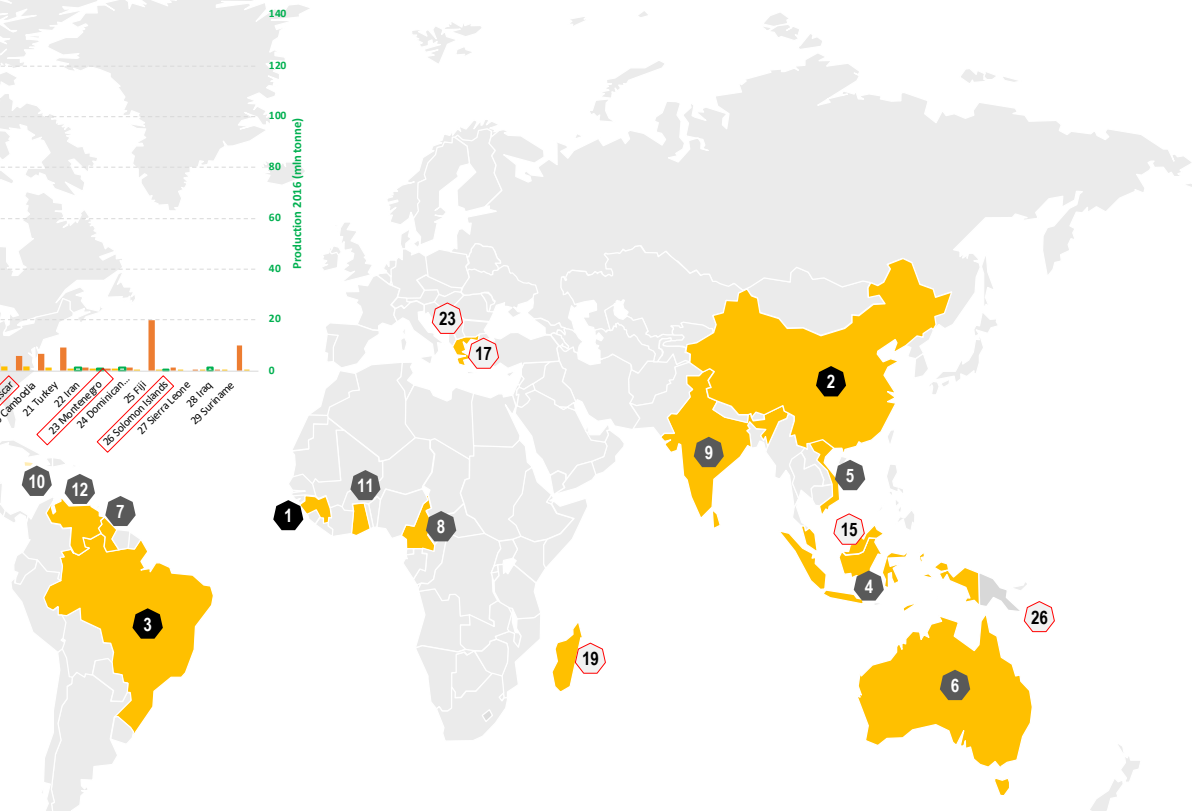
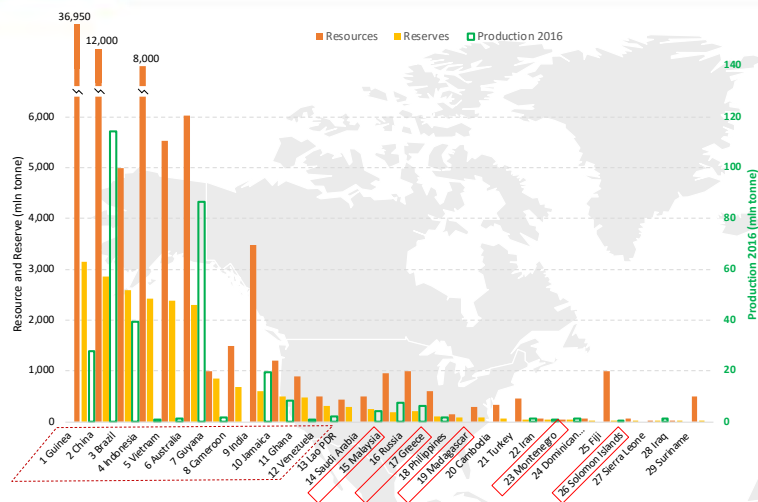


