ASSOCIAÇÃO BRASILEIRA DO ALUMÍNIO

BRAZILIAN ALUMINUM

SOLUTIONS FOR SUSTAINABLE LIVING

2017

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is published by

abal ASSOCIAÇÃO BRASILEIRA DO ALUMÍNIO

Rua Humberto I, nº 220 - 4º andar - Vila Mariana
04018-030 - São Paulo - SP, Brazil
Tel. 55 11 5904-6450 | www.abal.org.br

Cataloging in Publication
Carla Bueno CRB - 8/010135

R3823

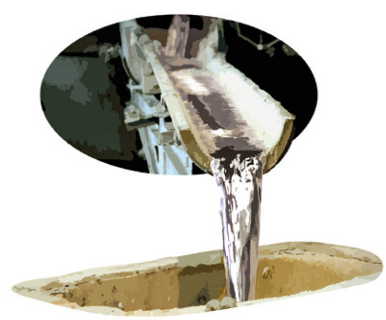
Associação Brasileira do Alumínio – ABAL

Brazilian aluminum: solutions for sustainable living / Associação Brasileira do Alumínio – São Paulo : Associação Brasileira do Alumínio, 2017.
61 p.: il.

Tradução de: Lucimar Menezes
Título original: Alumínio brasileiro: soluções para uma vida sustentável

1.Aluminum 2. Statistics 3. Sustainability
I . Menezes, Lucimar II. Título

CDU 669.71:504.06



ASSOCIAÇÃO BRASILEIRA DO ALUMÍNIO

The Brazilian aluminum industry has coped with an environment that has likely been the most challenging in the past decades. It is surely one that has unfolded the biggest changes, thus reminding us of the "Liquid Modernity" theory by Zygmunt Bauman. The said sociologist and philosopher sought to explain the contrast between the "solid" world with which we were so used and the contemporary world, in which the overwhelming speed of technologies and the access to information have spawn a sense of accelerated change and transience.

The moves taking place have caused the need for ABAL and its member companies to act proactively and effectively, and quite continuously respond to an ever-changing business environment.

Over the past ten years, our sector has begun to deal with new realities, where some beliefs then deemed as "sound" have disbanded:

- Although not owning good quality bauxite reserves, China has begun to account for over 50% of the world primary aluminum production;
- The Chinese aluminum products have landed in Brazil, thus threatening our manufacturing industry;
- Hydropower, which seemed to have a huge potential in our country, has turned into a scarce and costly one, making some primary aluminum production plants unfeasible;
- The concern about climate change has grown to the point that many organizations have now advocated carbon pricing as the key to face the climatic risks;
- The socio-environmental demands and costs for those operations using natural resources have multiplied. Moreover, those operations, which are often located in regions lacking minimum public infrastructure, do end up playing the role of the State, by means of permits and conditionings;
- Both credibility and reputation of an organization have become paramount assets and businesses have been under huge pressure for greater governance and transparency;
- New disruptive technologies have emerged, such as 3D printing and the "Internet of things" unfolding a potential to remodel some traditional processes;
- The circular economy and life-cycle thinking have focused on what our industry used to put into practice. Recycling has become vital.

In this constantly-changing environment, what remains unchanged is: the demand for more sustainable alternatives that will continue to evolve in a world pushed by population growth and a strong move to urbanization. And such is the environment where aluminum shows up as a solution for a sustainable and low-carbon emission future.

Aimed at fulfilling its role before members, ABAL has performed an increasingly relevant task of monitoring and assessing the outside environment, by diagnosing trends, risks and opportunities as a way to foster the Brazilian Aluminum and its industry.

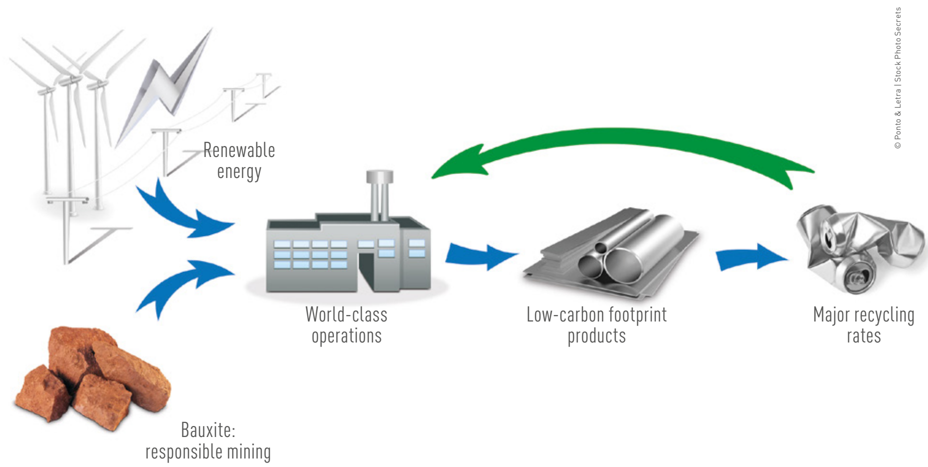
For doing it effectively and guiding the industry through a harmonic and integrated fashion, our Association has further reinvented itself and, on that end, it is nearing completion of a new strategic map, after making changes in its own management and governance processes.

This report showcases our vision about the future of aluminum in Brazil: an industry that gathers all the features for playing a leading role in working out solutions for a low-carbon economy.

The set of comparative advantages we own can become unparalleled competitive attributes, if our stakeholders are able to properly assess, communicate and understand them, whereas government bodies are willing to uphold them. They are:

- A predominantly-sourced hydroelectric power showing extremely low rates in greenhouse gas emissions;
- A responsible bauxite mining industry that stands out in global sustainability standards and regulations;
- A primary and processing aluminum industry operating at world-class standards and performance;
- Huge aluminum recycling rates;
- Low-carbon footprint in our aluminum products.

Sustainability in the aluminum chain in Brazil



Therefore, one can easily figure out that boosting the Brazilian Aluminum Industry might further be a triggering measure to globally mitigate greenhouse gas emissions.

We then urge government bodies, the industry and the society to join efforts so that the expected rise in aluminum consumption designed for Brazil for the coming years may come from those companies present in our country, thus spawning jobs, investments and wealth. And what really matters to get there is to use domestic raw materials, whether the Brazilian primary aluminum, which is the world's lowest causative agent for emissions, or the recovered scrap, which has ranked us as leaders for over a decade.

Enjoy your reading!

Silvio Porto
Chairman
Board of Directors
The Brazilian Aluminum Association (ABAL)

1 Global aluminum market outlook

Aluminum is a global commodity, which is produced at 236 plants located in 42 countries in five continents. Its price is referenced by the London Metal Exchange (LME). The worldwide production of primary aluminum in 2016 totaled 57 million tons, of which nearly 70% is found in China, Russia and Canada.

Its industrialization dates from very recently in the late 19th century. Then, given its traits of production and use, it requires a sort of life-cycle perspective, in a way sustainability issues can be addressed accordingly.

1.1. Aluminum growing demand will remain high

Historically, the average annual rate of growth in the world demand for primary aluminum has kept up with economic growth. Nevertheless, as from 2000, that rate has moved to 5.4% per year, considerably higher than the growth of the world economy that attained nearly 3% per year in the period.

