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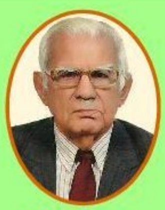

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STEEL PRODUCTION STRONG IN Q3 COS REMAIN UPBEAT ON DEMAND

Mumbai: India's top steelmakers are bullish on demand despite the third wave of the pandemic, after reporting strong production numbers for the December quarter. Buying activity has improved with a rise in pent-up demand and new projects from the infra side and fresh demand coming in from auto and appliances, said Jayant Acharya, director of commercial and marketing at JSW Steel. "We haven't seen much impact on output or demand due to the third wave," he told ET. "The severity of the cases are mild and there are guidelines but no business restrictions/lockdowns in place as of now. So, there is no supply disruption."

JSW reported a combined crude steel production of 5.35 million tonnes for the December quarter, up 6% sequentially and 28% year on year.

ArcelorMittal Nippon Steel India chief marketing officer Ranjan Dhar said judicious restrictions, Covid protocols and effective vaccine administration by the company have helped to keep production unaffected in December and the current quarter. "A series of initiatives undertaken by the government, which got delayed due to the second wave, is coming into play now," he said. "Yellow goods and infra segment has been doing very well." Tackling the third wave has been smooth so far because of increased awareness and adequate preparations by companies, Dhar said.

Moody's in a recent report said that India's steel consumption will rise by high single-digit percentages through 2022, with strong demand from infrastructure and construction, but weaker auto demand amid semiconductor shortage.

Steelmakers are closely watching the pandemic situation. "If a complete lockdown comes into place, we might switch back to exports," a senior industry executive said on condition of anonymity.

Jindal Steel and Power managing director V R Sharma said, "The demand has only been improving since November. We do not see any disruption in production. Only if different states start putting full lockdowns there will be an impact."

Dhar of AM/NS India said, "We do not foresee a very stringent restriction by the government and overall we are positive in terms of demand and output. However, we will be closely monitoring the situation."

Export is an option in case domestic demand slows down due to the third wave, said Dhar and JSW's Acharya. "However a complete lockdown is unlikely as the world is moving towards economic recovery," Acharya said.

Steel prices have been falling in the domestic and international markets.

Fitch Solutions released a report with expectations that steel prices will fall from an average of $950 per tonne to $750 per tonne in 2022, with the prices ultimately dropping to $535 per tonne over 2023-2025.

Indian HRC steel price doubled between June 2020 and October 2021 but is down 12% since then to ₹64,000 per tonne due to softening of coking coal and iron ore prices in the domestic and international markets.

"We believe Indian steel margins have peaked in the first half of FY22 and will fall sharply by FY23, albeit settle above historical levels," Jefferies said in a report. FY23 steel price is expected to be at ₹58,000 per tonne and coking coal at $230/t, 36% lower than the spot price, the report said.

Analysts said companies like the state-owned SAIL will be impacted more in terms of margins.

Source: The Economics Times

HON'BLE STEEL MINISTER SHRI RAM CHANDRA PRASAD SINGH LAYS FOUNDATION STONE FOR NEW 5 MTPA PROJECT AT JSW STEEL VIJAYANAGAR WORKS IN KARNATAKA

The new project is part of JSW Steel's Roadmap to achieve 18 MTPA capacity at its Vijayanagar facility by FY24.

Hon'ble Union Steel Minister, Shri Ram Chandra Prasad Singh, laid the foundation stone for the new 5 MTPA project at JSW Steel Vijayanagar Works integrated steel facility in Ballari, Karnataka. This brown-field expansion project is being undertaken through JSW Vijayanagar Metallics Ltd. a wholly owned subsidiary of JSW Steel Ltd. (the flagship business of US$ 13 billion JSW Group). The Company has earmarked a capex investment of Rs 15,000 crore for this expansion and is expected to be completed by FY24. The Foundation Stone laying ceremony was conducted in the presence of JSW Steel Chairman Shri Sajjan Jindal along with other government and company officials.

The Environmental Clearance (EC) for the project has already been received from the Ministry of Environment, Forests & Climate Change, Government of India and preliminary clearance from the 'Single Window High-Level Clearance Committee' (SHLCC), Government of Karnataka has also been secured. As part of the 18 MTPA Roadmap for its Vijayanagar Works Steel Facility, JSW Steel aims to achieve an additional 1 MTPA expansion through upgradation of the current facility to achieve 13 MTPA capacity within the next 12 months.

Speaking on the occasion, Hon'ble Union Steel Minister Shri Ram Chandra Prasad Singh lauded JSW Steel's contribution to build a stronger India. Dwelling on the growing potential of the steel sector, Steel Minister conveyed that the expansion projects would also help in augmenting the availability of world-class steel and the progressive plans of the Ministry of Steel, Govt. of India.

Speaking on the occasion, Shri Sajjan Jindal, Chairman of JSW Steel said, "I am thankful to Hon'ble Union Steel Minister for joining us on this memorable day and lay the foundation stone for the new brownfield project at our Vijayanagar steel facility. This expansion reiterates our commitment to be a significant partner in building a stronger India through sustainable means. The new 5 MTPA project at Vijayanagar is aligned to our Sustainability goals and focus on circular economy by optimizing our water, waste, carbon and energy footprint. We will efficiently execute this brownfield expansion by leveraging our strong project capabilities and track record. Through the new investments planned here, we will create new job opportunities as well as generate immense value for all our stakeholders. Through the introduction of Artificial Intelligence and other Industry 4.0 interventions at this facility, it will become an integral part of our network of digitally connected smart steel factories in India."

JSW Steel's manufacturing unit in Vijayanagar, Karnataka is the largest single-location integrated steel-making facility in India with a current capacity of 12 MTPA. The new brownfield expansion will be spread across 600 acres and includes establishing 4.5 MTPA Blast Furnace, Steel Melt Shop and 5 MTPA Hot Strip Mill along with other allied and auxiliary facilities.

JSW Steel, as part of its next phase of growth, is targeting an overall capacity of 37.5 MTPA in India and USA by FY25. The brownfield expansion at JSW Steel Vijayanagar Works is part of this broader target.

About JSW Steel: JSW Steel is the flagship business of the diversified US$ 13 billion JSW Group. As one of India's leading business houses, JSW Group also has other business interests in sectors such as energy, infrastructure, cement, paints, sports and venture capital. JSW Steel, certified as Great Places To Work in 2021, has emerged as an organization with strong cultural foundation and great potential to be among the Top 100 companies. Over the last three decades, it has grown from a single manufacturing unit to become India's leading integrated steel company with capacity of 28 MTPA in India & USA (including capacities under joint control). Its roadmap for the next phase of growth includes a target of achieving 37.5 MTPA steel capacity by FY25. The Company's manufacturing unit in Vijayanagar, Karnataka is the largest single location steel-producing facility in India with a capacity of 12 MTPA. JSW Steel has always been at the forefront of research and innovation. It has a strategic collaboration with global leader JFE Steel of Japan, enabling JSW to access new and state-of-the-art technologies to produce & offer high-value special steel products to its customers. These products are extensively used across industries and applications including construction, infrastructure, automobile, electrical applications, appliances etc. JSW Steel is widely recognized for its excellence in business and sustainability practises. Some of these recognitions include World Steel Association's Steel

Sustainability Champion (consecutively 2019 to 2021), Leadership Rating (A-) in CDP (2020), Deming Prize for TQM for its facilities at Vijayanagar (2018) and Salem (2019). It is part of the Dow Jones Sustainability Index (DJSI) for Emerging Markets (2021) and S&P Global's Sustainability Yearbook (consecutively for 2020 and 2021). JSW Steel is the only Indian company to be ranked among the top 15 global steel producers by World Steel Dynamics for 13 consecutive years since 2008. As a responsible corporate citizen, JSW Steel's carbon reduction goals are aligned to India's Climate Change commitments under the Paris Accord.

STEEL SECTOR LOOKS TO INCREASE PRODUCTION, ENHANCE RAW MATERIAL SECURITY IN 2022

Increasing per capita steel consumption and production of special steel as well as enhancing raw material security will remain the key focus areas of the government in 2022. Minister of State (MoS) Faggan Singh Kulaste said the focus will also be on finding new markets as the production of steel continues to grow in the country. As per the National Steel Policy 2017, the government has set a target to ramp up the country's crude steel production output to 300 million tonnes (MT) by 2030. The policy also seeks to increase the domestic per capita steel consumption to the level of 160 kg by 2030.

In an interview with PTI, Kulaste said the per capita steel consumption in the country is at around 72.3 kg at present, while the capacity is at 143.9 MTPA (million tonnes per annum), and the focus will also be on increasing the output of special steel. According to the minister, the Indian steel sector is full of opportunities, and the country must aim to grab the numero uno position in quality steel production. The ministry has already directed the public sector undertakings (PSUs) and private players to take measures to cut imports of special steel.

In 2021, "We signed an MoU with Russia for (to diversify) the supply of coking coal. Players are already using it. The talks with Mongolia are progressing (for the supply of coking coal). PSUs and private players have been directed to increase their Capex and outputs," the minister said. Besides iron ore, coking coal is another key raw material used for making steel. The industry remains dependent on imports from a select group of countries like Australia and South Africa to meet 85 per cent of their coking coal requirement. Industry body Indian Steel Association (ISA) said the finished steel demand in India is expected to be up by around 16.7 per cent to reach around 104 million tonnes by the end of 2021, and by the end of next year, it will be at 111 million tonnes.

ISA Secretary-General Alok Sahay said crude steel production during January-November 2021 period stood at 104.91 million tonnes, and finished steel production and consumption was at 97.882 million tonnes and 93.057 million tonnes, respectively. "We expect 124-125 million tonnes of crude steel output by 2022-end. Economies have been affected globally by the pandemic and India has been no exception. "However, Indian economy rebounded back very quickly and steel industry also was put back on rails with the revival of domestic demand growth. Upfront liquidity in infrastructure projects in the pipeline coupled with the government's emphasis on close project monitoring is driving the steel demand in 2022," he said.

ISA is the apex industry body representing the domestic steel players. In a statement, the state-owned Steel Authority of India Ltd. said 2021 was a challenging year for the company and the entire industry. In the April-June period of the passing year, the company faced one of the "severest calamities" in the form of the coronavirus pandemic.

However, in 2022, SAIL said it would aim to reduce the borrowings of the company. Its gross borrowings stood at Rs 22,478 crore as of September 30, and the same was at Rs 35,350 crore at the end of March this year. "In the medium term, we would like to plan our next phase of modernisation and expansion. Our low debt-equity ratio of about 0.44 gives us the confidence and the opportunity to embark on this next phase of capacity expansion. "We would put more thrust on operational efficiency, digital initiatives, enhanced mining operations, maintaining status as a preferred supplier of steel, etc. in the coming year," the company said.

Tata Steel CEO and MD T V Narendran said the initial few months saw the world and India come out of the COVID crisis with accelerated economic recovery, aided by a concerted focus on vaccination, liquidity push by central banks, policy support and massive investment in infrastructure. During the second COVID wave in April and May, when India bore the brunt of the humanitarian crisis, the steel industry was able to supply liquid medical oxygen and various COVID-related infrastructure support.

"We are optimistic about 2022 and believe that the current strong upcycle will sustain for a longer horizon. The government's focus on infrastructure, ongoing reform measures, including divestment, rationalisation of the Goods and Services Tax, and unwavering thrust on initiatives like 'Aatmanirbhar Bharat' will provide momentum to India's growth story," he said. On the business front, Narendran said, "We expect continued focus on enhancing the ease of doing business while also reducing the overall cost of doing business. We look forward to policy measures to promote usage of steel industry by-products like steel slag, implement a national mining index and revamp the mines auction process".

In a statement, JSW Steel CFO and Joint MD Seshagiri Rao said the importance that has been given to the infrastructure and the National Infrastructure Pipeline (NIP) has created a huge demand for steel. With the kind of policies that are being followed by the government "I am sure that India in the global steel industry will become the 300 MT country before 2030".

V R Sharma, Managing Director of Jindal Steel and Power Ltd. (JSPL), said that in 2022, the steel industry would enhance its role in national development, employment generation and continue to participate meaningfully in economic developments. "We at JSPL are advancing in our quest of making available world-class steel products at an affordable price for building nation of our dream. We are going to enhance our production during 2022, which will further increase the availability of steel in the domestic market," he said.