Indian Bauxite



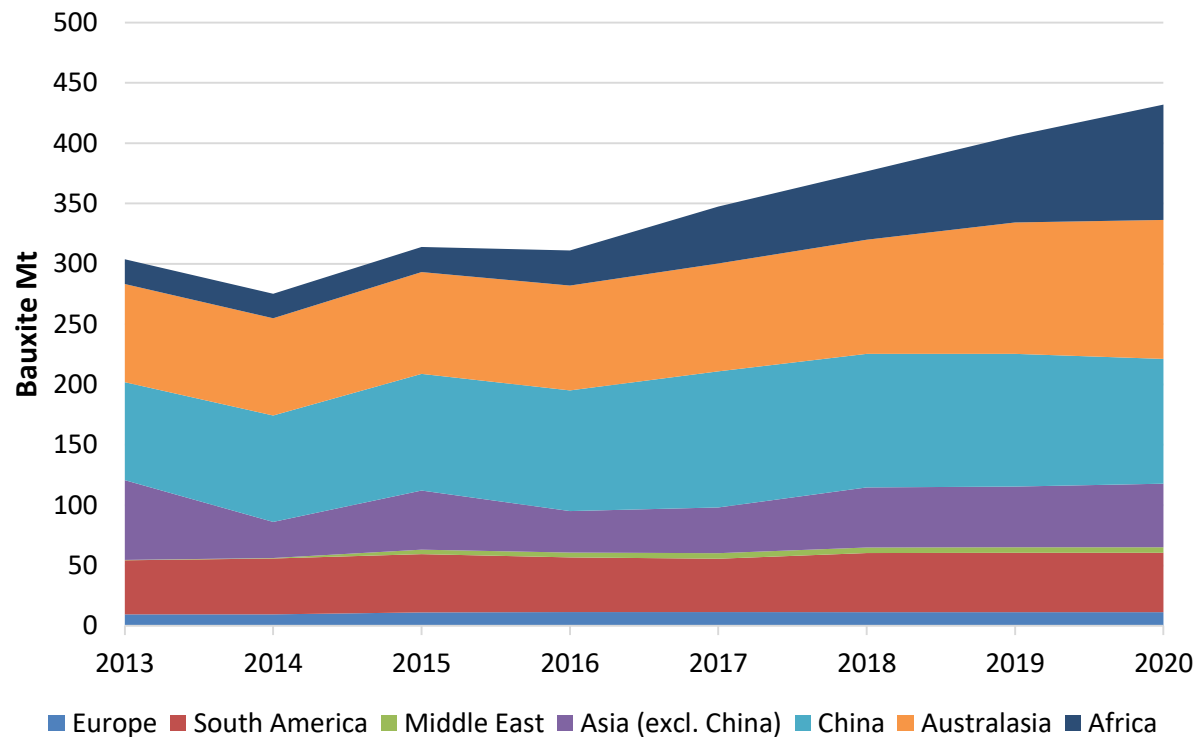
- Bauxite is plentiful in the earth's crust.

Global Bauxite Reserves and Resources By Country



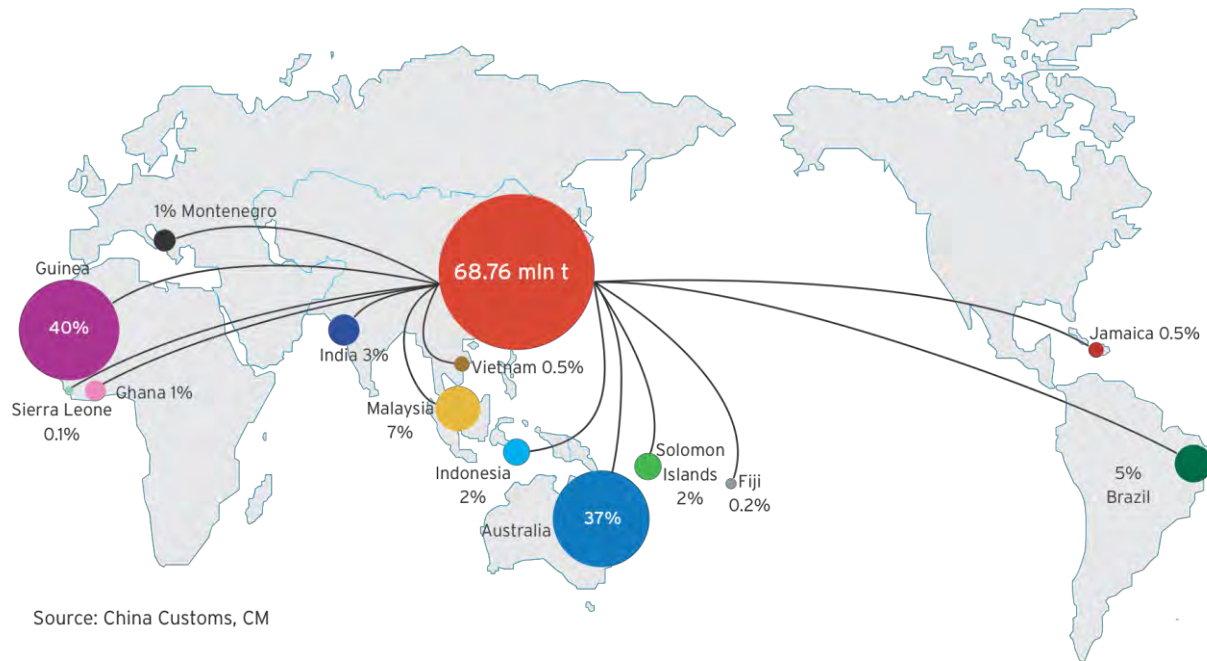
Major changes are underway in the global bauxite supply chain....