The reason for such difference stems chiefly from the unprecedented expansion of industrialization and urbanization in China. Between years 2001 and 2007, ninety (90) million people migrated from rural areas to the cities. Such move then boosted the average annual growth of the construction sector in China in 14.2% per year, while the country's GDP grew by 9.6%.

For 2025, experts have foreseen that the global demand for aluminum, which in 2016 achieved 58 million tons, will keep on growing mostly thanks to China and Asia that have sustained their strengthened presence in the overall production of aluminum.

1.2. Larger demand in the transport, civil construction and energy markets

The growing use of aluminum in the **transport sector** is due to the greater presence of the metal in the manufacture of motor vehicles, trucks, buses, vessels, subways and trains. Its properties of lightness and resistance boost safety while helping deplete greenhouse gas emissions.

A recent forecast made by *Ducker Worldwide*, a consulting firm, for the automotive sector has shown up to a 30% rise in aluminum consumption over the next 10 years, mostly in countries provided with emission limit regulations and sustainable mobility programs.

In the **civil construction segment,** expectations are fairly favorable. The diversity of aluminum products such as frames, lining panels, facades, roof structures and side locks, partitions, ceilings, boxes, forms, scaffolding and braces, coupled with the concern with sustainable construction, allows a positive projection of thriving demand for that segment.

Green buildings also bring opportunities for use of aluminum, once they are a sort of facilities where recycling and eco-efficiency in construction is critical, demanding architectural solutions that encourage optimum use of natural lighting.

Regionally, expectations have been optimistic in the United States, Asia and the Middle East, while in Europe indications are for a moderate growth, depending on investments and policies that bear up both the technological modernization of plants and the use of recycled material. Conversely, the construction segment in China is likely to demand greater use of recycled metal.

As for the **energy sector,** a recent study by the World Bank assessing the role of metals in a low-carbon future provides for greater use of renewable sources such as wind and solar energy, in addition to the escalated use of batteries, which will result in larger intensity of metal use, including aluminum.

1.3. Production: China's growing dominance in the global offer

The data of the International Aluminum Institute (IAI) has shown that from January 1999 to July 2015, China's production grew 14 times, achieving 2.7 million tons on an annual basis. In year 2000, Chinese production accounted for 10% of the global production and, nowadays, it has reached 55%.

The global demand for aluminum will remain promising, not only boosted by the conventional applications related to growth and infrastructure, but also and everyday more by its enlarged use in markets valuing low-carbon footprint.

1.4. Middle East expands capacity

The Middle East has consolidated its position as a global producer of primary aluminum, jumping from 1.2 million tons in 2000 to 5.5 million tons in 2016, thus corresponding to an average growth rate of 10% per year. Such a substantial rise in production has been driven by the countries of the Gulf Cooperation Council (GCC), comprising Saudi Arabia, the United Arab Emirates, Qatar, Bahrain and Oman.

In 2015, of the ten largest primary aluminum production plants in the world, five were located in the Middle East, particularly in the UAE, with a production capacity ranging from 585,000 to 960,000 tons of aluminum per year.

The widespread availability and competitive cost of energy coupled with government policies adding value to the aluminum chain have been key factors in the unprecedented growth of the Gulf countries in the global context of the industry. However, it is worth noting that projections have shown that the annual production growth rate in the Middle East will tend to slow down, as the maturity stage of more significant capacity expansion projects is reached.

Also noteworthy is that given the thermal sources and non-renewable resources in use, the carbon footprint of the aluminum produced in those regions exceeds the world average, while in China it is around four to five times higher than in Brazil.

2 Challenges and opportunities for the aluminum industry in Brazil

2.1. Growth constraints for demand in the short term

Though Brazil gathers paramount competitive advantages such as high-quality bauxite and clean and renewable energy, for it to produce aluminum and leverage the advancement of a diversified manufacturing and high added value chain, the country has lost competitiveness.

The elevated energy cost is the major cause behind such context due to macroeconomic factors, growing duties and lack of a long-term policy for the sector.

The industry has walked the way of a recessive environment which the country has gone through since 2015, a year when key indicators dropped, deepened by the political crisis that has existed since then.

For the third year in a row, the domestic demand for processed aluminum products has shrunk, closing 2016 with a consumption of 1,205 thousand tons against 1,512 thousand tons in 2013. Similarly, the processed aluminum production moved from 1,451 thousand tons in 2013 to 1,212 thousand tons in 2016.

Nonetheless, in what comes to the initial stage of the production chain, there was positive performance with production of bauxite and alumina hitting records, with increments of 5.9% and 4.2%, respectively. Exports for those products were another record and also accounted for showing positive figures in the sector's balance of trade.

With increased demand for processed products and cut-down in primary aluminum production capacity, Brazil has become an importer for the metal, which has then undermined the competitiveness of the entire chain.

Away from signs of change in such scenario, the country will remain a net importer of primary aluminum until the conditions of profitability help justify resuming the existing idle capacity.

2.2. Energy and bauxite: key factors for balancing strengths in the global context

Historically, the availability of raw materials and energy has favored investments for installing aluminum production capacity in regions where such competitive conditions are present.

Bauxite

Notwithstanding the fact that plenty of bauxite is available in geological terms, the challenge for the industry has been the economic and commercial access to it. Increasingly, concerned critical success factors tend to focus on infrastructure, logistics, efficiency and social and environmental responsibility of the mining operation.

Considering a global aluminum demand of about 84 million tons of primary aluminum in 2025, the supply of bauxite would need to achieve around 420 million tons, a paramount fact for the ore exporting countries.

> **The production of aluminum in Brazil, regardless of the current adverse environment, can reap prospects of resuming investments. They will surely rely on the country's recovery of economic growth and concurrent policies and actions in place that find ways to optimize the existing natural resources and hence boost our competitive advantages like clean and renewable energy.**

In China, the huge rise in primary aluminum production, associated to the decrease in its bauxite reserves, has led the country to seek other suppliers, encouraging some countries which quickly began to develop their mining, so as to export and supply the Chinese industry.

That is the case of Indonesia, which once accounted for 70% of bauxite imports by China, producing around 12 million tons per year (i.e. 12% of the world volume), until the Government enacted a shutdown in operations in 2014 owing to environmental problems. Thus, Malaysia has turned into a leading supplier to China. Part of the bauxite mining in the country is carried out by small companies, which are not required to conduct environmental impact studies for activities performed in areas smaller than 100 hectares. Such move has spawn a series of social and environmental issues like dust and noise emissions impacting the communities surrounding the mines, a set of factors that also caused the shutdown of bauxite mining activities in Malaysia back in January 2015.

The conditions for resuming production in those countries are still being negotiated, though it is evident that the aluminum value chain and China's demand pressure have global implications.

Being the third largest bauxite reserve in the world with high-quality ore, Brazil might increase its exports and benefit from that trend in the bauxite market, despite the risk of rising costs in sea freight.

As for alumina, the closure of capacity at plants in the Atlantic also opens opportunities for Brazil, which holds a prominent pole of alumina production in the North of the country, supplied by Amazon reserves that are abundant and top-class.