Source: The Economic Times

GREEN STEEL PRODUCTION IN SWEDEN

Sweden has shown it has potential to become a pioneer in green steel production.

Sweden's steel industry produced 4.4 Mt of crude steel (3.4 Mt of finished steel) in 2020, representing 3.2% of crude steel production (2.5% of total finished steel production) across the EU-27 and the UK. Despite its modest share in the region's steel production, Sweden has been making headlines by being a frontrunner in the global race to produce fossil fuel-free at a commercial scale. At least two initiatives, HYBRIT and H_2 Green Steel, separately, have been launched with a target to manufacture 10 Mt of crude steel annually by 2030.

Sweden's decarbonisation drive in the steel industry signals substantial cost reduction potential for green steel over the coming decades, due primarily to the declining cost of renewable and green hydrogen and increasing carbon prices. The country boasts Europe's largest iron ore reserves and excellent renewable energy resources – two primary prerequisites for the production of green hydrogen and decarbonised crude steel. At a levelised cost of electricity (the price of electricity required for a project where revenues would equal costs, including making a return on the capital invested) at US$30 per megawatt-hour (MWh), wind power is a highly economical source of power generation in Sweden today. Further cost reductions are expected with better financing structures for onshore wind, lower capex for onshore and offshore installations, technological optimization for asset management and state support for offshore grid infrastructure.

Alkaline electrolysis technology is most likely to play a key role in green hydrogen production which is crucial for Sweden's green steel production. Compared to proton exchange membrane electrolysis, it has a lower capex of US$925 per kW today and it is expected to halve by 2030, enabling a levelised cost of US$1 per kilogram of green hydrogen using onshore wind power. A combination of hydrogen from alkaline electrolysis and renewable energy from onshore wind will produce the most cost-effective green crude steel in Sweden.

Producing green steel with cost parity to conventional steel in the 2020s is quite possible if we use natural gas-based direct reduction iron and the electric arc furnace steelmaking process as a baseline.

Although the HYBRIT and H_2 Green Steel projects are backed by industrial heavyweights, some critical parts of the proposed value chain rely on technology solutions that have yet to be tested at an industrial scale, posing considerable challenges that must be overcome to deliver on the promises. Notably, both ventures have yet to find solutions for secure and economical storage of hydrogen and demonstrate their technology's commercial success.

Global steel demand will reach 1.87 billion tones/yr by 2030, 6.47% higher than in 2020. The case for green steel will grow stronger as its cost reduce. In addition, the success of green hydrogen to produce green steel at a commercial scale will justify the enthusiasm around its ability to accelerate decarbonisation.

Source: Weekly News, 23.12.2021 Steel Times International

TATA STEEL REPORTS A 16% JUMP IN CRUDE STEEL PRODUCTION FOR 9M OF FY22

Tata Steel Ltd.'s crude steel production grew by 16% year-on-year (yoy) to 14.16 million tonnes as at the end of nine months ending 31st December 2021, and its total deliveries increased by 4% at 13 MT yoy on the back of continued economic recovery.

"During the third quarter of FY22, Crude steel production was up 1.5% quarter-on-quarter (qoq) to 4.8 MT and overall deliveries were lower by 4% (qoq) 4.41 as an increase in domestic deliveries was offset by lower exports," the company said in a statement.

Tata Steel's Automotive & Special Products segment deliveries increased by 53% yoy in 9M ending FY22 and the 3QFY22 deliveries were broadly similar on QoQ basis, the company said. Branded Products & Retail segment deliveries increased by around 14% yoy in 9MFY22 with 3QFY22 deliveries were higher by 2% qoq.

"Tata Steel's micro-segmentation approach in the MSME segment has helped to increase the downstream branded play by 31%," the company's statement said. Industrial Products & Projects segment deliveries increased by 11% yoy in 9MFY22; 3QFY22 deliveries were higher by 3% qoq with an increased focus on value-added products, the company said. Tata Steel Aashiyana, an e-commerce platform for Individual Homebuilders, registered 129% growth in 9MFY22, total gross revenue stood around Rs 960 crores.

Tata Steel Europe steel production grew by 13% yoy to 7.79 MT and total deliveries increased by 4% yoy as of 31st December 2021. During 3QFY22, Crude steel production and deliveries remained broadly similar on QoQ basis amidst supply chain issues in steel-consuming sectors including chip shortages faced by the Automotive sector.

Source: The Economic Times

JSL SUPPLIES 2,000-TONNE STAINLESS STEEL FOR KANPUR METRO PROJECT

Jindal Stainless Limited (JSL) said recently that it has supplied 2,000-tonne steel for the Kanpur Metro Project, inaugurated by Prime Minister Narendra Modi a few days back. On December 28, the Prime Minister inspected the Kanpur Metro Rail Project and undertook a metro ride from the IIT metro station to Geeta Nagar.

"The PM recently inaugurated a 9-km long completed stretch of Uttar Pradesh Metro Rail Corporation's (UPMRC) Kanpur Metro Project. JSL has supplied 2,000 tonnes of stainless steel for the project," the company said in a statement.

For the project, Jindal Stainless supplied high-quality stainless steel in various tempers (strength levels) to Alstom. The first train set was handed over to UPMRC by Alstom on September 18, 2021.

The scope of the metro project includes the design and development of 201 coaches. Each coach will require approximately 9-10 metric tonnes of stainless steel, supplied by Jindal Stainless, the steel firm said. The company further said it has already supplied stainless steel to metro projects in Sydney and Queensland, apart from Delhi, Kolkata, Bangalore and Chennai metro projects.

Source: The Economic Times

TATA STEEL LONG PRODUCTS TO BUY NEELACHAL ISPAT FOR RS 12,100 CRORE

The centre on Monday said it has approved the bid of Tata Steel Long Products Limited to purchase Neelachal Ispat Nigam Ltd. (NINL) for Rs 12,100 crore.

Apart from Tata Steel, consortium of Jindal Steel & Power Limited and Nalwa Steel and Power Ltd. and JSW Steel Limited also bid for the company.

“Government approves strategic buyer for Neelachal Ispat Nigam Ltd. located in Odisha. The highest bid of Rs12,100 crore by M/s Tata Steel Long Products Ltd. is accepted,” DIPAM secretary Tuhin Kanta Pandey tweeted.

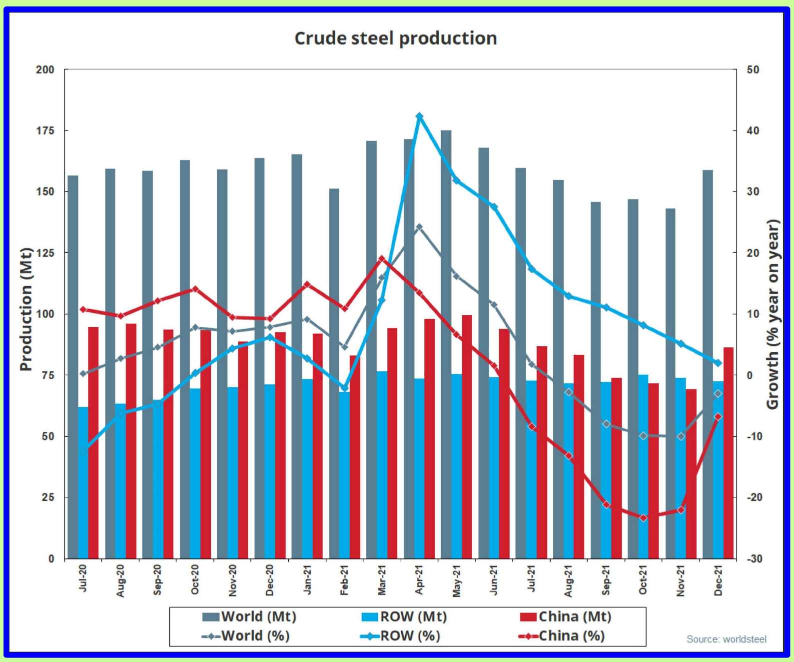
The amount will go towards settling liabilities of the company in the order provided in Waterfall Agreement. The company has debt and liabilities exceeding Rs 6,600 crores as on 31.3.2021, including overdues of promoters banks, other creditors and employees. The finance ministry added that the company has negative net-worth of Rs 3,487 crore and accumulated losses of Rs 4,228 crore as of March 31, 2021. In a statement issued on

Monday, the ministry said the bid for NINL was approved by Alternative Mechanism, comprising Nitin Gadkari, Nirmala Sitharaman and Piyush Goel.

NINL is a joint venture of four Central Public Sector Enterprises, MMTC, NMDC, BHEL, MECON and two Odisha government PSUs, OMC and IPICOL. The company has an integrated steel plant with a capacity of 1.1 MT at Kalinganagar, Odisha. The company has been running in huge losses and plant has been closed since March 30, 2020. The expressions of interest (EoI) were invited on January 25, 2021 and final three bids were received by December 23. The ministry said the employees of NINL, will continue with the company in terms of the share purchase agreement (SPA), which binds the buyer to have a lock-in period of one year. The strategic buyer will also be bound to follow the terms of voluntary retirement scheme applicable to CPSEs whenever such a decision to taken.

Source: The Economic Times

DECEMBER 2021 CRUDE STEEL PRODUCTION AND 2021 GLOBAL CRUDE STEEL PRODUCTION TOTALS



December 2021 crude steel production

World crude steel production for the 64 countries reporting to the World Steel Association (worldsteel) was 158.7 million tonnes (Mt) in December 2021, a 3.0% decrease compared to December 2020.

Crude steel production by region: Africa produced 1.2 Mt in December 2021, down 9.6% on December 2020. Asia and Oceania produced 116.1 Mt, down 4.4%. The CIS produced 8.9 Mt, down 3.0%. The EU (27) produced 11.1 Mt, down 1.4%. Europe, other produced 4.3 Mt, down 0.8%. The Middle East produced 3.9 Mt, up 22.1%. North America produced 9.7 Mt, up 7.5%. South America produced 3.5 Mt, down 8.7%. The 64 countries included in this table accounted for approximately 98% of total world crude steel production in 2020. Regions and countries covered by the table:

- **Africa:** Egypt, Libya, South Africa
- **Asia and Oceania:** Australia, China, India, Japan, New Zealand, Pakistan, South

Korea, Taiwan (China), Vietnam

- **CIS:** Belarus, Kazakhstan, Moldova, Russia, Ukraine, Uzbekistan
- **European Union (27)**
- **Europe, Other:** Bosnia -Herzegovina, Macedonia, Norway, Serbia, Turkey, United Kingdom
- **Middle East:** Iran, Qatar, Saudi Arabia, United Arab Emirates
- **North America:** Canada, Cuba, El Salvador, Guatemala, Mexico, United States
- **South America:** Argentina, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, Uruguay, Venezuela

Table 1. Crude steel production by region

	Dec 2021 (Mt)	% change Dec 21/20	Jan-Dec 2021 (Mt)	% change Jan-Dec 21/20
Africa	1.2	-9.6	16.0	26.7
Asia and Oceania	116.1	-4.4	1,382.0	0.6
CIS	8.9	-3.0	105.6	5.6
EU (27)	11.1	-1.4	152.5	15.4
Europe, Other	4.3	-0.8	51.2	11.6
Middle East	3.9	22.1	41.2	1.2
North America	9.7	7.5	117.8	16.6
South America	3.5	-8.7	45.6	17.8
Total 64 countries	**158.7**	**-3.0**	**1,911.9**	**3.6**

Top 10 steel-producing countries

China produced 86.2 Mt in December 2021, down 6.8% on December 2020. India produced 10.4 Mt, up 0.9%. Japan produced 7.9 Mt, up 5.4%. The United States produced 7.2 Mt, up 11.9%. Russia is estimated to have produced 6.6 Mt, the same as in December 2020. South Korea produced 6.0 Mt, up 1.1%. Germany produced 3.1 Mt, up 0.1%. Turkey produced 3.3 Mt, down 2.3%. Brazil produced 2.6 Mt, down 11.4%. Iran is estimated to have produced 2.8 Mt, up 15.1%.