- 2017 global bauxite production of 350Mt.
- Forecast 2020 - 430Mtpa.
- 2014 – Indonesian ban removed 30Mt from supply.
- Replaced by Malaysia until 2016 when local mining ban introduced.
- Guinea has been the source of growth since 2016.



In 2020 bauxite production is forecast to be dominated by China (100Mt), Australia (110Mt) and Guinea (100Mt) accounting for >70% of global production.

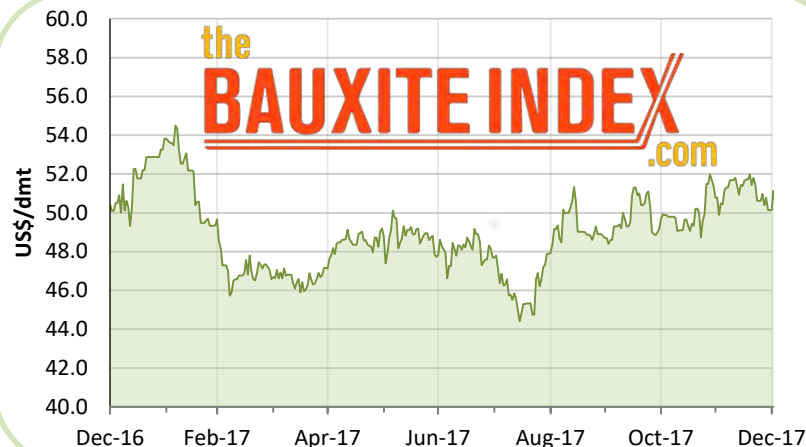
Emergence of Guinea as a major bauxite supplier to China



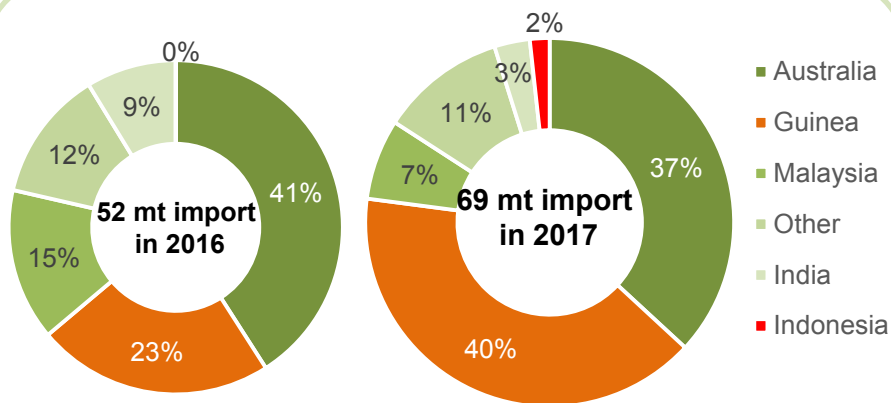
- In 2017, Guinea overtook Australia to become China's largest supplier of bauxite.
- Investments in Guinea are likely to see imports grow significantly over the next five years.
- Malaysia is likely to re-enter the market in H2 2018, as the mining ban in Kuantan is lifted.
- Indonesia is also likely to return in 2018, as the minerals export ban is relaxed.

Bauxite Market Update 2017

CBIX Bauxite Prices



China's Bauxite Imports by Country



- Some bauxite mines in Northern China are forced to shut down given stricter environmental audits, resulting in tightening supply and prop prices. Refiners start to purchase from South of China or import the material since September
- Bauxite imports increased 32% YOY in 2017. **Guinea** has become the largest bauxite exporter to China and **Indonesia** bauxite has returned to the Chinese market
- Given tight supply outlook for domestic bauxite, new alumina capacity will be reliant on imported bauxite and is distributed along the Chinese coastline, such as Chalco Fangcheng project, Bosai Yingkou project and Jin'gang Aluminium Jinzhou project