Energy

The key decision factors for finding the right location for primary aluminum production are availability of competitive energy and effective logistics. Under this context, many plants were built in the 80s and up until the end of the 90s, when they were then ranked on the first or second quartile of the global aluminum cost curve. Nevertheless, as from the end of year 2000, some changes in that paradigm could be seen.

Worldwide, energy supply contracts for primary aluminum production plants must be long-term ones. The alternative of seeking market supply is not feasible. When the existing contracts expire, the companies need to renegotiate them in a dramatically different context compared to that when they were formalized, thus resulting in ascending energy prices.

Moreover, it is more and more difficult to secure competitive access to energy resources in locations that are both remote and difficult to exploit, but which might otherwise be economically leveraged to supply new primary production plants. Allied to this is the fact that the best natural energy resources have been taken over and new aspects of sustainability in exploiting those resources have unfolded massive social and environmental costs.

2.3. The aluminum industry relevance to Brazil's economic development

The aluminum industry is paramount for Brazil, a country aspiring to join the Developed Economies List in the long run. The developed countries have pursued two types of trajectories towards the aluminum industry:

- Aluminum-exporting countries that boosted their competitive natural resources of bauxite or energy, by means of long-term industrial and economic policies aimed at boosting economic development and generating skilled and steady employment. Among those are Canada, Norway, Russia and Australia, which own abundant natural reserves (e.g. energy or bauxite), as well as a strongly-advanced industry.
- On the other hand, those developed countries that today are aluminum importers, at some point, learned how to use their primary industry towards building a multifaceted chain of processed and high added-value products. The United States, Spain, France, Italy, Germany and Japan fall into that category. Brazil, however, does not have incentive policies to the industry on any of the trajectories above.

Emerging exporters such as the Middle East countries have shown an aluminum industry in breakneck expansion, with access to abundant and low-cost energy, hence being a vector of economic development. They are further bound to become major global exporters of primary aluminum or semi-manufactured goods.

2.4. An industrial policy for aluminum

An integrated aluminum chain represents a strategic ground for economic and social development. In Brazil, aluminum should be viewed from the perspective of a fully- structured and competitive production chain, from mining to final product and recycling.

Recovering the competitiveness, dynamism and investment capacity for the Brazilian aluminum industry should encompass the vision above, mainly by government bodies.

In the short term, the industry has sought some conditions of competitiveness in primary production, in a way to enable Brazil to resume its primary aluminum production and reactivate those production lines that are currently shut down.

Therefore, a straightforward and steady industrial policy must be in place, enabling a secure regulatory environment that ease the burden on and encourage long-term investments at all the other steps of the production chain. That might potentially help to set up a healthy business environment with clear-cut regulations and a more rational tax framework that does not burden producers.

The types of incentives to the aluminum industry might range from the major producing countries in the world, although economic development and job generation remain as their core (focus). Whether in upstream (e.g. bauxite, alumina, primary aluminum) or downstream (e.g. processed products) production, the chief levers for industrial policies comprise energy, labor, investments, tax and duties.

Energy has been the most common lever when it comes to securing access to energy or energy prices that are more propitious for the electro-intensive industry. As for labor, the competitive advantage lies in stimulating people's skill development and lowering manpower costs (like in the Middle East). Investments are related to better funding conditions and access to goods (i.e. mainly China and the Middle East).

Boosting the Brazilian aluminum industry as a measure to mitigate global greenhouse gas emissions might be another way of thinking this issue.

ABAL has surveyed those CO_2 emissions connected with the international move on such products, reaching the findings below:

- Shipping bauxite and alumina exported from Brazil to North America, for example, emits about 50 kg of CO_2 per ton of product shipped.
- Differently, shipping imported aluminum from Russia to Brazil emits about 37 kg of CO_2 per ton of aluminum.
- Only in 2015, if the bauxite and alumina produced in Brazil and aimed for exports had been processed locally, thus preventing imports of primary aluminum to supply the Brazilian processing industry, generating nearly 900,000 tons of greenhouse gas emissions only in shipping would not have occurred.
- If in 2015 all those products processed in Brazil had been manufactured using Brazil-produced aluminum, at least 1.25 million tons of CO_2 e emissions would have been prevented.

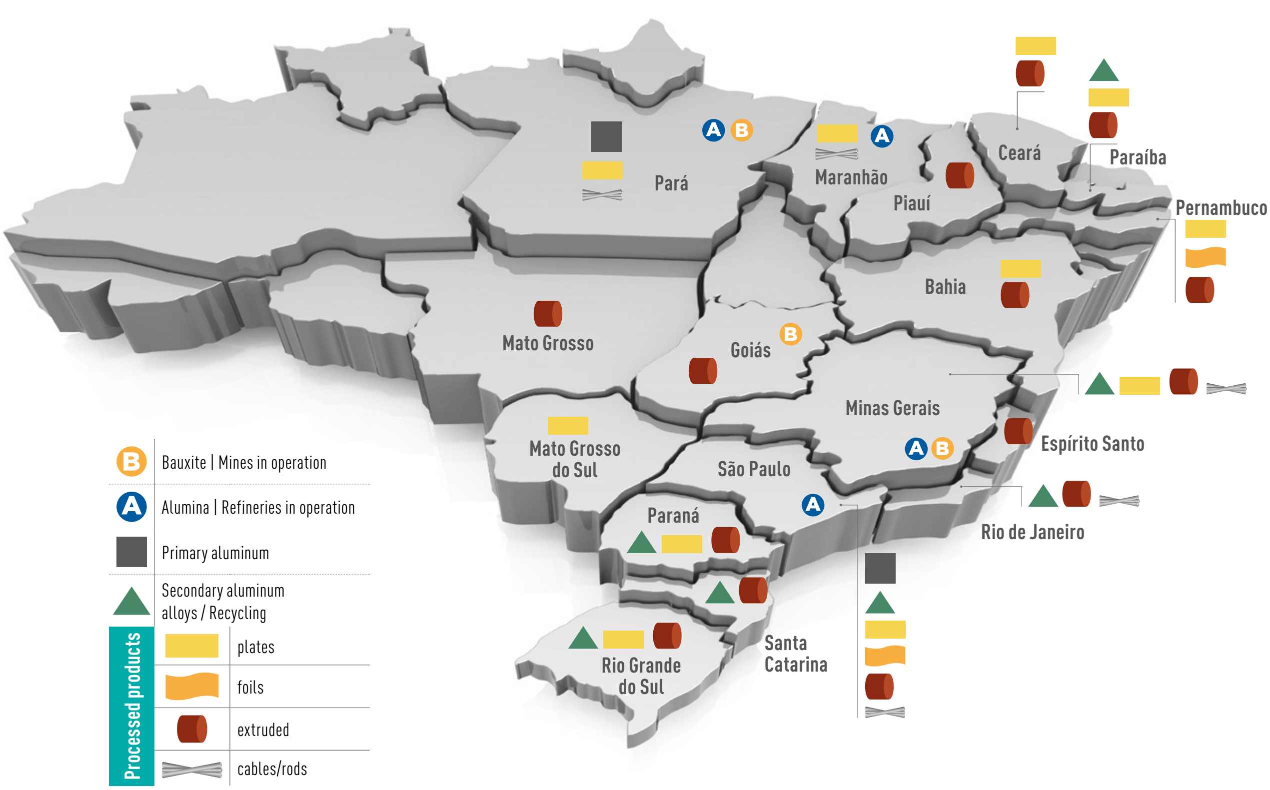
Below are a few examples of aluminum industry incentives in other regions:

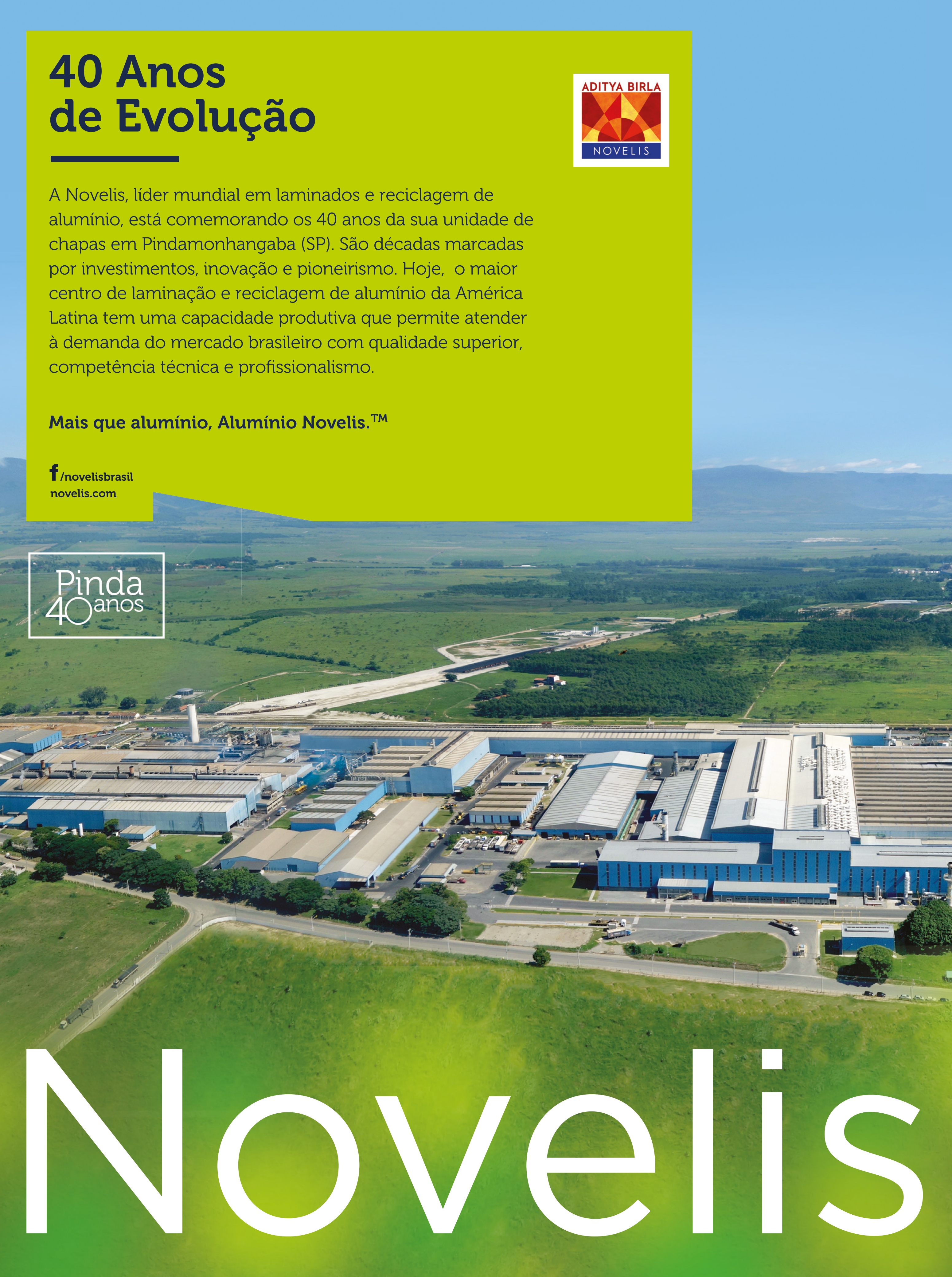
- **AluQuébec - The Québec Aluminium Industrial Cluster:** In Canada, the presence of high-potential hydroelectric power that could be exported to the US has spawned higher socioeconomic value for the aluminum industry. AluQuébec is an initiative engaging producers, customers, suppliers, research and training centers, government bodies and other stakeholders focused on carrying out projects for doubling the volume of aluminum processed in Québec over the next ten years, with the United States as their desired main destination.
- **Massena, NY:** The prolonged power supply contract in Massena, NY, USA, helped secure 900 jobs at the plant, thus causing a current economic impact of about US$ 160 million in the region.
- **China:** The less-developed provinces in the countryside of China, those

that are not subject to the air-quality related restrictions affecting big Chinese cities, have become centers for larger aluminum production. Plentiful reserves of low-cost coal, interest rate incentives to stimulate investments are competitive advantages in those regions. Xinjiang is the region having a considerable aluminum production, and being the farthest away from the Ocean (about 6000 km/3728 miles). Having both bauxite and coal available, though under harsh conditions for shipping them out, makes using such coal to supply both energy and produce aluminum more attractive than just selling it.

- **The Middle East:** Exporting the region's energy potential in the form of gas is ineffective, the reason why there is an opportunity to "pack" that energy for bringing about greater added value and generating development, economic diversification and jobs. Governments have preferably allocated gas to aluminum production projects, thus ensuring access to a low-cost energy. Such initiative has attracted companies to the region to produce a manifold portfolio that also supports expanding the downstream production.

The Aluminum Industry in Brazil




40 Anos de Evolução
ADITYA BIRLA
NOVELIS
A Novelis, líder mundial em laminados e reciclagem de alumínio, está comemorando os 40 anos da sua unidade de chapas em Pindamonhangaba (SP). São décadas marcadas por investimentos, inovação e pioneirismo. Hoje, o maior centro de laminação e reciclagem de alumínio da América Latina tem uma capacidade produtiva que permite atender à demanda do mercado brasileiro com qualidade superior, competência técnica e profissionalismo.
Mais que alumínio, Alumínio Novelis.™
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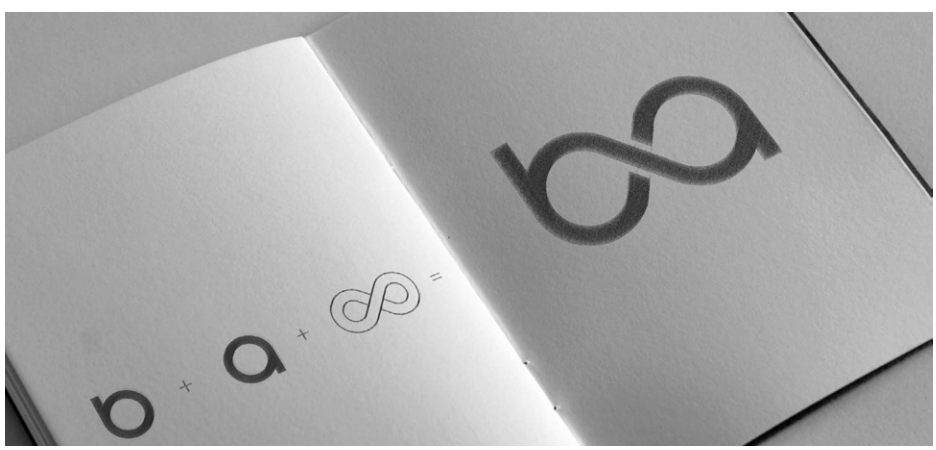
novelis.com
Pinda 40 anos
Novelis