2021 global crude steel production totals

Total world crude steel production was 1,950.5 Mt in 2021, a 3.7% increase compared to 2020. Please see the Steel Data Viewer for the complete listing of annual production totals by country.

Table 2. Top 10 steel-producing countries

	Dec 2021 (Mt)		% change Dec 21/20	Jan-Dec 2021 (Mt)	% change Jan-Dec 21/20
China	86.2		-6.8	1,032.8	-3.0
India	10.4		0.9	118.1	17.8
Japan	7.9		5.4	96.3	14.9
United States	7.2		11.9	86.0	18.3
Russia	6.6	e	0.0	76.0	6.1
South Korea	6.0		1.1	70.6	5.2
Turkey	3.3		-2.3	40.4	12.7
Germany	3.1		0.1	40.1	12.3
Brazil	2.6		-11.4	36.0	14.7
Iran	2.8	e	15.1	28.5	-1.8

Rank		2021	2020	%2021/2020
1	China	1 032.8	1 064.7	-3.0
2	India	118.1	100.3	17.8
3	Japan	96.3	83.2	15.8
4	United States	86.0	72.7	18.3
5	Russia (e)	76.0	71.6	6.1
6	South Korea	70.6	67.1	5.2
7	Turkey	40.4	35.8	12.7
8	Germany	40.1	35.7	12.3
9	Brazil	36.0	31.4	14.7
10	Iran (e)	28.5	29.0	-1.8
11	Italy	24.4	20.4	19.7
12	Viet Nam (e)	23.6	19.9	18.4
13	Taiwan, China (e)	23.3	21.0	10.9
14	Ukraine	21.4	20.6	3.6
15	Mexico (e)	18.4	16.8	9.5
16	Spain	14.0	11.0	27.7
17	France	13.9	11.6	20.3
18	Canada (e)	12.8	11.0	16.2
19	Indonesia (e)	12.5	12.9	-2.9
20	Egypt	10.3	8.2	25.1
21	Saudi Arabia	8.7	7.8	12.3
22	Poland (e)	8.4	7.9	6.5
23	Austria (e)	7.9	6.8	17.1
24	United Kingdom (e)	7.4	7.1	3.9
25	Belgium (e)	7.0	6.1	13.6
26	Netherlands	6.6	6.1	9.4
27	Malaysia (e)	6.5	6.6	-1.8
28	Australia	5.8	5.5	6.0
29	Thailand (e)	5.6	4.5	25.8
30	Bangladesh (e)	5.5	5.5	0.0
31	Pakistan (e)	5.3	3.8	39.9
32	South Africa (e)	5.0	3.9	29.5
33	Argentina	4.9	3.7	33.5
34	Slovakia	4.9	3.4	41.2
35	Czechia	4.8	4.5	7.9
36	Sweden	4.7	4.4	6.1
37	Kazakhstan (e)	4.4	3.9	12.5
38	Finland	4.3	3.5	24.1
39	Algeria (e)	4.0	4.0	0.0
40	Romania (e)	3.4	2.8	21.8
	Others	36.2	34.0	6.4
	World	**1 950.5**	**1 880.4**	**3.7**

Source: World Steel Association

THE GLOBAL ALUMINIUM INDUSTRY 40 YEARS FROM 1972

1. Introduction

Today, the global aluminium industry has only a bare resemblance to what it was in the early 1970s. The most important structural changes are the geographical relocation of bauxite, alumina and aluminium production centres; shifts in the degree of concentration and integration; the emergence of new consuming regions, the development of new end-use markets and the threat of substitutes, including recycled metal; the historical decline in real prices of the metal and the recent upward shift in the industry cost curve; the market adjustment mechanisms and, more recently, the rising popularity of commodities as an asset class.

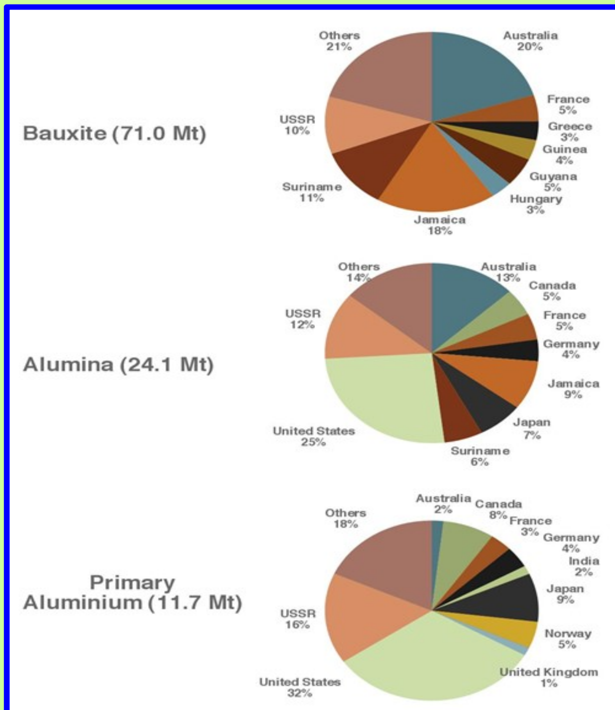


Figure 1: World Production of Bauxite, Alumina and Aluminium (1972)

The main objective of this paper is to highlight and analyse these changes over the last four decades. Commencing with an identification of the main characteristics of the aluminium industry in the early 1970s, the paper then examines the main forces or drivers that have deeply modified the structure of the global aluminium industry, factors such as energy crises, arrival of new players, variations in exchange rates, shifting trends in aluminium cost curves, and the role of emerging economies. The main characteristics of current global aluminium industry are then presented, with a view on future demand and production.

2. The Global Aluminium Industry in the Early 1970s

The year 1972 saw bauxite production dominated by four countries — Australia, Jamaica, Suriname and USSR — which together held a 60% global market share. Today, only Australia is on a list of the top six producers. Even greater changes have occurred in the location of alumina-producing countries. In 1972, more than 45% of global alumina production was concentrated in five industrialized countries, poorly-endowed with bauxite reserves: United States, Japan, Canada, France and Germany. The other major producers were then Australia (13%), USSR (12%), Jamaica (9%) and Suriname (6%). Today, among the countries mentioned above, only Australia is still a significant producer, with alumina production having generally shifted from industrialized or aluminium producing countries to bauxite producing regions.

Major shifts have also occurred in the geographic location of aluminium production centres. The combined share of United States, USSR and Japan reached almost 60% of global primary production in 1972. Today, their corresponding share barely exceeds 10%. Norway, Germany and France have also been replaced on the list of top aluminium producers. This relocation of bauxite, alumina and aluminium production centres has been accompanied over the last 40 years by other significant structural and behavioural changes that need to be analysed.

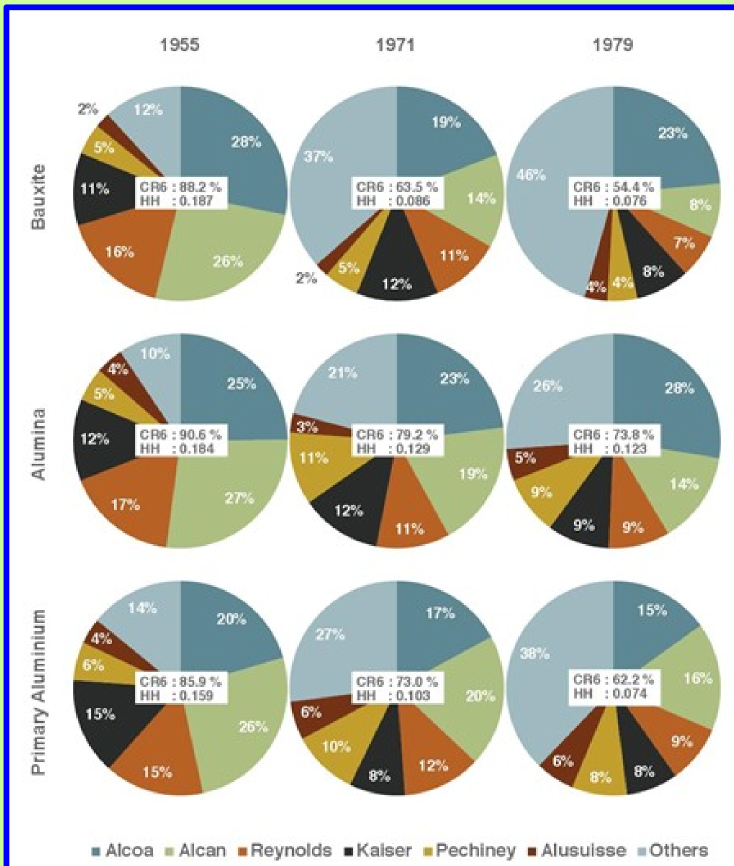


Figure 2: Market Shares and Degree of Concentration[1] in Global Bauxite, Alumina, & Primary Capacities: 1955, 1971, 1979

The international aluminium industry was dominated in the early 1970s by the "Six Majors" – Alcoa, Alcan, Reynolds, Kaiser, Pechiney and Alusuisse – with a combined share then exceeding 60% for bauxite, approaching 80% for alumina and hovering around 73% for primary aluminium. Despite this robust degree of concentration, Figure 2 indicates that it was even higher in the mid-1950s (between 85 and 90% at each step of the production process), while towards the end of the 1970s the combined market share of the Six Majors was still significant. An alternative way to measure the degree of concentration is to sum the square of each producer market share (the HH index) in order to give more weight to large players in an industry and thus better assess the existence of market power. This index is presented in Figure 2. In addition to a high degree of concentration, Figure 2 also suggests that the aluminium industry of the early 1970s was highly integrated, since the companies with smelters were operating alumina plants to supply alumina to the smelters and bauxite mines to supply bauxite to alumina refineries.

Vertical integration also extended beyond the integration of mining, refining and smelting: the operations of the largest aluminium companies of that period also embraced the production of downstream fabricated aluminium products such as sheet & plate, extruded products, wire, cable & tubes and foil.

Given the product characteristics (light weight, strength, moderate melting point, ductility, conductivity, corrosion resistance and barrier properties), aluminium consumption experienced a compounded annual growth rate (CAGR) of almost 10% over the 1945-1972 period – thus exceeding GDP growth, a clear sign of increasing intensity of use of aluminium per product – gaining ground in building applications, electric cables, basic foils and the aircraft industry. In the early 1970s, an additional boost resulted from the development of aluminium beverage cans. Forty-years ago, 62% of global consumption of primary aluminium was concentrated in six industrialized Western countries, the United States leading the pack with a market share of 36.3%, and Japan second at 10.3%. China's share was below 2.5% in 1972, while about 12% of global demand was then concentrated in the USSR. For total aluminium consumption by end-use, the pattern was quite different by region.

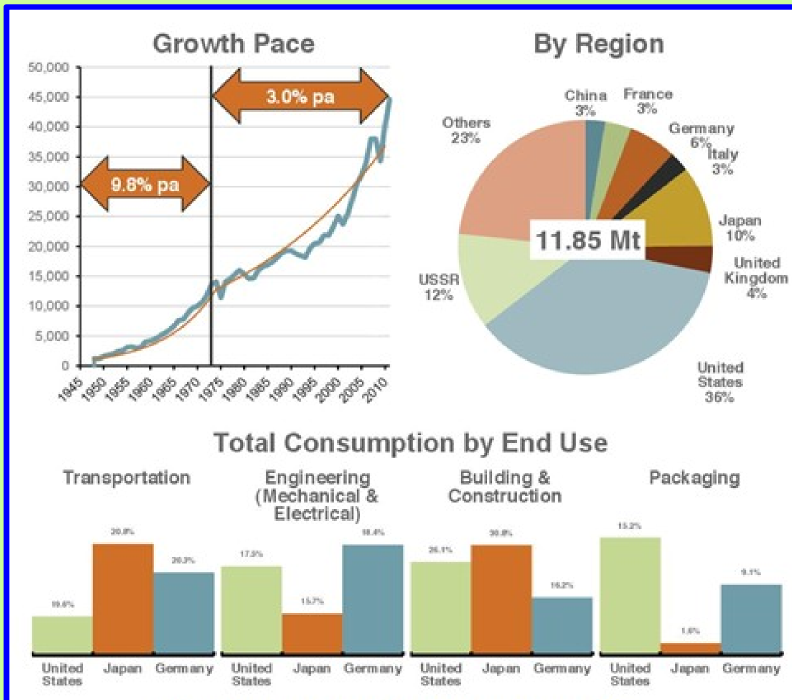


Figure 3: Primary Aluminium Consumption, 1972

Slightly more than 20% of German aluminium was used by the transportation sector, followed by engineering (18%) and building & construction (16%). Only 9% of aluminium shipments were directed to the packaging sector. The picture was quite different in Japan where aluminium demand was dominated by building & construction (31%), followed by transportation and engineering; the Japanese packaging sector was absorbing in the early 1970s less than 2% of total demand. While similar to Japan with building and construction consumption at 26%, the US packaging consumption share was much higher at 15.2%.