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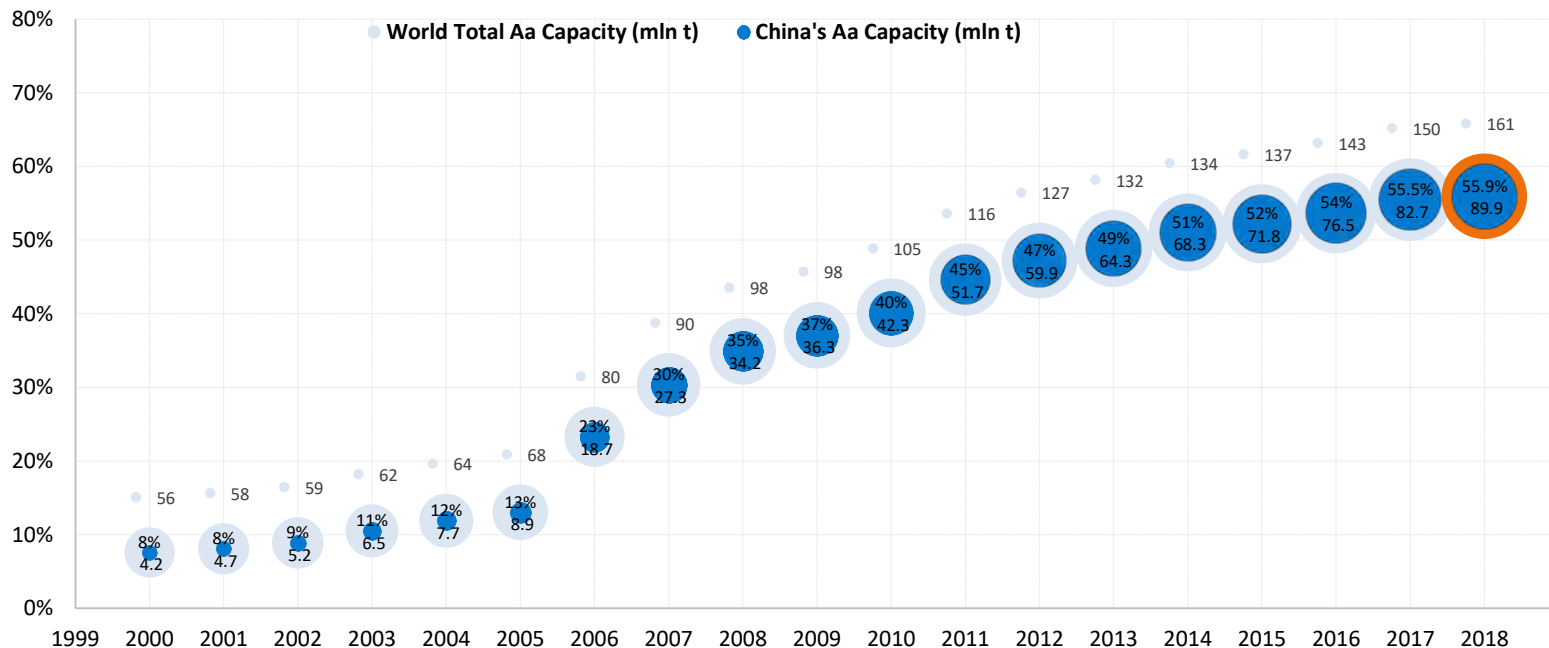
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* SSSR - Structural Supply-Side Reform

Global Alumina Capacity Growth – China vs World (% MTPY)