3 The new ABAL

Within this environment of speedy changes, The Brazilian Aluminum Association (ABAL) has sought continuous improvement to keep on fulfilling the mission of spreading the uses and the advantages of aluminum, harmoniously being the voice of the all-embracing aluminum production chain in Brazil, and providing quality services to its members and the society. ABAL does expect to be acknowledged for its robust, sustainable, modern and innovative role.

To that end, when its 47th anniversary was celebrated last May, the Association finalized a modernization project of its visual identity and communication channels.

The new trademark has embedded the symbol of infinity, which fairly embodies aluminum as a material and the evolution of the aluminum industry.



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Those changes go beyond the brand itself: ABAL's headquarters were remodeled, having now more open and well-lit spaces that inspire interaction and dialogue.

In the same period, the Aluminum Cultural Center, a space showcasing the history and the challenges in the aluminum industry, was opened to become the key institutional contact point between the industry and the society.

Learn more:

ABAL's visual identity and brand handbook

The Aluminum Cultural Center

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ABAL has undergone a process of modernizing and redefining its strategy, so as to reinforce its role as a legitimate representative organization that holds the potential to turn prospects into reality.

Below are some initiatives ABAL has worked out on three fronts: **strategy, governance and management**.

3.1. Strategic Route for the Brazilian Aluminum Chain 2030

Brazil owns one of the largest bauxite reserves in the world, being the third producer of bauxite and alumina, for years ranked the sixth largest producer of primary aluminum.

Nonetheless, the energy crisis affecting the country in recent years has become a dramatic structural constraint for the sector, leading to the closure of primary aluminum plants and generating disruption in the production chain.

As a consequence, Brazil went from exporter to importer, then becoming the 11th in the world ranking for primary aluminum production.

Having in mind that the aluminum industry segment is vital to the Brazilian economy and a provider of solutions to an outlook of low greenhouse gas emissions, regaining competitiveness in the chain is paramount to allow recover the primary aluminum production, sustain those investments in the processing segment and consequently secure jobs and wealth for the country.

To leverage such recovery, the ABAL's Board of Directors has invested in implementing a long-term strategic planning for the Brazilian Aluminum chain, aiming to strengthen competitiveness and trigger innovation for the target companies.

A strategic roadmap has then been drawn up as a resource for the new planning, valuing both the relationship and knowledge sharing with stakeholders. **The Observatory of the Industry Federation in Paraná (FIEP)** has headed the works, relying on the support by the **Ministry of Industry, Foreign Trade and Services (MDIC)** and the **National Confederation of Industries (CNI)**.

Nearing completion, that project has addressed changes and trends in the economy, technology and the society on a worldwide, countrywide and local perspective up until year 2030. It aims to predict potential impacts on the aluminum chain in Brazil, by pinpointing and cooperatively building strategic ways and courses, as well as a schedule of converging actions intended to innovate and foster sustainable development for every single part in the chain.

It will result in a document gathering all the accomplishments and plans to then drive ABAL's priorities, which will be published and be made available to all member companies, governments and other pertinent stakeholders.

Drawing up a roadmap will help:

- Strengthen and build up competitiveness for the aluminum production chain in Brazil;
- Identify and plot innovation and sustainable development strategies in the long-term for the distinct arms in the chain;
- Foster environments that attract and retain businesses and investments;
- Map out new products, technologies and services.

The works comprised studies and surveys split into four panels with experts, and addressed specific chains of the aluminum chain in Brazil, such as:

2017

May 9	Panel 1	Mining Industry and Primary Processing (Bauxite, Alumina and Primary Aluminum)
May 11	Panel 2	Recycling (Scrap and Secondary Aluminum)
May 30	Panel 3	The Semi-manufactured Industry (Extrusion; Flat-Rolled products; Wires and Cables; Casting, Forging and Aluminum Powder)
June 7	Panel 4	Applications for aluminum products

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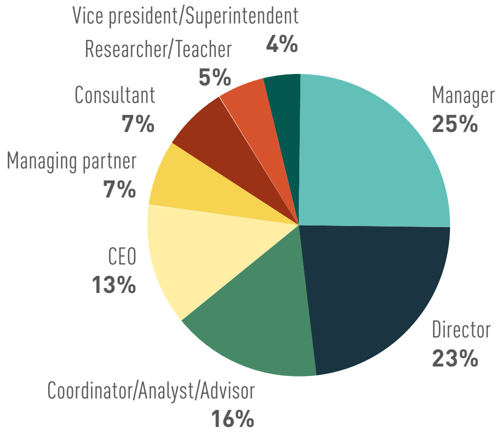
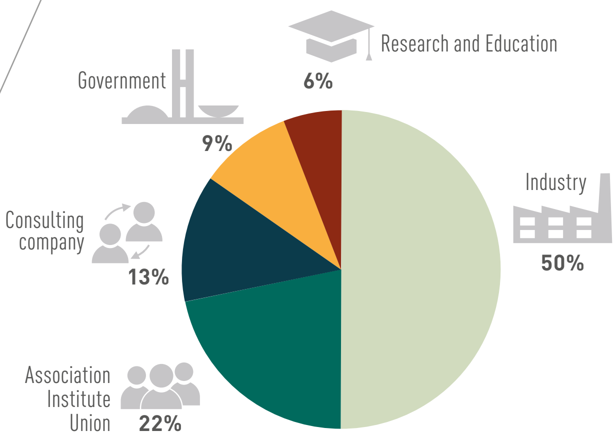
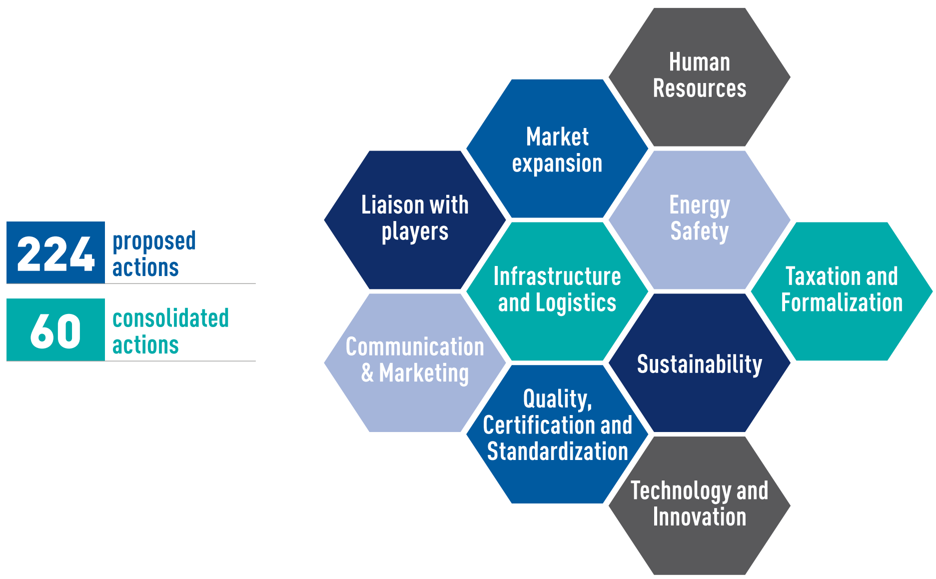
The total 119 participants from 75 organizations were split as follows:





During the panels with experts, outlook visions for each arm in the chain were built, while their critical success factors were determined. One can predict that the actions proposed in the roadmap will comprise initiatives related to the following themes:

Panels with Experts + Web consultancy



3.2. Governance

Aiming to reflect the moves in the Brazilian market, by strengthening representation of the processing companies, ABAL has made outstanding alterations to its Bylaws, in addition to its existing Code of Ethics and Member's Handbook, which address the Association's goals, activities, and members' rights and obligations.

The Technical and the Marketing Committees jointly work in pre-competitive collaboration related topics that are common to Members but do not affect their conditions to compete in the market, such as monitoring and engagement

Corporate Governance

IBGC Instituto Brasileiro de Governança Corporativa

Brazil has been through an unparalleled political crisis, with severe economic consequences. Companies praised and regarded as solid have found it hard to win bids, make investments and even fulfill their financial commitments.

When looking at the brighter side of such scenario, we can expect that one of the achievements in the period will be inevitably better governance for both public and private institutions.

In contrast to the "little Brazilian way" that is still part of our deep-rooted culture, it is plain that there is a need for laws, codes and practices that strengthen transparency, ethics and efficiency.

On that end, corporate governance is the system through which companies and other organizations are managed, monitored and motivated, involving the relationship between owners, the Board of Directors, executive officers, inspection and control bodies and other stakeholders.

Best Corporate Governance practices convert principles into objective recommendations, aligning interests focused on preserving and optimizing the organization's long-term economic value, enabling access to capital and contributing to the quality of the organization's management, its longevity and common good.

in regulatory, tax and sustainability issues, and market tracking to ensure that trade safeguarding measures are implemented.

ABAL continues to refine its corporate governance, by coming up with some actions that include:

- New Bylaws for the entity approved in September 2015
- Member's Handbook
- The Ethics Committee and the Technical Committee for Legislative Tracking
- Focus on pre-competitive topics

Learn more:

ABAL's Goals | ABAL's Code of Ethics and Bylaws | A Handbook for Members

3.3. Management

The entity operates under the lead of Technical and Marketing Committees to carry out activities and fulfill goals. To strengthen engagement and seek strategic alignment, top-level executive officers from the member companies have managed those Committees.

A Committee of Coordinators has also been tasked, holding monthly meetings to ensure the team works in a dynamic and integrated manner to address all relevant matters in full adherence to ABAL's goals.

Another highlight is the initiative towards integrating Sustainability into the Association's strategy. Collaboratively and through partnerships, ABAL has actively engaged in outstanding initiatives, such as:

- **Member of the Aluminium Association Stewardship Initiative (ASI):** in July 2016 ABAL joined ASI, a global non-profit organization that leads initiatives to settle standards for aluminum product certification.
- **Carbon footprint certification of aluminum products:** four member companies - CBA, General Cable, Latasa and Novelis Recycling – engaged in the pilot project of the Brazilian Association for Technical Standards (ABNT) for certifying the carbon footprint of Brazilian products.

- **International principles for responsible bauxite mining**, in association with the Australian Aluminium Council (AAC) and the International Aluminium Institute (IAI). (see box starting at page 25)
- Publication of the report **Bauxite in Brazil - Responsible Mining and Competitiveness** in April 2017.

- **The National Day of Aluminum Recycling**: since 2003, the 28th of October marks the day the aluminum can recycling index for beverages is published, together with other activities done through lectures and technical visits carried out by ABAL and the Brazilian Association of Aluminum Can Manufacturers (Abralatas). For 15 years, Brazil has been a world leader in recycling, with nearly 98% of recycling rate.

4º Pedal
Dia Nacional da Reciclagem do Alumínio

- **ABAL's "Aluminum at Schools" Project**: it aims to spread knowledge over and strengthen education, research and technological innovation in aluminum in partnership with renowned technical and higher-education institutions in the country, by designing educational programs and technical and scientific events in the areas of Metallurgy, Civil Construction, Architecture and others.

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- **Technical standards**: by means of its Technical Committee, ABAL plays the role of overseeing and sponsoring the Brazilian Aluminum Committee (ABNT/CB-035), which is in charge of drawing up technical standards for the aluminum chain.

- **Regulations for Bauxite International shipping**: ABAL is a member of the Global Bauxite Working Group, which has been tasked by spokespersons from bauxite mining industries in Australia, Brazil, China and Russia, with the aim of putting forward technical principles to ensure ore shipping is safe, by preventing its potential liquefaction conditions. The International Maritime Organization (IMO), a specialized body of the United Nations, approved that proposal in September 2017.

- **The International Aluminum Congress**: it was held in São Paulo from June 7 to 9 in 2016, gathering 930 attendants. Among the attendants, the event had 273 students and teachers of technology, engineering and architecture courses.

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- **The Packaging Coalition:** since year 2015, ABAL has integrated a team of other 21 sectorial entities to engage in the Packaging Coalition, which has been founded to meet the Packaging Sector Agreement, an instrument of the National Solid Waste Policy (PNRS)).

RESPONSIBLE BAUXITE MINING PRINCIPLES

The Brazilian Aluminum Association
and
The Australian Aluminium Council

1. Governance

1a. Manage the business with high standards of integrity, transparency and compliance with the applicable laws and regulations.

1b. Implement internal controls, management systems, policies, procedures and codes of conduct to deliver environmental, social and governance outcomes.

1c. Seek public consultations in mining locations, as an aim to secure the social license to operate.

1PD. Public Disclosure:

1PDi. Sustainability reporting: communicate governance approach and environmental, social and economic material impacts, preferably following GRI-G4 Sustainability Reporting Guidelines.

2. Social and Economic Benefits of Bauxite Mining

2a. Engage in the social, economic and institutional development of the communities in which the company operates, throughout the mining lifecycle (from exploration to closure).

2PD. Public Disclosure:

2PDi. Direct economic value as an outcome.

2PDii. Economic value shared including employee wages and benefits, payments to governments, local purchases and community-related investments.

3. Respect and support human rights, cultures, heritage and values of local communities, including indigenous peoples

3a. Consult and cooperate in good faith with communities and indigenous peoples' representatives, especially when new projects or major changes to existing projects may have significant impacts.