In each end-use sector, aluminium was in the early 1970s displacing substitutes, including cast iron, rolled and galvanized steel, tinplate, cast zinc, copper wire and tube, timber, glass, cardboard and metallised paper. The rivalry between substitutes would become harsher in the following decades as consumers continuously assessed not only the functional characteristics of competing materials but also their relative prices. Within the aluminium sector, the substitution of primary metal by recycled aluminium metal has been a significant change, with a shift in environmental and social attitudes over the period bringing the industry to a new paradigm in terms of sustainability and product life cycles. The aluminium beverage can takes centre stage during the early part of the period under review and further reinforces the development of the aluminium recycling industry. According to WBMS data, aluminium recovered from scrap in Western countries represented in 1972 about 21% of Western World total (primary and secondary) consumption of aluminium. The latter share remained below 24% until the end of the 1970s.

Market adjustment mechanism

Forty years ago, the peaks and troughs of aluminium demand were managed by changes in capacity rates of utilization or inventory accumulation but as little as possible by changes in price. This was the period dominated by producers' list prices which were typically rigid despite considerable instability in market conditions. Such insensitivity or "stickiness" of producers' prices is possible as long as:

1. The metal demand facing a dominant group of producers is in the short run insensitive to price variations (because of a lack of substitutes);
2 The average total cost curve is flexible (because variable costs are important in the cost structure since there are very few take-or-pay contracts); and
3. The management is able to coordinate cutbacks of production (because of a soaring concentration ratio).

If the above conditions prevail, then the producing firms or dominant strategic group of firms will use their market power to stabilize prices against developing excess capacity. Market prices cannot survive in such market conditions since prices are then too sticky.

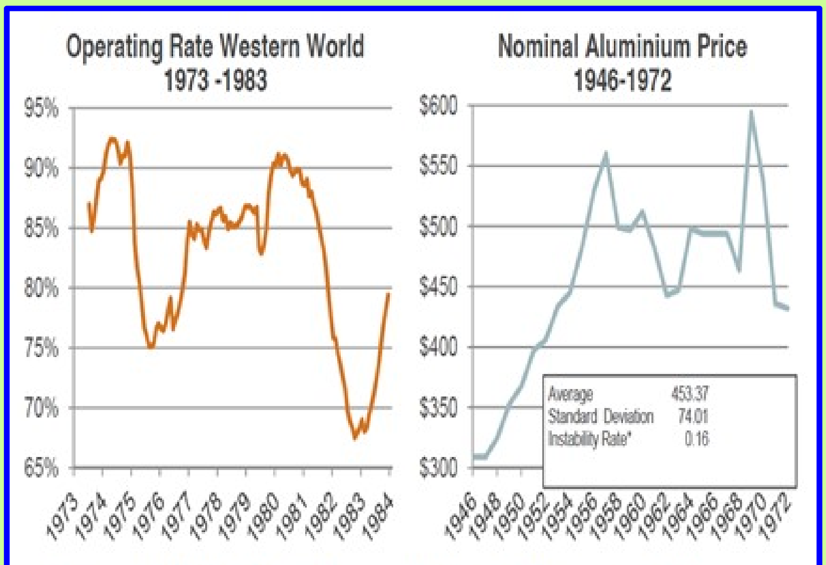


Figure 4: Utilization Rates and Nominal Aluminium Prices

As suggested above, these conditions were to a large extent present in the global aluminium industry between the mid-1940s and the early 1970s. Consequently, aluminium nominal prices hovered around their average of US$ 453 per tonne during the 1946-1972 period (see Figure 4) with a degree of instability of only 0.16, measured as the standard deviation over the average price for the period. However, during that same period, utilization rates below 80% were not uncommon. In October 1978, in spite of strong producer opposition, the first aluminium contract was introduced on the LME, a clear sign that the major Western producers had started to lose control of price setting in their industry.

Historical decline in real prices of metals

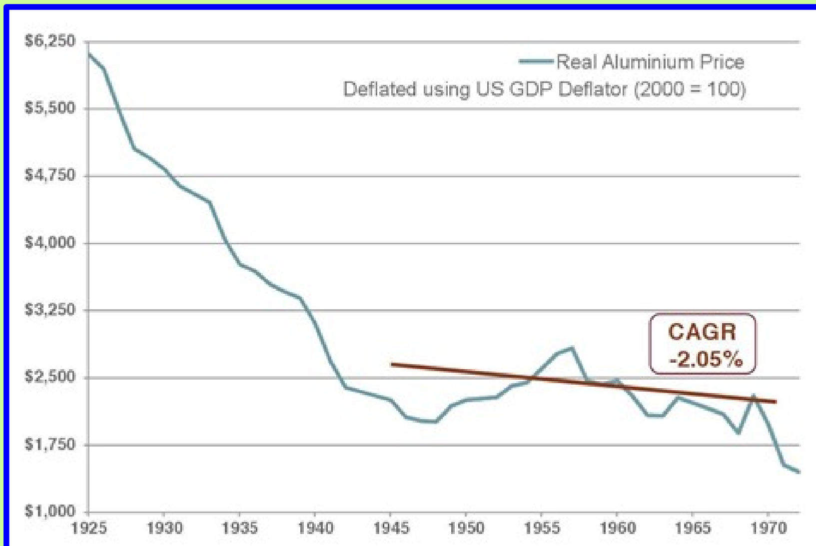


Figure 5: Real Aluminium Price: 1925 -1972

Finally, the global aluminium industry was characterized, until the mid-1970s, by declining real prices. There may be disagreement about identifying the appropriate price deflator, selecting a relevant time period or estimating a trend that periodically changes in some unknown way, but the fact remains that real prices of primary aluminium were sliding down. As suggested by Figure 5, the rate of decline has been estimated at about 2% per year during the1945-1972 period. Technological change and economies of scale tend to push down extraction and processing costs over time, whereas the need to exploit lower-grade poorer quality deposits or the use of fast increasing input costs (such as energy or chemical products) tends to drive production costs up. Thus, for a long period of time, the beneficial effects of technological change have offset the adverse effects of higher production costs, allowing the real price to decline.

This favourable trend cannot continue indefinitely as rising costs of bauxite and, above all, energy will eventually offset the decline in production costs. Other drivers such as exchange rates, greenhouse gas regulation and the shape of the industry cost curve must also be taken into account.

3. Main Drivers of Change Since 1972

In a nutshell, the global primary aluminium industry of the early 1970s was highly concentrated and vertically integrated. A large share of the alumina and aluminium production was taking place in industrialized countries and not in regions endowed with abundant bauxite or energy resources. Primary consumption was then increasing at a faster pace than GDP, a clear sign of increasing intensity of use of aluminium relative to most of its substitutes. Prices were quite stable since market imbalances between demand and supply were corrected by volume variations. Finally, real prices were declining by about 2% per year due mainly to improved economies of scale. Why are the structural characteristics of the global aluminium industry so different today? What have been the main drivers of change since 1972?

Higher energy prices

Energy shocks of 1973 and 1979, and the surge of energy demand in China, India, Brazil and other fast growing emerging economies in the early years of the new millennium have pushed up prices not only of oil but also of all other forms of energy (Figure 6). Even if discoveries of new energy supply or financial crises have kept prices at bay, the general trend has definitely been upward, thus increasing the price of electricity generation. The latter jump in electricity prices has dramatically altered the international competitiveness and hence location of industries such as aluminium whose production process uses large amounts of electricity. Energy shocks and the soaring energy demand in many emerging economies did not push up the price of electricity equally in all countries. Some nations are endowed with ample supplies of hydropower or low cost coal preventing electricity costs from rising as sharply as in nations more dependent on imported oil-generated power.

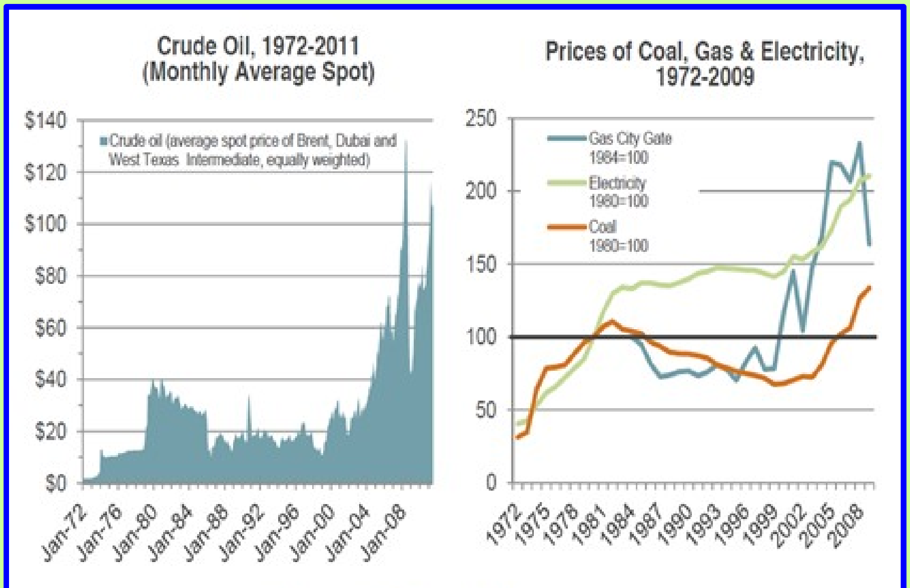


Figure 6: Energy Prices

The interregional differences in electricity prices and hence in countries' primary aluminium production costs were exacerbated by the factors mentioned above, accelerating the shift of primary aluminium production centres that began in the 1970s from high cost locations such as Japan, United States and Western Europe to lower cost regions such as Australia, Canada, Middle East, Russia and China. In the last 10-15 years, the shift has accelerated, with the Middle East strengthening its position as a leading aluminium production centre; within China, the move is from the high cost areas of the south and south-east to the west and north-west regions. However, differences in electricity prices do not fully explain the shift in primary aluminium production centres. The impact of public policy — electricity rates below the long-run marginal opportunity cost of production, taxes, exchange rates, trade tariffs, or industry subsidies — also needs to be taken into account. The clear objective of these policy-induced changes to competitiveness was to promote growth of the aluminium industry in the low-cost power countries or maintain its existing size in high-cost ones.

Arrival of new players

Starting in the late 1960s, the Six Majors' share of primary aluminium production started to decline, reflecting the entry of new private producers, conglomerates and of partly or wholly state-owned enterprises. While the main objective of the private new entrants was profit maximization through diversification, brought about by horizontal integration, economies of scale or better control of raw materials/markets for final products, the motivations or goals of state-owned enterprises (SOEs) are less clearly specified.

Among the main SOEs objectives, one should note:

- addressing uncompetitive market structures due to the presence of economies of scale, established marketing and distribution systems, patents or ownership of rich mineral resources;
- compensating for insufficient investment resulting from excessive risk aversion and short-sightedness of private entrepreneurs;
- improving national employment, income distribution and regional equality; or,
- the pursuit of political goals such as the national sovereignty of natural resources.

Government influence on mining, refining and smelting activities may take a variety of forms, including not only various degrees of equity ownership but also interventionist policies on the exploration/exploitation of mineral and energy resources, changes in royalties and other forms of taxation, the movement of foreign exchange, policies on local purchase requirements and employment restrictions (such as targets for substituting nationals for foreign personnel in management positions). According to the OECD *(Aluminium Industry: Energy Aspects of Structural Change, 1983, p.99)*, 46% of primary aluminium capacity in the world was under direct government influence in the early 1980s, either through state ownership or equity participation. With centrally planned economies excluded, government involvement remained significant since 31% (including Pechiney which was nationalized in 1981) of the global capacity were then under direct government influence.