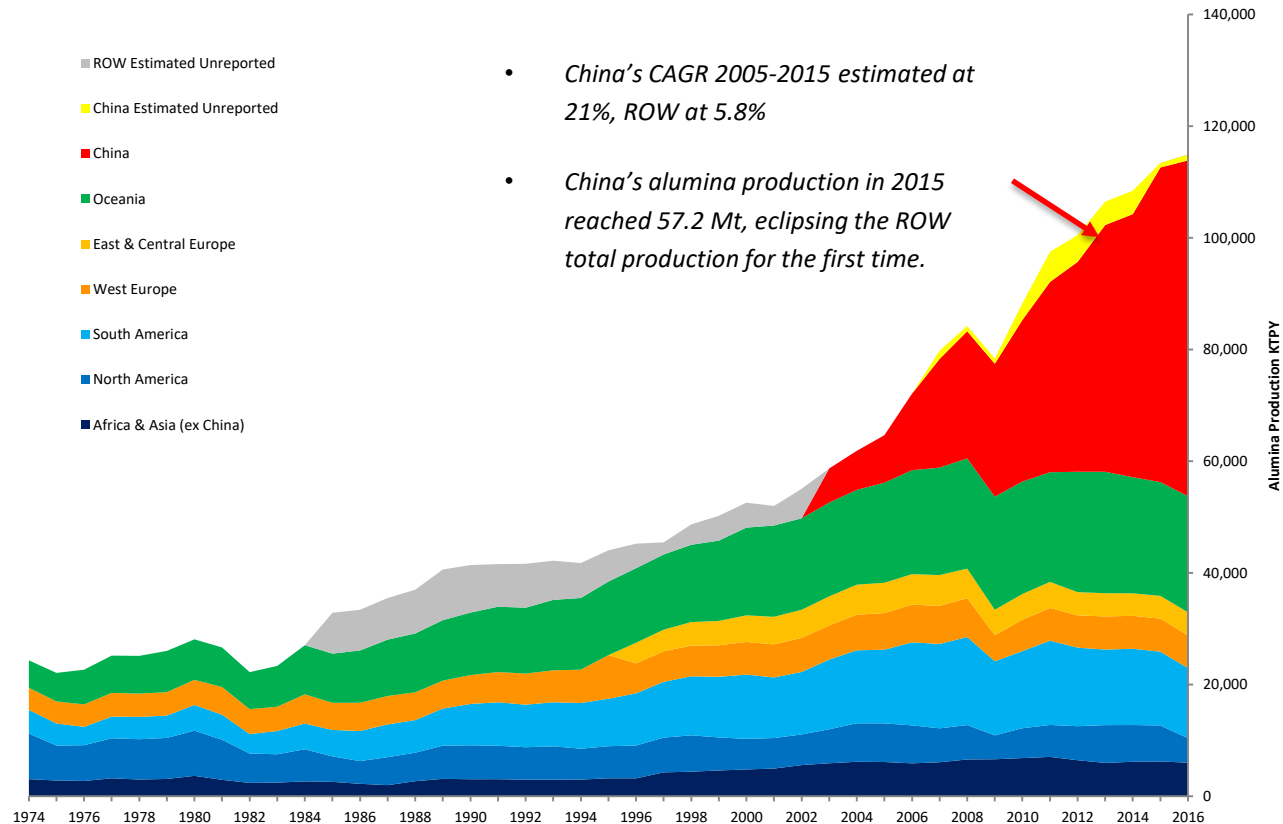
Source: IAI, CM Group

- China added the world's cumulative refining capacity to 2005 in less than a decade.
- In 2018, we forecast a further 7.2 MTPY (5% world capacity) to come onstream in China.
- From 2019 to 2023, we forecast another 25 MTPY (15% world capacity) to come onstream in China.

Global Alumina Production 1974 to 2016

Since 2006

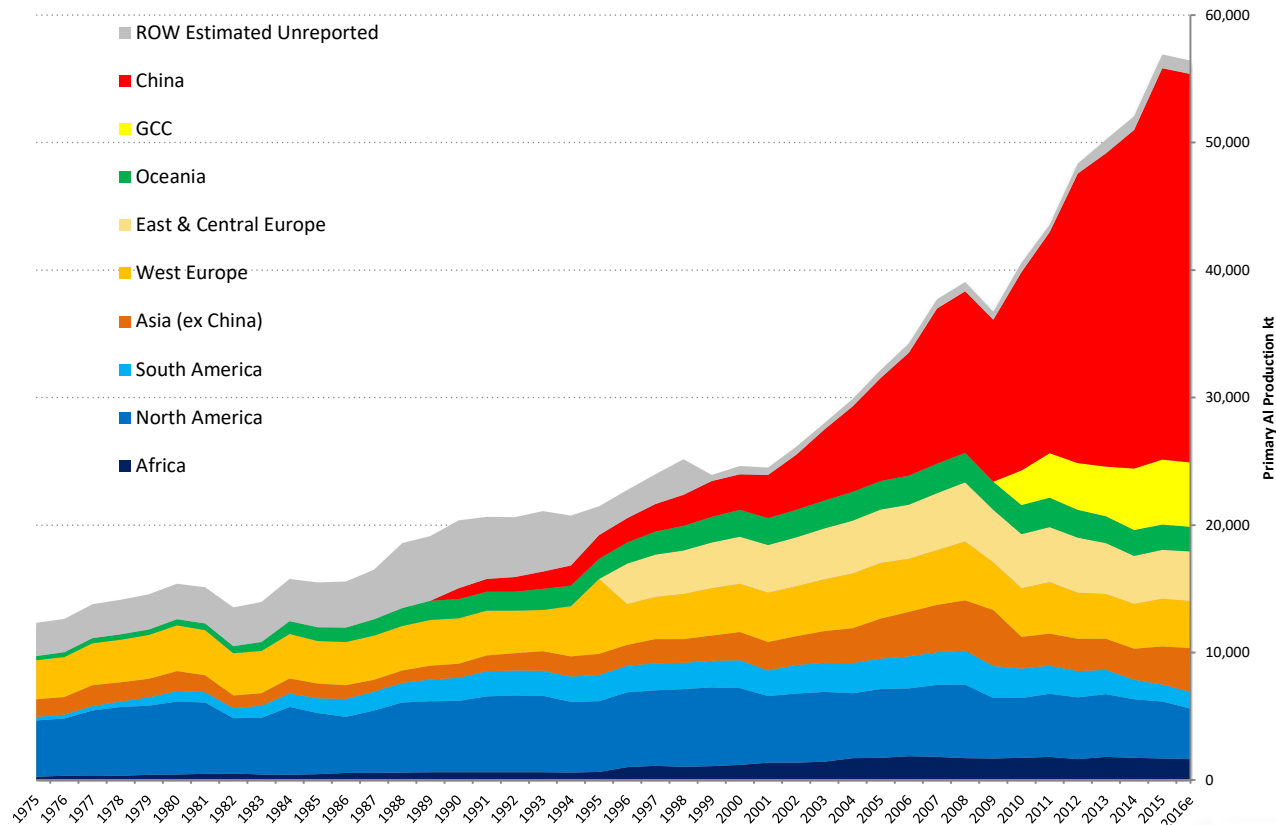
- Strong China AI growth emerged
- China developed its own 'home-grown' refining technology
- Build times were as low as 9 months
- China's proportion in world alumina production jumped from 13% in 2005 to 50% in 2015
- On a full-cost basis, low-cost Chinese refineries are globally competitive
- New alumina refineries are likely to be built either in China or outside of China by the Chinese