3b. Consider feasible alternatives to avoid or minimize physical, social and/or economic displacement, while balancing environmental, social, and financial costs and benefits, paying particular attention to impacts on the poor and vulnerable, including women.

3c. Set up an appropriate communication means for community engagement that includes a feedback structure for complaints, suggestions or periodic consultation.

3d. Conduct a social impact assessment before implementing or making major changes.

3e. Workplace Management: The Company may respect the rights of workers, as set forth in local law and international conventions, including associating freely.

3PD. Public Disclosure:

3PDi. GRI Mining and Metals Supplement - MM6: Number and description of significant disputes relating to land use, customary rights of local communities and indigenous peoples.

3PDii. GRI Mining and Metals Supplement - MM9: Sites where resettlements took place, the number of households resettled in each, and how their livelihoods were affected in the process.

3PDiii. Number of stakeholder consultations performed.

4. Emergency preparedness

4a. Site specific emergency preparedness and response plans developed in collaboration with potentially affected stakeholders' groups such as communities, workers and their representatives, and relevant agencies.

4b. Inform potentially-affected parties of significant risks from operations, including tailings dam safety and water storage dams, and of the measures that will be taken to manage the potential risks effectively.

4PD. Public Disclosure:

4PDi. Existence of emergency plans, how they are prepared (consultation, rehearsal, regular review and modification), their content and means the company uses to adequately inform and prepare the potentially affected.

5. Continuous improvement of health and safety performance

5a. Provide safe and healthy working conditions for employees and contractors, taking all practical and reasonable measures to eliminate workplace fatalities, injuries and diseases.

5b. Have a documented occupational health and safety management system that is compliant with applicable national and international standards and seek to reduce and monitor risks at workplaces.

5PD. Public Disclosure:

5PDi. Recordable accident rates and fatalities.

6. Continuous improvement of environmental performance

6a. Assess and monitor environmental impacts of projects – from exploration to decommissioning and closure.

6b. Have a documented environmental management system that is compliant with applicable national and international standards.

6c. Noise and dust impacts on neighboring communities and employees should be evaluated and managed to reduce risks and exposures.

6d. Control and monitor vehicle traffic to reduce risks and impacts on the surrounding communities.

Responsible Bauxite Mining Principles

6e. Provide for safe storage and disposal of hazardous and non-hazardous wastes, tailings and residues.
6f. Design and plan all operations so that adequate resources, including financial, are available to meet the closure requirements.
6g. Maintain plans to minimize discharges to water that may have adverse effects on humans or the environment.

6PD. Public Disclosure:
- 6PDi. GHG emissions and energy use.
- 6PDii. Quantity of hazardous and non-hazardous waste and associated waste disposal methods.
- 6PDiii. Water use and material water-related risks.
- 6PDiv. Exposure of the communities to noise and dust, along with initiatives to mitigate risks.
- 6PDv. Volume, type, potential impact and remediation actions taken of significant spills.
- 6PDvi. Research and development projects to improve environmental performance over the longer term.
- 6PDvii. GRI Mining and Metals Supplement - MM3: Total amount of overburden, rock, tailings and sludge and their associated risks.

7. Conservation of biodiversity and integrated land use planning

7a. Assess the risk and materiality of the biodiversity impacts and dependencies from the land use and activities over which the company has direct management control or significant influence.
7b. Rehabilitate land disturbed or occupied by operations in accordance with appropriate post-mining land uses.
7c. Draw up and update rehabilitation and mine closure plans.
7d. Implement a Biodiversity Management Plan, developed in consultation with relevant stakeholders, to address material impacts.
7e. Commitment to "No Go" in World Heritage properties.

7PD. Public Disclosure:
- 7PDi. GRI Mining and Metals Supplement - MM1: Amount of land (owned or leased, and managed for production activities or extractive use) disturbed or rehabilitated.
- 7PDii. GRI Mining and Metals Supplement - MM2: Number and % of sites with Biodiversity Management Plans in place.
- 7PDiii. GRI Mining and Metals Supplement - MM10: Number and % of sites with closure plans in place.

Learn more:

ABAL's Organization Structure

ABAL's Goals

Aluminium Stewardship Initiative

Carbon footprint certification - *Revista Alumínio*

Report: Bauxite in Brazil - Responsible Mining and Competitiveness

National Day of Aluminum Recycling - 28th of October - *Revista Alumínio*

"Aluminum at Schools" Project

Technical standards

International Aluminum Congress

Presente na vida da gente

Estar presente na vida das pessoas. Esse é um dos objetivos do Territórios Sustentáveis, programa patrocinado pela Mineração Rio do Norte (MRN) e que contribui para a construção de um horizonte de oportunidades e autonomia em três municípios paraenses: Oriximiná, Terra Santa e Faro. As ações do Territórios Sustentáveis fortalecem a administração pública, favorecem o desenvolvimento socioeconômico e a gestão ambiental. Este ano, o Territórios Sustentáveis foi a iniciativa vencedora do 1º Prêmio Estadual de Inovação da Indústria Mineral do Pará, na categoria Tecnologia Socioambiental. Um reconhecimento pela transformação de hoje com os olhos no futuro. Saiba mais em **www.territoriossustentaveis.org.br**

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4 Aluminum and sustainable living solutions

The making of a successful strategic planning requires considering a vision of the future, and acknowledging that it will be the outcome of our today's actions. It is also critical to share that vision, because the future will be shaped from the synergy of the choices of governments, companies and the society. A careful observation about what happens today allows us to identify signs of changes that are underway and will strongly impact on the aluminum industry.

This section is intended to compile the forward-looking vision found in some markets, together with the growing relevance of aluminum as an enabler of sustainable solutions.

Peter Senge in his book *"The Necessary Revolution - how individuals and organizations are working together to create a sustainable world"* points out that despite uncertainties, three guiding ideas are critical to building the future:

1. All moves are grounded on new mindsets
2. Institutions, working in networks, are paramount
3. Ignoring the needs of future generations, by focusing only on the present moment, is unacceptable.

Ultimately, as the voice for this sector we must get together and act seamlessly for accomplishing the vision of having aluminum as a path for sustainability.

4.1. Sustainable Development goals

The need to set up a vision of sustainable outlook has thrived over the past decades, bringing together several government bodies, organizations, international cooperation and concerned citizens in the planet. The adoption of the 2030 New Sustainable Development Agenda by 193 UN Members in September 2015 has turned into the most thunderous common consent reached so far, recognizing the eradication of poverty as an imperative condition, and taking on the "2030 Agenda for Sustainable Development".

The new agenda comprises 17 Sustainable Development Goals at its core, abbreviated as SDGs, further to 169 goals that are aimed to wipe out poverty and nourish a decent life for everyone within the boundaries of the planet.

Since its publication, governments, companies and other organizations have sought to identify how their policies, actions and products align with those goals.

Those companies that have effectively used natural resources, having well-balanced human capital policies in place are capable of adding value to those goals. With that said, we will then place focus on the products and services they afford to the market and how they line up with a specific SDG.

4.2. Aluminum: versatility for sustainability

Aluminum availability is quite recent in history. For millenniums, mankind used to be familiar with gold, silver, copper, iron and glass, when the aluminum economic production process then started in 1886.