In addition to the Six Majors of the early 1970s, a long list of private or government-influenced producers has joined the fray over the last four decades. Among the most significant are UC Rusal, Chinalco/Chalco, BHP Billiton, Rio Tinto Alcan (combination of Alcan, Alusuisse, Pechiney and Comalco), Hydro Aluminium (combination of VAW and CVRD/Vale aluminium assets), Century Aluminium, Ormet, Glencore, CVG of Venezuela, China Power Investment Corporation (CPI), Dubai Aluminium Company, Aluminium Bahrain, Mubadala, Hindalco, Nalco, Vedanta Resources, Aluar, CBA, and various Chinese State governments or private investors (including Guangxi Investment Group, Zengshi Group, Wanfang Group, Zhongmai Group, Yankuang Group and Xinfa Group). The list of merged or acquired producers over the same period is also significant and includes among them Alcan, Reynolds, Alumax, Alusuisse, Corus, Pechiney, Gencor, RTZ-Comalco, Hoogovens, VAW, Howmet, Hanna Mining, Camargo Correa, Ardal Sunndal Verk (ASV), Alumix, Noranda, Granges AB, Commonwealth, Martin Marietta Aluminium, SUAL, Northwest Aluminium and others.

The Six Majors of the early 1970s have shared their presence with newcomers not only in the production of primary aluminium but also in bauxite and alumina. Among them, Alumina Limited, Chinalco/Chalco, BHP Billiton, Rio Tinto Alcan, Nalco, Hydro/Vale, UC Rusal, Chiping Xinfa, Weiqiao, East Hope Group, CVG-Bauxilum, Glencore, Aluminium of Kazakhstan, Kaiman Sanmenxia, Hindalco, CBA Vedanta, Luneng Jinbei, Dadco, Minmetals, Bosai Minerals Group, Guinean State, Government of Ghana, Vimetco, PT Antam, Xinfa Group, Government of Guyana, Jamaican State, CVG, and Mytilineos Holdings are worth mentioning.

Exchange Rates

Aluminium is a US-dollar based commodity, listed on the *London Metal Exchange* (LME). However, most production and consumption takes place outside the US. Thus, if the US-dollar price of aluminium starts moving up, this may be explained by reasons which have nothing to do with the industry fundamentals.

Metal prices may be strengthening only because the US dollar has been losing ground against a basket of major currencies. Conversely, the US-dollar based price of aluminium may be losing ground not because of softer industry fundamentals but simply because the US dollar has been appreciating against other currencies. Variations in exchange rates also affect producers' competitiveness when all costs are expressed in US dollars.

For example, a weaker US dollar relative to other currencies is good for American producers not only because of higher aluminium prices expressed in US dollars but also because it reduces their domestic costs relative to other producers. Their competitiveness is enhanced unless a large share of their inputs is imported. Here, the Australian, Canadian or European producers are disadvantaged because the appreciation of their currency has made their domestic inputs more expensive when expressed in US dollars.

The result is quite different when the US dollar strengthens relative to the Euro or the Chinese Yuan: in this case the competitiveness of US aluminium producers starts shrinking, unless a very large share of their inputs is imported, because of higher relative costs, while the opposite becomes true for the European or Chinese producers.

Figure 7 illustrates the high degree of volatility of the US dollar relative to the currencies of its main trading partners over the last 40 years. It clearly suggests that the lower aluminium prices over the years 1995-2002 were due not only to weaker industry fundamentals — excess supply during the 1990s due to the dumping of Russian metal on Western markets and lack of demand in the early 2000s because of the "dotcom recession" — but also to the stronger US dollar over the whole period. Conversely, if there seemed to be no limit to the higher aluminium prices over the years 2002-2008, this was not only the consequence of soaring demand due to easy credit conditions or inadequate supply related to the low prices of the previous decade, but also to the weakening of the US dollar over that period. Thus, the role of exchange rates must be taken into account when comparing the global aluminium industry at two points in time given that their variations affect not only aluminium prices — the latter tend to vary in opposite directions when expressed in various currencies — but also the producers' degree of competitiveness.

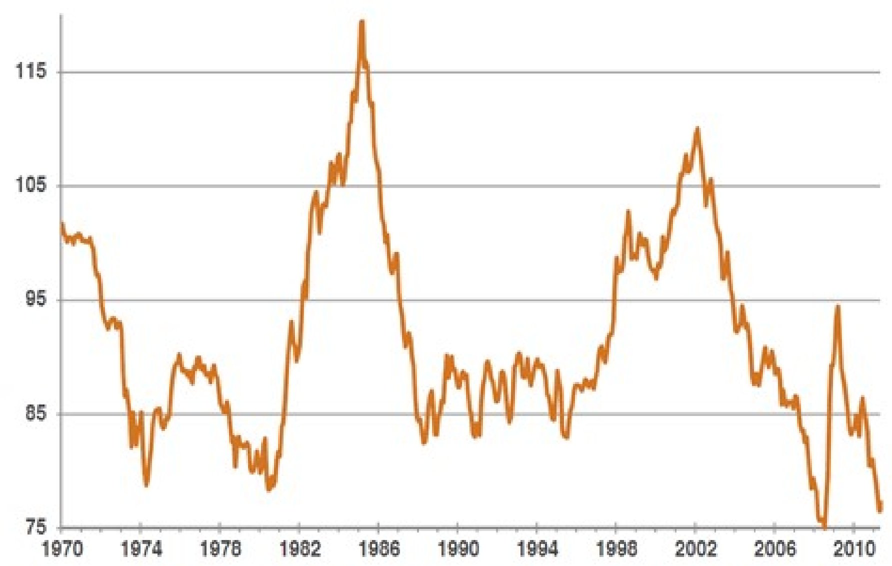


Figure 7: US$ Trade Weighted Exchange Rate (1970 = 100)

Shifting trend in aluminium cost curves

Operating cost curves — which reflect raw materials, energy, labour, maintenance and overhead costs for each smelter arranged in ascending order — remain one of the most useful tools of industry analysis. Operating cost curves for the primary aluminium industry became popular in the late 1970s as various producers and consulting firms developed quite detailed cost models reflecting the current and expected operating costs of each smelter. Some also include capital costs of each plant, based on estimates of actual costs incurred at the various stages of the project from inception to present capacity.

Operating cost curves generate useful information such as:

- the weighted average operating costs for all the smelters in a given year;
- identification of the smelters in each quartile of the curve and thus guidance on the point at which proportions of the industry will find current prices below their short run

operating costs;

- benchmarking facilitation, by providing targets to be reached in order to improve energy or alumina efficiency and thus reduce costs;
- proportion of the industry not viable on a commercial basis relative to alternative investments, if depreciation and interest on short-term loans for working capital and long term debt are added to operating costs.

The evolution of operating cost curves since 1980 for the global primary aluminium industry clearly identifies two distinct trends. First, the shape of the industry cost curve has been flattening over the last few decades, implying a much lower gap between the low (in first and second quartile) and high (in third and fourth quartile) cost producers. Flatter cost curves may be seen as a consequence of globalisation: lower tariff barriers and disappearing captive markets have forced the closure of high cost capacities, while new investments have taken place at the low end of the cost curve.

Second, operating costs curves have continuously declined between 1980 and 2003, driven down by factors such as:

- **technology** (the closure of less energy efficient and more polluting Søderberg systems which involve the use of a continuous self-baking carbon anode and their replacement by the prebaked carbon anode technology; the widespread use of point feeding system of the raw materials alumina, cryolite or fluoride; lower costs through improved cell design and increased current density as the industry moved from 50kA cells to 400-500 kA cells);

- **lower energy prices** (as suggested by Figure 6, energy prices have come down from the time of the second energy crisis in 1980 to the early 2000s; this was particularly true for coal, crude oil and gas);

- **appreciation of the US dollar** (see Figure 7) (with the exception of the 1986-1988 period, the US dollar has strongly appreciated between 1980 and the beginning of 2002, pushing down not only metal prices but also the cost of inputs varying with the price of the output);

- **stable/weaker alumina prices** (Figure 8 suggests that with the exception of the late 1980s — when aluminium and thus alumina prices reached new highs — and of 1999, when the Gramercy alumina refinery exploded, nominal spot alumina prices have generally remained below $200/tonne over the 1980-2003 period; thus, real prices of alumina were definitely down during that period).

However, after moving down between 1980 and 2002-2003, the global primary aluminium industry cost curve trend shifted in the following years on **soaring energy prices** (due to significant increase in resources demand by China and other BRIC countries), **a weaker US dollar** (resulting in higher input costs as the price of alumina, energy or carbon products in many contracts is linked to the price of aluminium) or a **stronger Chinese Yuan** (as a large share of Chinese smelters are located in the third or fourth quartile of the cost curve, this factor increased the steepness and the level of the cost curve), and, **higher alumina and carbon products prices** (driven up by higher demand in China as this country accounts for over 80% of the increase in global production between 2002 and 2011). Environmental regulation also played a certain role in driving up the cost curve. The only exception to this upward trend were the years 2009-2010 when output and input prices were negatively impacted by the worst recession since the end of World War 2. Improvements in alumina and aluminium technology continued to keep costs at bay; however, the impact on operating costs was more than offset by the drivers highlighted above.

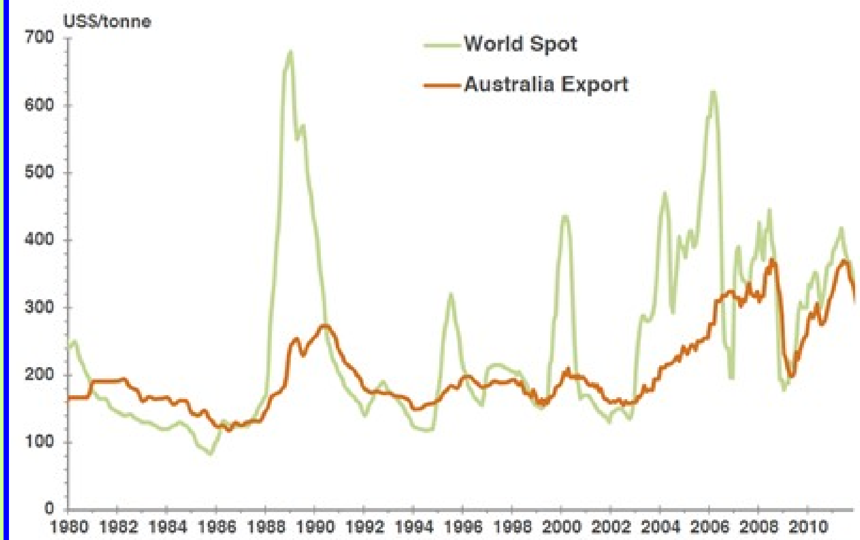


Figure 8: Alumina Prices – Spot and Australian Export, 1980-2011

Emerging economies

No matter which measure is used, the emergence of the developing economies in general and of BRIC — Brazil, Russia, India and China — countries in particular represents one of the most significant structural changes of the last 40 years. Starting with the global economy, the combined output of the developing economies (the world excluding the original members of the OECD but including Turkey) accounted in the year 2000 for slightly more than 20% of global GDP measured at market exchange rates. This share has almost doubled to reach 38% in 2010. If GDP is measured at purchasing-power parity (PPP), which takes into account the higher real spending power provided by lower prices in poorer countries, emerging economies overtook the developed world in 2008 and accounted for 75% of global real GDP growth over the last decade.

Other economic indicators such as inflows of direct foreign investment, capital spending, foreign exchange reserves, mobile-phone subscriptions, motor-vehicle sales or commodity consumption (using 60% of world's energy, 65% of all copper and 75% of all steel) also support the conclusion of a structural shift in world economic power during the last few years. If only the four BRIC countries are considered, their real GDP valued at market exchange rates relative to the world equivalent almost doubled from 6.5% in 2000 to 11.7% a decade later (see Figure 9). Using GDP measured at PPP, the BRIC share exceeded 24% in 2010 as compared to 15.9% ten years earlier. Improvement has been particularly impressive for countries such as China (second largest share of global GDP measured at PPP) and India (fourth on the same scale). The impact of the BRIC economies on the global primary aluminium industry has been even more significant, not only in terms of surging demand but also on the supply side of the market (Figure 10).