Source: ROW - IAI, China - CM Group

Global Primary AI Production by Region 1975 to 2016

- China became the world's largest smelting region in 2003.
- China's primary AI capacity CAGR 2005-2015 was 14% compared with ROW at 0.6%.
- China now represents around 60% of global primary AI capacity..
- China is forecast to produce around 30.8Mt of primary AI in 2016.
- More capacity is currently under construction (2.5 MTPY) and we expect more projects to be announced over the next two years.



Refinery Capital Costs Falling – China the #1 Location for New Capacity Addition



- Alumina refineries in the future are likely to be built in China, but how will they be operated?
- Capital costs are significantly lower, but operating costs are increasing with higher bauxite costs

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Picture: Bauxite Loading Facility Construction, Guinea, March 2018

Environmental - Summary

*Global bauxite market is undergoing **transformational change**, driven by strong Chinese **AI demand growth** and its **depleting domestic reserves**.*

*China initially targeted **Indonesia and Malaysia** for bauxite supply, but both countries **imposed bans** and/or restrictions, citing **poor mining practices** and a need to add value in-country.*

*No matter where bauxite mining occurs in the future, it must be conducted **responsibly and sustainably**. The eyes of the world are increasingly focused on **mining practices**, especially those who use the **end products**.*

Bauxite mining bans: lessons for other countries?

- Kuantan (Malaysia) mining ban extended five times, to mid 2018, mining resumption likely H2 2018
- Requirement to fully clear stocks and review mining operations
- Environmental, safety: water pollution from wash plants, dust, overloading, heavy traffic, poor rehabilitation
- Illegal mining – licensing issues, royalty gaps
- Lessons if Indonesia resumes (or Vietnam starts) exports?



West Kalimantan, Indonesia



Kuantan, Malaysia

Evolution of China's Environmental Policy



China will Continue to Reduce Pollution Medium-term



Increasing public awareness regarding environmental issues

January 2018, CCTV, the largest national TV station reporting Shandong Xinfu's misconduct: non-compliant primary Al capacity goes unreported and associated environmental issues.

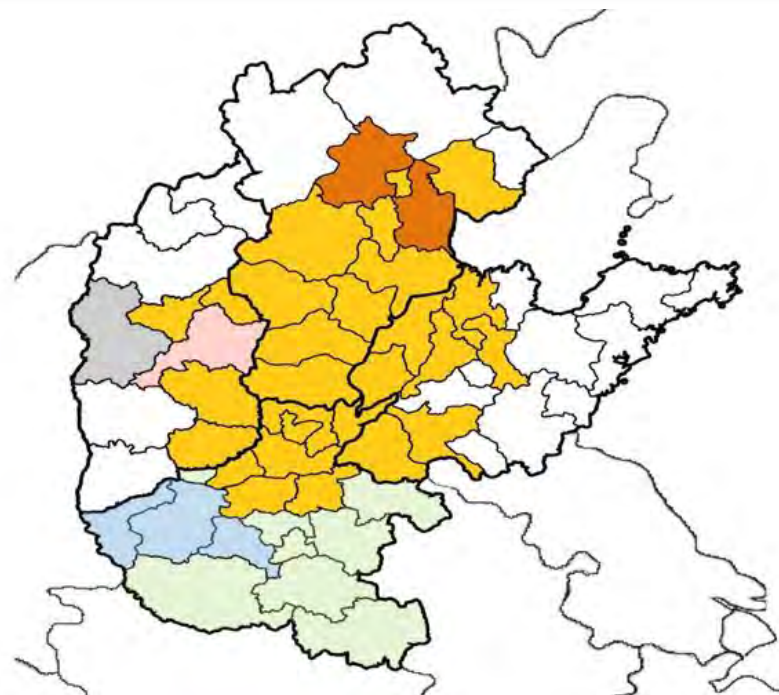
- Slogan of "lucid waters and lush mountains are valuable assets" widely recognized
- More press and resident reports of environmental violations
- Increased transparency in government environmental administration
- Aiming to achieve the goal of innovative, coordinated, green and open development for everyone

Critical bottlenecks in the 'clean-up' process can be:

- Local government's involvement
- Negotiation power of large producers
- Policy consistency - replacing coal with gas, clean fuel of heating