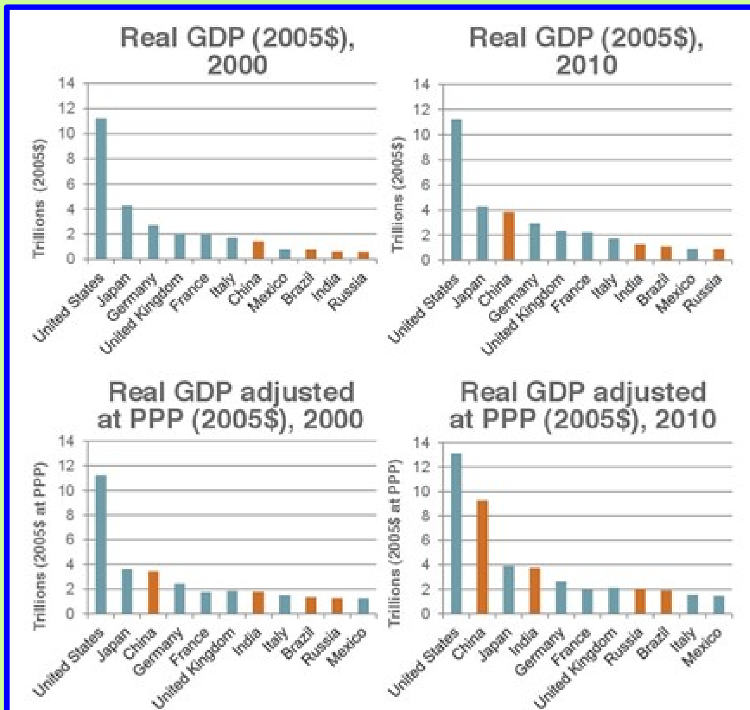


Figure 9: BRIC's Share of World Real GDP Measured at Market Exchange Rates and at PPP (2000-2010)

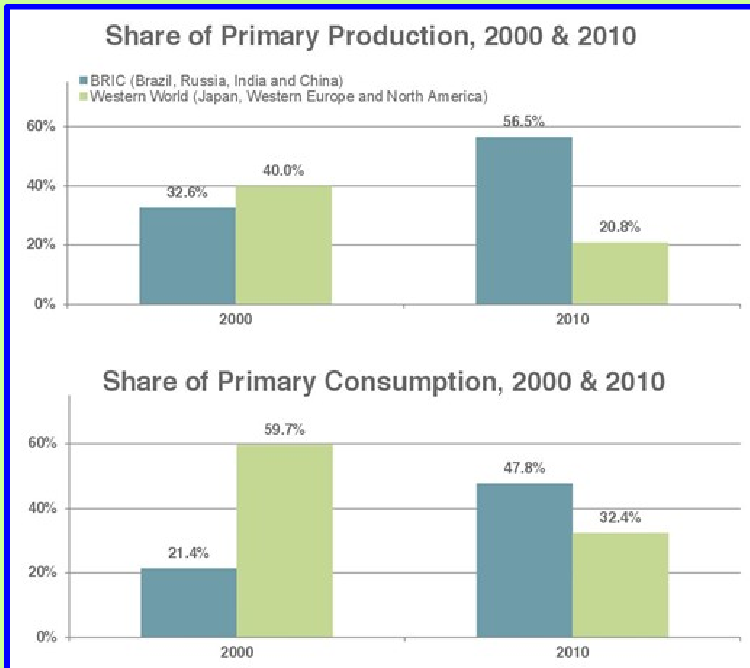


Figure 10: Share of Developed & BRIC Economies in Global Primary Aluminium Production & Consumption (2000 & 2010)

Figure 10 indicates that the BRIC countries were producing almost 8Mt of primary aluminium in the year 2000 or a third of global production, with Russia accounting for 13.3% of the global total. Ten years later the BRIC contribution had surged to over 23 Mt (56.5%) of global primary production, with China being by far the largest producer. During the same period, the cumulative share of Japan, Western Europe and North America was sliced by half from 40% (or slightly below 10Mt) to less than 21% (or slightly above 8.5Mt). As for primary consumption, the BRIC share surged from about 21% in 2000 to 48% ten years later, while the share of major industrialized consuming countries went in the opposite direction from about 60% to below 33% over the same period. To sum up, the global primary aluminium industry has been profoundly modified by drivers such as the rise in energy prices, the arrival of numerous new players, the US dollar depreciation over the last decade, the shifting trend in aluminium cost curves and the emergence of the BRIC economies. The impact of these drivers on the main characteristics of the current global primary aluminium industry will now be analysed in greater detail.

4. Current Picture of the Primary Aluminium Industry

The geographic distribution of bauxite, alumina and aluminium production has shifted significantly since 1972. Starting with **bauxite**, while Australia increased its share of global output from 20% to 32% over the last 40 years, Jamaica, Suriname and Russia are no longer on the list of the major producers, having been replaced by Brazil (15%), China (14%) and Indonesia (11%). The combined market share of the four largest producers is now over 70%. A complete relocation of producing centres has also been taking place in the global **alumina** industry. The production shares of Japan, Russia, Jamaica and Suriname have drastically shrunk since 1972 – and today four countries (China, 35%; Australia, 23%; Brazil, 11%; India, 4%) have a combined share of 73% of global alumina output. While the BRIC countries now account for almost 40% of global bauxite output, this share jumps to 53% for alumina. In the latter case, production has definitely shifted towards countries with access to an abundant and inexpensive source of bauxite. In addition to being the most important cost element, the

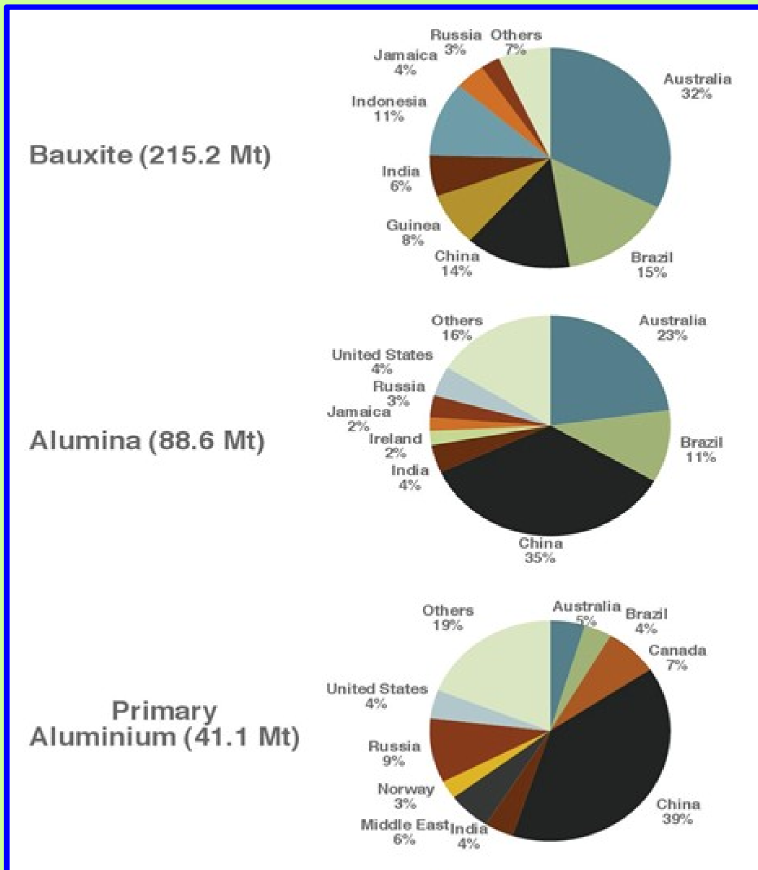


Figure 11: Geographic Distribution of World Production of Bauxite, Alumina and Aluminium (2010)

bauxite cost is the most important source of variation of alumina production cost. China has become the largest alumina producer, but continues to import a large share of its bauxite needs, mainly from Indonesia. If bauxite cost remains the most significant driver of the current location of alumina production, shifts in the geographic location of **aluminium** production is determined to a large extent by variations in energy prices. Even if capital, alumina and energy costs account for about equal shares of total aluminium production costs, energy costs vary much more between countries than the two other cost elements; consequently, energy costs remain the most important determinant of international differences in aluminium production costs (about 70% of the variability in aluminium's total cost is linked to energy cost). Unsurprisingly, US share of global primary output has moved down from 32% in 1972 to only 4% in 2010. The same applies to Japan (its share dropping from 9% to nil during the same period) and most European producer countries of the early 1970s, with the exception of Iceland and Norway.

Primary output has been moving to China (with around 40% market share) not only because of its natural sources of comparative advantage (energy is abundant and relatively cheap in its western and north-western regions) but also because of policy-induced sources of competitiveness related to provincial subsidies, exchange rates and trade policies. Other major producers include energy-rich regions such as Russia (9% in 2010), Canada (7%), the Middle-East (6%), Australia (5%), Brazil and India with 4% each. The Middle-East region share is continuing to grow with the commissioning of the EMAL and Qatalum smelters in 2011 and Ma'aden smelter in 2013. Despite being endowed with vast energy resources, Russian output has been moving up during the last 20 years at a slower pace than global production, bringing down its market share.

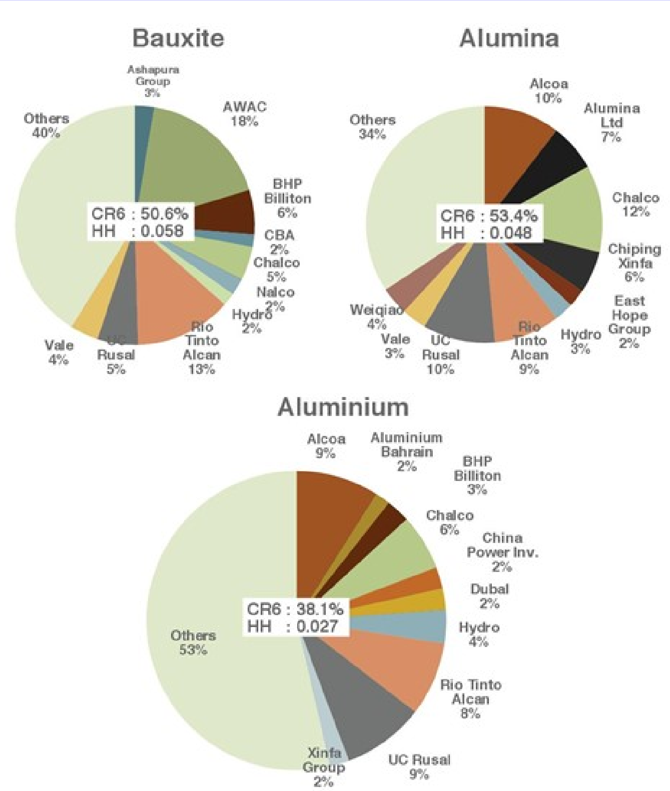


Figure 12: Market Shares and Degree of Concentration[2] in Global Bauxite, Alumina & Primary Aluminium Capacities (2010)

What are the other new characteristics of the global aluminium industry?

Lower degree of concentration and integration, and more "strategic groups"

The arrival of new private or state-owned enterprises has also completely modified the degree of competition within the industry. Starting with **bauxite**, not only the share of the six major producers has dropped to about 50% in 2010 (the HH index also lost ground to reach 0.058 during the same period), but even the players have changed: Alcoa (10.6%) is still present through a 60% ownership of AWAC and Alcan was acquired by Rio Tinto providing Rio Tinto Alcan (RTA) with a market share of 13.1%; the others have been replaced by Alumina Ltd. (7% through its 40% ownership of AWAC), Hydro (a pro-forma share of 6.1% in 2010 since Hydro acquired Vale's aluminium business on February 28, 2011), BHP Billiton (6%), UC Rusal (5.5%) and Chinalco/Chalco (4.6%).

The story is similar in the global **alumina** market. The share of the six most important producers (CR6) has come down from almost 80% to slightly more than 53% over the last four decades. If the degree of concentration is measured using the HH index, the drop is even more important from 0.129 to 0.048. Once again, while Alcoa (10.4%) and RTA (9%) are still present, the other players are newcomers: Chinalco/Chalco (11.9%), UC Rusal (9.8%), Alumina Ltd. (6.5%), Hydro (6%) and Chiping Xinfa (5.8%). Figure 12 highlights the significant presence of Chinese alumina producers – the cumulative share of Chinalco/Chalco, Chiping Xinfa, East Hope Group and Weiqiao was around 24% in 2010.

As expected, the arrival of new players has also reduced the degree of concentration in the global primary **aluminium** industry. The share of the original Six Majors back in 1972 has dropped from 73% to 38% four decades later. Given the disappearance of very large players, the HH index suggests a much more drastic drop from 0.103 to 0.027. No single company in 2010 had a degree of ownership of the global primary capacity exceeding 9%, while three Chinese producers (Chinalco/Chalco, 6%; China Power Investment, 2.3%; and Xinfa Group, 2.1%) had a combined share of 10.4%.

However, the most distinctive feature of the current global aluminium industry is the fact that many producers are not fully integrated with upstream and downstream assets. For example, RTA and BHP represent large conglomerates with no downstream facilities but with large upstream interests. On the other hand, Alcoa and Hydro (since the 2010 acquisition of Vale's aluminium assets) are fully integrated, while UC Rusal, Chinalco/Chalco and some Chinese producers are stronger upstream than downstream.

Finally, some large producers such as Alba and Dubal are focused on the smelting stage of the production value chain. The various types of producers reflect not only a lower degree of integration over time but also the presence of many "strategic groups", defined as clusters of firms following the same strategy, making the same type of choices with respect to some key variables such as resource commitments, and thus having the same interests. An increase in the price of aluminium is certainly positive for "upstream-only integrated producers", while being detrimental to those with downstream operations fighting for a higher market share relative to substitutes.

The degree of competition within an industry is positively correlated with the number of strategic groups, suggesting that competition within the aluminium industry may be even larger than what is indicated by the current degrees of concentration.

Shifts in consumption patterns by region and by end-use market: China and transportation dominate

Global primary aluminium consumption has been increasing at a compounded annual growth rate (CAGR) of about 5% over the last decade, despite two recessions and continuous market threats of substitutes. During this period, demand growth rate has been much faster in countries such as China (CAGR of almost 17%) and India (10.4%) than in the rest of the world (0.8%), reflecting the growth and growing importance of the BRIC countries. This is better illustrated by Figure 13 which presents use of primary aluminium by region in 2010. In 1972, more than 60% of global consumption of primary aluminium was taking place in six industrialized countries, with the United States leading the pack at 36%, followed by Japan (10%), Germany, France, Italy and the United Kingdom. In 2010, the combined share of these same industrialized countries was barely exceeding 25%. The same is true for Russia: its market share dropped from 12% in 1972 (for USSR) to less than 2% in 2010. The leading role in global consumption is now played by China whose market share has swelled from 2% in 1972 to 40% today. As for India and Brazil, they have more than doubled their market share. Thus, almost half of global primary consumption is today accounted by BRIC economies.

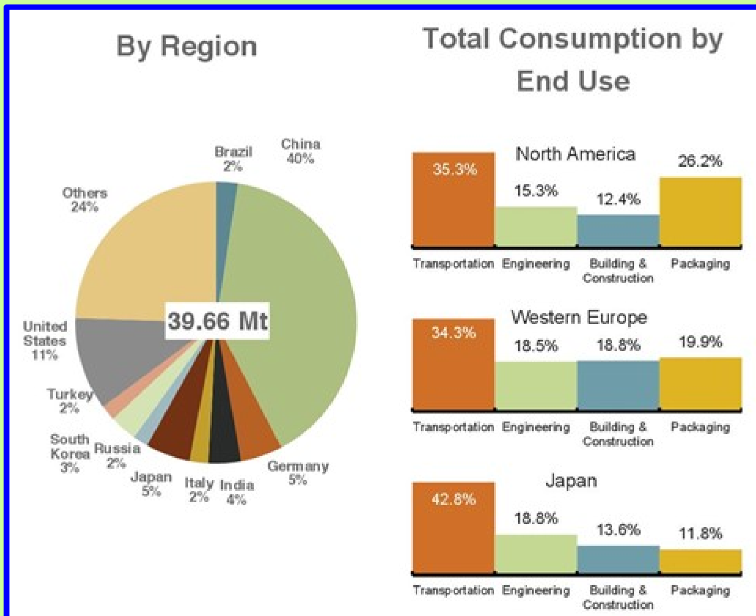


Figure 13: Primary Aluminium Consumption (2010)

What about the total aluminium consumption by end-use market? Transportation has become the most significant end-use market, accounting for almost 43% of the metal used in Japan and 35% of North American and West European aluminium shipments. This contrasts with the situation 40 years ago when this end-use market was responsible for about 20% of total consumption in the United States, Japan or Germany. According to Ducker Worldwide (see *Aluminium International Today*, September 2011), a well-known research firm in this field, automakers are accelerating their shift to aluminium away from other materials for new car and light truck construction in order to safely and cost effectively lower the weight of their vehicles. Ducker's survey of North American auto producers indicates that since lighter vehicles get better fuel economy with fewer emissions, aluminium is already the leading material in the engine and wheel markets and is gaining market share in hoods, trunks (boots) and doors. Aluminium usage has increased every year for nearly 40 years to reach 148kg in 2009 and should hover around 156kg in 2012. Stricter fuel economy regulations should accelerate the use of aluminium in bumpers, heat shields, brake callipers, ABS and driveline components, cylinder heads or bed plates.

However, the market challenge from alternatives remains present: the steel industry continues to invest millions of dollars to demonstrate that high strength steels can be engineered to provide the same weight savings as aluminium; composites (like carbon fibre) also represent a serious competitor in the automotive and aerospace sectors. Although composites have a cost and repair disadvantages, their price is coming down while offering improved corrosion properties and good aesthetics.

As for the other end-use markets, a number of circumstances favour aluminium:

- the copper to aluminium substitution (as the price differential reached record highs) in overhead cables, heat sinks for electronics, utility buss bars, battery cables, wire harnesses and aluminium wiring in air conditioners and white goods;
- the wider use of aluminium in consumer electronics for backing plates for flat screen TVs (a lightweight alternative to steel), tablet computers, mobile phones, laptops or as a laminated film used in exterior packaging for batteries;
- the use of aluminium in green applications such as solar panelling (used in the frame) and wind farms (in submarine cables for off-shore wind farm projects);

However, substitution can work both ways – and aluminium remains under challenge in the buildings sector where plastics have become increasingly popular, in the aerospace sector with inroads by composites and in the US packaging industry where aluminium has lost market share in the individual drinks market to plastic bottles.

Investor demand and market fundamentals as price drivers

As for most commodities, the global aluminium industry is characterized by a strong relationship between the real price of the metal and the gap between demand and supply of the metal as captured by the variations in total stocks (including both visible and unreported inventories) expressed in weeks of shipments. Prices tend to explode for very low levels of inventories, while being quite stable despite high level of inventories as prices cannot drop below their average operating costs for a long period of time. As mentioned earlier exchange rates also play a role given that aluminium prices are generally expressed in US dollars—thus a weaker dollar drives up the US-dollar price of aluminium.

However, since the middle of the past decade, another aluminium price determinant has been identified with the rise in popularity of commodities as an asset class, with investors using a variety of instruments and strategies to gain exposure to commodity prices. The most important investment vehicles used include:

- various **Commodity Index Funds** (CIFs), where investments are made through the purchase of commodity futures, which are then rolled forward by being sold at or prior to maturity and replaced with a new futures purchase with a more distant maturity date as long as they provide positive returns from rising spot commodity prices;
- **Commodity Trading Advisors** (CTAs) or momentum investors where decisions to buy or sell are based on trends or technical factors (mainly past patterns of price behaviour);
- **hedge funds** where investment decisions are based on their view of the economy outlook or of the metals' fundamentals;
- **proprietary trading desks** of major investment banks or trading firms that invest in commodities on their own account (note that some of these major banks and commodity traders have their own warehouses and provide incentives to metal holders to guarantee that enough metal would sit in their warehouse at full rent to cover the cost of the incentives paid; these stocks are referred to as "stealth or unreported" stocks since their importance may only be estimated).

What is the impact of this investor demand on spot aluminium prices?

The answer is not straightforward, even if the rise in popularity of commodities' investment coincided with a surge in many commodity prices. In general, spot prices (for immediate delivery) are lower than future prices (in the case of aluminium, official contracts exist for 3-, 15- , 27-, 63- and 123-months), and the difference or "contango" between the two prices is high enough to at least cover finance and warehousing costs.

The presence of such contango induces investors to buy spot and sell futures, raising the spot and reducing the futures prices until the gain from the contango covers no more than the costs mentioned above. Obviously, near-zero interest rates and subsidized warehousing costs increase the contango and thus the expected return from such deals.

The same applies if the futures price moves up because of higher investor demand: the contango becomes wider, inducing more investors to buy spot and sell forward, which raises the spot price. In all other market circumstances (insufficiently high contango or spot prices higher than the futures price), the mechanism linking spot and the futures price is less clear as other variables such as expectations about the futures price or the cost-benefit ratio of holding inventories must also be taken into account. Nevertheless, even if investor demand may in some cases influence spot prices, this new driver has made the traditional relationship between supply, demand, stocks and prices more murky not only because this influence is not straightforward but also because of the increased presence of unreported stocks. The latter are currently estimated in the 3.0-4.5Mt range, which makes price forecasting and apparent consumption calculations more challenging.

5. Outlook

The primary aluminium industry of today has little resemblance to what it was 40 years ago. BRIC economies now account for more than 40% of bauxite production, while alumina output has shifted towards bauxite-rich countries and away from industrialized economies. Reacting to the continuous increase in energy prices and in some cases to government industrial policies, primary production has moved from regions such as the United States, Japan and most West European countries towards China, Russia, Canada, Brazil, Australia, the Middle-East, and now India and some parts of South East Asia. The degree of competition has surged, driven not only by lower concentration and integration, but also by the presence of different strategic groups with different economic interests.

Significant structural changes have also taken place on the demand side of the industry equation where the 60% combined share of global consumption held by six industrialized countries in 1972 has shrank to 25%, replaced by China (40% in 2010), India and Brazil. As for end-use markets, transportation now dominates, accounting for 35-40% of Japanese, North American and West European total shipments. Aluminium spot prices are also more volatile than 40 years ago: during the 1973-2011 period, the degree of volatility (standard deviation over average prices) reached 0.335, more than doubling the corresponding value for the 1946-1972 period. Investor demand has “financialized” base metals markets. This new driver may explain some of the increase in metal prices when futures prices exceed spot prices by a margin high enough to more than offset financial and warehousing costs. Other variables need to be taken into account under alternative market hypotheses.

Looking forward, even if primary aluminium consumption has been growing at a pace of about 3% per year (see Figure 3) over the last 40 years, a higher CAGR of around 4.0% can be expected over the next two decades as urbanization, industrialization and economic development in BRIC and other emerging countries continue to positively impact the use of aluminium. Even if the consumption per capita of mature economies such as Germany, South Korea, Japan and the United States has stabilized at around 20kg in 2010 and may come down slightly during the years ahead, this is not the case for countries such as India (only 2kg per head), Brazil and Thailand (about 5kg), Turkey (8kg) or Malaysia and China (slightly above 10kg per capita). If these countries follow more or less the same pattern of growth as the current mature economies, primary aluminium consumption should double in the next 20 years. Drivers such as stricter environmental policies, energy efficiency, downsizing, globalization or the continuous development of new applications may drive up the use of aluminium at a faster rate than expected. On the downside, the negative substitution in favour of plastics or new materials, policies favouring growth instead of sustainable development or the challenge of developing new applications in an industry as fragmented as aluminium may result in less demand than forecasted.