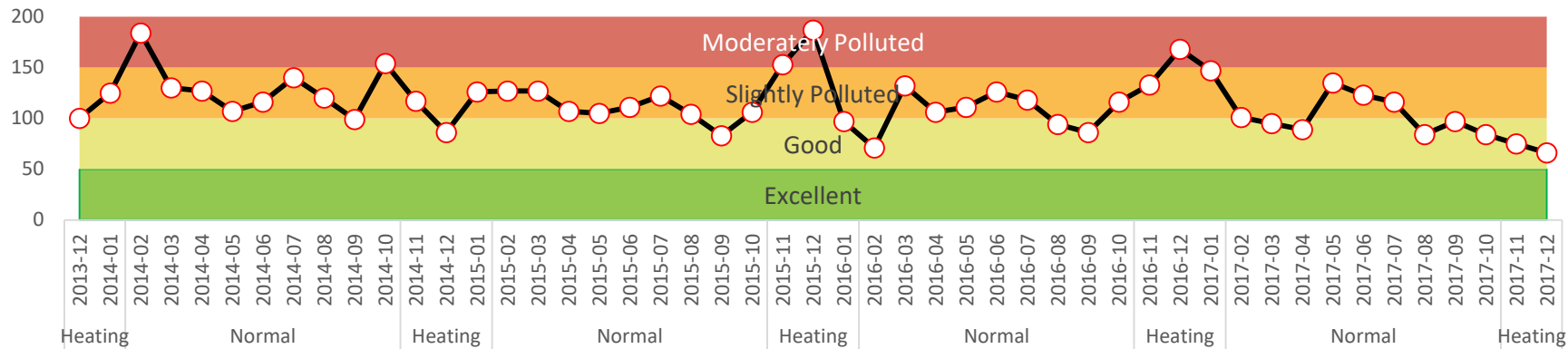
Winter Heating Season Cuts – why and what do they mean?

- Winter heating cuts policy was introduced to reduce air pollution around Beijing during the winter months.
- Cuts were wider and deeper than under the original '2+26 Cities' program.
- Additional 12MTPY refining capacity (mainly in Shanxi) was also caught up in the cuts.
- Some plants (e.g. Chalco) commenced cutting earlier than the mid November date (i.e. from end Oct).
- Has the policy been successful?



The Policy Appears to be Working....

Beijing Air Quality Index (AQI)



2015



2017

China's Carbon Exchange - Price History (RMB/t CO₂e)



- Subdued commodity markets over the past few years means many producers have cut production. As historic emission is a key measure for carbon quota allocation, emission quotas are in oversupply, which has lead to recent price softness for carbon credits.

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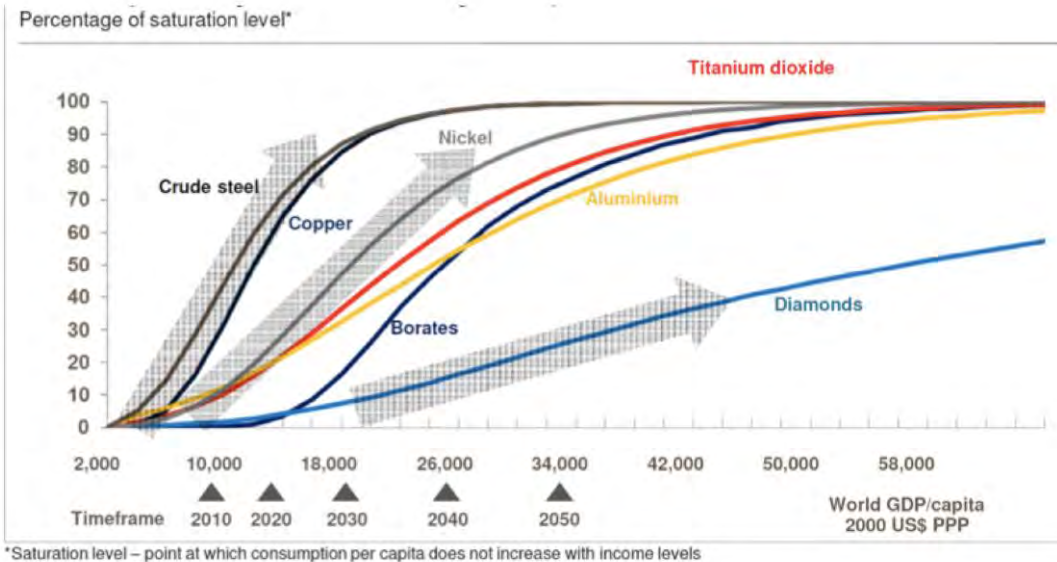
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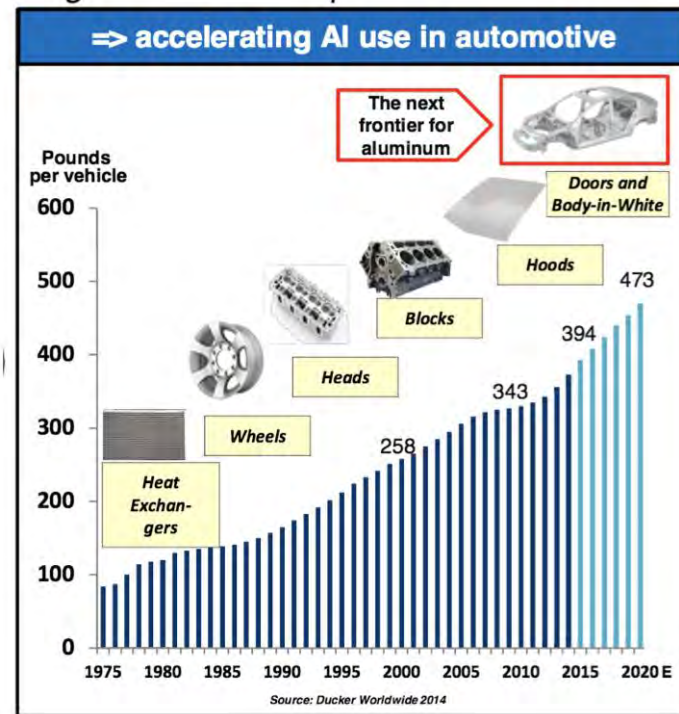
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Strong Outlook for Global Primary Al Growth