This growth projection implies the "equivalent" of about 40-50 new smelters (with a capacity of 500-kty each) will be needed to satisfy 2030 forecasted demand. The required additional capacity will in fact be even higher as some smelters will be dismantled or idled during the same period. These expansions (brownfield) and/or new investments (greenfield) will raise new challenges in terms of commissioning additional capacity of bauxite, alumina and carbon products, and developing new sources of energy. Given that electricity will remain the most important driver of competitiveness, the new smelters will be found in the Middle East region, Russia, the western and north-western provinces of China, Malaysia, Africa (including Algeria, Angola and the Congo), India and other regions where stranded energy can be available. Policy-induced sources of competitiveness (subsidies, legislation, undervalued exchange rates) will remain present, influencing not only the level of total supply but also its distribution among the regions mentioned above. The future of the global aluminium industry will be influenced by its ability to minimize environmental impacts and to be considered as a solution to some of the problems generated by CO_2 emissions. For example, according to a recent study by *The Aluminum Association* (September 2011), North American 2009 "light-weighting" of vehicles with aluminium offset 90% of the energy consumption and 96% of cumulative greenhouse gas emissions associated with primary aluminium production. Even more, 75% of all the aluminium ever manufactured –dating back 125 years and over multiple generations – is still in use today as the metal is recycled after each use phase, further compounding the metal's sustainability dividends.

Just like the rise in energy prices in the mid-1970s, legislation on CO_2 emissions may impact both sides of the market simultaneously. Supply growth may to some extent be hindered by higher production costs related to emissions and higher raw material and power prices. However, CO_2 caps may also favour the use of aluminium by encouraging energy efficiency and light-weighting, with potential beneficiaries in the transportation, power distribution & transmission, air conditioning & refrigeration, renewable energies, green buildings and other end-use sectors. Aluminium product characteristics such as lightweight, strength, moderate melting point, ductility, conductivity and corrosion resistance will continue to be in demand well into the future.

Source: www.world-aluminium.org

TOP 5 ELECTRIC VEHICLE DESIGN CHALLENGES

Expect to see many more electric vehicles (EV) on the road in the near future. The drastic price drop of batteries, rise in consumer appetite for more sustainable transportation options, and the availability of an increased number of EV options indicate improvements to the supply and demand for electric cars in recent years. By 2025, experts predict that car shoppers around the world will have the choice of more than 400 EV models, which could push EV sales to between 6 million and 11 million units.

This consumer demand for higher fuel efficiency and decreased vehicle emissions has accelerated the development of pure electric and hybrid electric vehicles (HEV). These vehicles depend on advanced electronically controlled systems working together across a wide range of operating conditions to ensure efficient performance, safety, and reliability.

Generally, vehicle electrification is focused on the powertrain driven by electricity and its auxiliary systems such as on-board and off-board charging systems, as well as wireless power transfer.

However, vehicle electrification also means electrifying other components of the vehicle such as electronic power-assisted steering, electronic stability program, electronic traction control, intelligent light system, smart electromagnetic suspension, all-wheel drive, airbag deployment system, and more.

Increasing electrical content and complexity coupled with shorter design cycles require design teams to continually improve their design methods for mechatronic integration. Read on to learn about the top five design challenges for electric vehicles and power semiconductors, and why a robust design flow can accelerate the growth of hybrid and electric vehicles going forward.

EV Design Challenge #1: Shorter Driving Range and Degrading Batteries

One of the top challenges of vehicle electrification is the limited driving range of lithium-ion batteries. These batteries provide a range of 249 to 311 miles, while most drivers prefer a range of 435 miles or more. Additionally, the battery's design is limited by the size and mass of the pack. Increased mass requires more energy for vehicle movement and negatively affects the vehicle's handling, acceleration, and braking. Beyond providing a limited driving range, all batteries become less efficient over time. While most auto manufacturers guarantee that EV batteries will not degrade below a certain level for around eight years, the lifespan of the car will likely be much longer (in which case, it becomes more likely that the driver will need to replace the battery).

EV Design Challenge #2: Electric Vehicle Charging Infrastructure

In the future, we are likely to see increased charging infrastructure as well as faster chargers that will make EVs extremely competitive with gas vehicles. The current charging infrastructure, however, falls a bit short. The biggest issue is long-distance travel (think cross-country road trips), where charging stations are not always available along your route. Installing more (and fast) charging stations to create a more robust charging infrastructure takes massive investment. However, daily re-charging in home garages, workplaces, and/or commercial parking areas (retail locations, motorway rest areas, etc.) would mean that EV drivers never have to stop at filling stations in their everyday lives.

EV Design Challenge #3: Selection of Power Semiconductors

Power conversion systems are essential for modern EVs. For example, a DC-AC inverter system is used to convert DC from the battery and run an AC induction motor. A combination of AC-DC converter and DC-DC converter along with power factor corrector (PFC) is used in charging systems. These power conversion systems use silicon-based power semiconductor switches such as power

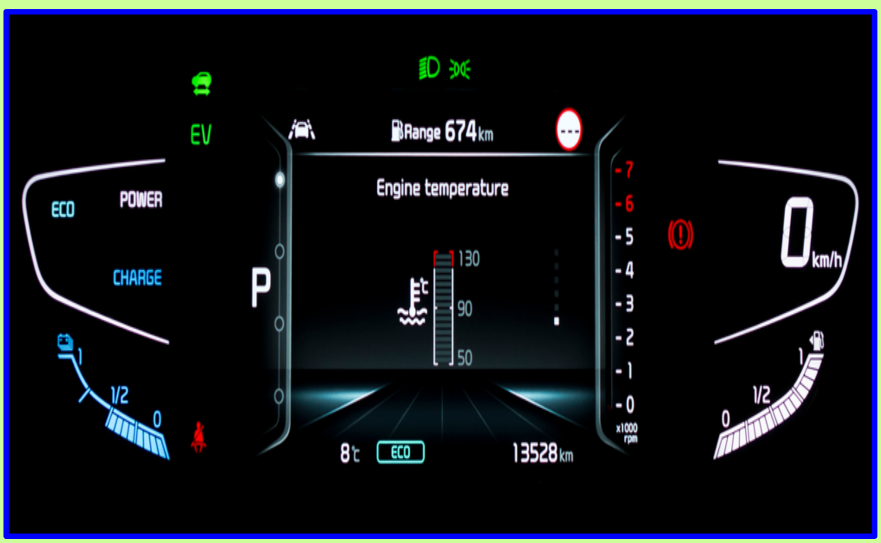
MOSFETs to increase efficiency and minimize energy loss. The downside is that silicon power MOSFETs are limited in operating voltage up to 250 volts.

On the other hand, an insulated-gate bipolar transistor (IGBT) can handle operating voltage from 400 volts to 1600 volts. However, IGBTs are not used in high-frequency operations (>30 kHz) due to poor switching performance. Power MOSFETs with better switching performance are used in frequencies above 200 kHz. To overcome these limitations, wide-bandgap devices such as silicon carbide (SiC) and gallium nitride (GaN) must be used. Wide-bandgap devices can operate in high voltage (> 1200 volts) and high frequency (> 200 kHz) due to the wide energy bandgap. They also operate with less on-state resistance and high thermal conductivity. This improves the efficiency by 2%, which is a great deal in EVs.

Since the power density and thermal conductivity of a wide-bandgap device are higher than a silicon device for the same power rating, the size of the device and thermal management system (heat sink) is also smaller. With the higher operating frequency, the size of the passive components is also smaller (size and weight are huge considerations in EVs). SiC diodes are also sometimes recommended for the PFC to make the charger more efficient and reduce the size of the components, but wide-bandgap devices are expensive and not many manufacturers commercially produce them. Therefore, not many EV manufacturers opt for wide-bandgap devices as it is a premium solution.

EV Design Challenge #4: EV Reliability Is Key

The reliability of powertrain components such as the battery, motor, and power electronics on the road is a key challenge for powertrain design engineers as these components are vulnerable to environmental stresses such as temperature variation and mechanical shocks. Automotive power IC designers take the upmost care in the design and manufacturing of integrated power devices. The design of thermal management systems is vital in determining the efficient and reliable operation of e-powertrain components. Suppliers and original equipment manufacturers (OEMs) need to consider material properties, non-uniform distribution of current, voltage, magnetic flux, and component temperature. The performance of one component can impact the flux distribution



in another.

Another big EV challenge related to reliability is how the microcontroller can optimize the power efficiency for different components inside the EV, from high- to low-end designs to ensure long-term design flexibility. Also, on-chip memory solutions need to comply with the AEC-Q100 standard to satisfy the strict operating temperature specifications. The use of 7nm and 10nm parts creates lots of systematic defects and integration challenges that haven't been debugged yet. These processes still have a lot of maturing to do.

EV Design Challenge #5: Adapting to the Fluctuating Automotive Supply Chain

The OEM-supplier relationship varies drastically from gas-powered vehicles to EVs. There are roughly 3,800 fewer parts in an electric motor vs. an internal combustion engine. This has many advantages for the manufacturer and eventual car owner, including significant cost reduction (and economies of scale because there are fewer suppliers), less maintenance, and an overall reduced cost of ownership. For suppliers, though, there is a clear downside. They are more closely tied to the OEM and are almost forced to rely on the same simulation tools as the OEMs do. This means that integration is more important today than it ever has been before.

Robust Design and Electric Vehicle Design Challenges

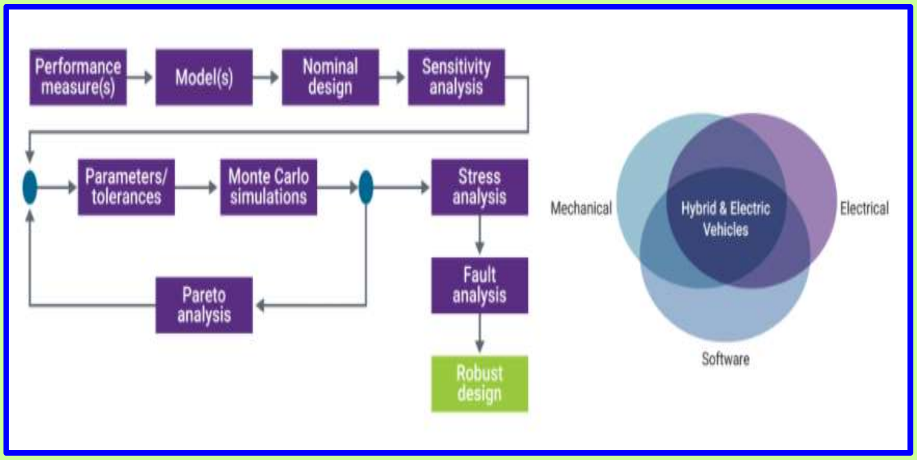
The primary goal of the robust design is to find the most cost-effective design solution that meets performance, safety, and reliability specifications set by the industry and consumer demand. Adopting a comprehensive simulation solution along with a robust design methodology ensures design teams can effectively analyze and verify complex drivetrain systems across a wide range of conditions.

Synopsys' Saber® platform features powerful design, modeling, and simulation capabilities to analyze and verify system interactions across multiple physical domains. Saber includes a broad collection of models and tools for simulating HEV systems, including:

- Motors (analytical and FEA-based models)

- Power devices – IGBTs, MOSFETs, BJTs
- Batteries, ultracapacitors, and charging systems
- Inverters, DC/DC converters, switches, speed controllers, capacitors
- Mechanical components

Advanced schematic capture, extensive model libraries, powerful model characterization tools, industry standard language support, and state-of-the-art simulation and analysis enable design teams to successfully deliver reliable systems that meet strict performance criteria. As embedded software content and complexity is increasing in electric vehicles, Saber combined with Virtualizer™ and Silver delivers a comprehensive virtual prototyping solution for EVs enabling exploration of design options, evaluation of trade-offs, development of embedded software, and multiple layers of verification before any hardware is built. As proven technologies that accelerate software development, integration and test, Virtualizer and Silver enable developers to quickly establish virtual Hardware-in-the-Loop and Software-in-the-Loop solutions for electric vehicles.



Summary

As the demand for EVs picks up, so too will the challenges for design teams. The current EV design challenges — limited driving range, high costs, battery issues, long charging time, and inadequate charging infrastructure along with issues with various power semiconductors and other devices — are difficult, but not impossible to solve. The key lies in increased collaboration from interdisciplinary design teams and robust design tools that allow for extensive modelling and simulation features.

Source: blogs.synopsys.com