- Projected metal usage as GDP/capita increases globally. Growth in aluminum usage in China in early stages; it will take decades for usage to catch up with current usage levels of steel or copper
- Has Al intensity peaked in developed countries?



China in 2018 by the numbers.....another remarkable year

- **Bauxite Mining**

- From **20 to 40 MTPY** mining and export capability in Guinea, West Africa, by Chinese consortium
- Domestic bauxite mining in China up by **4% to 94 million tonnes**.
- Imported bauxite up 20 **million tonnes** in 2017 to 70 million tonnes



- **Alumina Refining**

- **6.9 MTPY** domestic refining capacity built.
- **1.0 MTPY** refining capacity under construction outside China (Indonesia)
- **1.7 MTPY** refining capacity acquired by Chinese interests (Alpart, Jamaica)
- **11.5 MTPY** domestic refining capacity currently under construction (with more planned)



- **Primary Al Smelting**

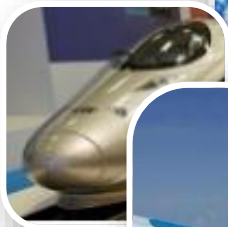
- **2.4 MTPY** new domestic smelting capacity built
- **2.5 MTPY** domestic smelting capacity currently under construction (with more planned)



5-Year Outlook: Stronger Manufacturing and a Greener Environment

13th 5 Five Year Plan (2016~2020): Innovative projects and Energy projects

- Clean and efficient usage of coal
- Smart power grids
- Space, air, ground sensor networks (SAGSN)
- Big data
- AI and robots
- R&D of new material
- Renewable Energy & nuclear power
- 60GW regular hydro-power
- Wind-power and photovoltaic power generation in middle-east and southern China
- Installed nuclear power capacity: 58GW; with 30 GW under construction
- AP1000 project at Sanmen and Haiyang; other projects at Fuqing, Fangchenggang, Rongcheng(CAP1400)
- Ensure supply system of nuclear fuel



“Made in China 2025” plan:

From general consumer goods to satisfy domestic demand for high-end equipment and industrial products, focusing on:

- Large aircraft
- Integrated circuit
- New materials
- Engines for aircrafts
- 5G
- NEV(new energy vehicles)

Implication for industries

- Low-end manufacturers under pressure as China shifts to higher value-added products and services
- A general lift in commodities prices as demand for high-end products grows
- Demand for high-end equipment and industrial products to boost usage of Cu, Li, Co, Ni
- Demand for light-weight vehicles and aircrafts to boost usage of Al and Mg



Source: State Council, MIIT, Xinhua

13th FYP Impact already being felt....

- Greater industry consolidation, led by larger, rejuvenated SOEs
- Higher CAPEX for new projects? Longer project lead times due to the need for valid approvals and environmentally compliant equipment – a move offshore?
- Higher OPEX for new and existing producers.
- Higher industry utilization rates driven by forced closures, leading to tighter supply and the likelihood of *higher cost marginal domestic production*.



Primary Al Production Line, Chongqing
Qineng Group, China – 2017



Establishment of BaoWu Group - 2016



Industry Outlook - Summary

*The aluminium supply chain is set to **grow strongly** over the next decade, particularly **bauxite mining**. In that time, the world will require at least **another 5 mines the size of Huntly** and **10 refineries the size of Pinjarra**.*

*Where they are built and how they are operated will be driven by **industry players and governments** and the **regulations and guidelines** that drive their **behaviour**.*

*Demand surges, supply-chain shocks and, seemingly more so than in other markets, **skittish policy making by unstable governments**, are all likely to play critical roles.*

*It's changing quickly, so **strap in for the ride**.*

End of Presentation

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