Despite being present at the rate of 8% in the Earth's crust, the reason for its late appearance is that that metal has a great affinity for oxygen, to which it binds in a very strong combination. The amount of energy required to segregate aluminum from oxygen posed the greatest hardship to isolate the metal.

In 1886, Charles Martin Hall in the United States and Paul Heroult in France simultaneously devised the electrolytic process for obtaining molten aluminum metal. Little more than a decade later, the Austrian Carl Joseph Bayer carried out the chemical process that gets the alumina from bauxite.

Aluminum allows solutions that help transport, packaging and buildings become more sustainable. Learning about and quantifying its benefits will enable that the industry plays a top position in the future and the society find the answers to meet the UN's approved Sustainable Development Goals.

Those two breakthroughs were the cornerstone for the birth of the aluminum industry and its foundations, which are still in use today, with technological enhancements seen in modern refineries and smelters around the world.

Once it is produced, aluminum acts as a real bank of energy for future generations, and it can be infinitely recycled with about 5% of the energy needed to produce it in the first place.

Aluminum embodies a long list of intrinsic properties: it is lightweight, corrosion resistant, highly conductive and reflective, non-toxic, durable and recyclable. Using different processing methods and alloys, aluminum takes the desired shape, strength, and density.

Casting, rolling, forging and extruding processes provide designers and manufacturers with uncountable solutions.

Aesthetically, it is a metal that enables alluring solutions for facades and manufacturing of bold-design pieces of art or utensils.

Over and above, the products using aluminum contribute to lowering transport costs, energy and greenhouse gas emissions.

Later we will see more details in the sectors of transport, civil construction and packaging. With the development of aluminum production processes, increasing recycled content and use of clean sources of energy, the aluminum industry soon will reach a point of neutrality and assured effect upon climate, having in mind the entire life cycle of its products.

One still cannot predict to what extent the demand for aluminum will be influenced by aspects of sustainability in the construction, transport and packaging markets, which account for about 70% of aluminum consumption in Brazil.

ABAL's role is to aware the society about such move, by unfolding the major traits of aluminum in some applications, working jointly with its members, universities and governments to stress out the value of such metal as an enabler of sustainable solutions.

Learn more:

Physical and chemical properties of aluminum

4.3. Aluminum in packaging: a barrier that preserves

The raw materials of the early packaging in human history, around 4,000 B.C., were made of animal bones, parts of trees and shells. Later, root baskets and ceramic vases came to exist, and were then followed by glass, fabric, wood, paper, cardboard, foil, until the present day with aluminum and plastics.

The way packaging works evolved from simple packaging for transport to nowadays, when customer information, product durability, larger exposure and logistics feasibility have begun to draw the consumer's attention and substantially affect competitiveness.

Packaging evolves from human needs, further reflecting their socio-economic development level.

In the various segments such as food, beverages, cosmetics and medical supplies, packaging designers seek to select the handiest materials, taking costs into account and keeping in mind that packaging is the element fostering interaction between the product and the consumer.

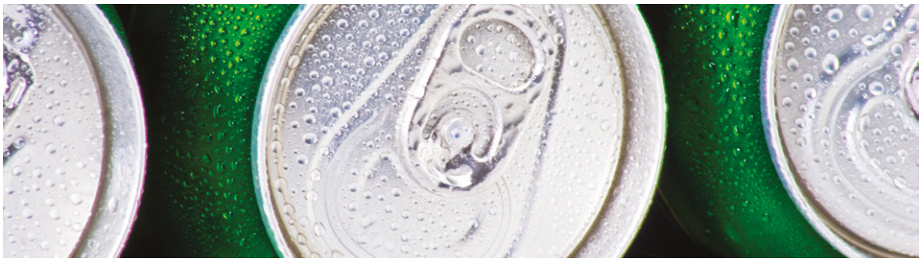
Packaging speaks for a segment in which the major changes stemmed from consumer awareness are shown more expressively.

Coupling concerns such as convenience and practicality with health, well-being and sustainability have steered the breakthroughs in the packaging industry.

The Sustainable Packaging Coalition organization is devoted to encouraging sustainable packaging, which they define as follows:

- The raw materials and suppliers are responsible
- They are designed to be effective and safe throughout their life cycle
- They meet market performance and cost requirements

- They are made using renewable energy
- Once they are in use, they are recycled effectively as a valuable resource for future generations, in a true closed loop for all packaging materials



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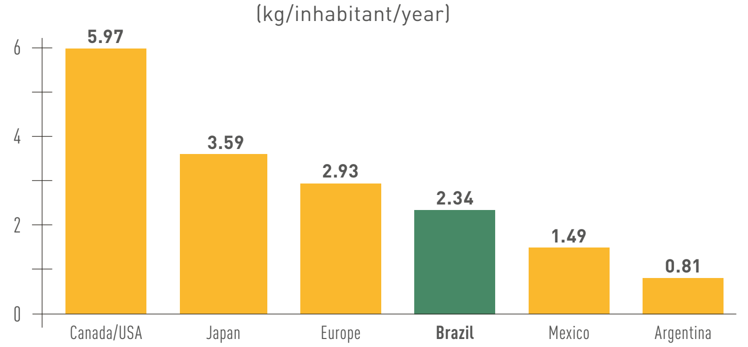
The packaging market in Brazil demanded about 480,000 tons of aluminum in 2015, a volume nearing the previous year's one, which accounted for about 37% of the total of aluminum consumed, with predominance of the cans at nearly 85%.

The world average of this segment represents around 15% of the total aluminum consumed.

As for *per capita* consumption, the table below has shown that Brazil still has a huge potential for growth, even when it is compared with countries having similar *per capita* income, as is the case of Mexico.

Per Capita consumption of aluminum packaging - 2015

(kg/inhabitant/year)



Source: International entities and ABAL's calculation

Regardless of its type and purpose, aluminum-made packaging is enormously versatile in both shapes and finishing and it can be coated, flat-rolled, printed, cut, coldly-shaped and embossed. The barrier property that aluminum holds helps prevent food and medicines from being touched by light, air, moisture, microorganisms, gases, oils, greases, volatile compounds and steam, thus allowing storage for long periods and minimizing losses. On top of that, they are nontoxic, temperature resistant, sound thermal conductors, durable, low weight and endlessly recyclable.

The growing needs of food for a growing population is an enduring challenge, mostly considering the restrained natural resources such as land, water and energy. Lowering food waste is one of the strategies earning greater significance from governments and the industry.

The report entitled Foresight. The Future of Food and Farming Project Final Report estimates that reducing in half food waste, which today is at about 30%, throughout their value chain can be done. As such, the sustainable packaging added with the barrier aluminum provides, can play a leading role in the list of innovative solutions for storage, transport and packaging.

Packaging and the Sustainable Development Goals - SDG 2

Goal: End hunger, achieve food security and nutrition improvement, while fostering sustainable agriculture

Taarget: By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable conditions, including infants, to safe, nutritious and sufficient food all year round.

Learn more:

Aluminum applications - Packaging

Aluminum in aseptic packaging

The use of the well-known long-life packaging in Brazil started from milk packages. Today, they serve as packaging for juices, isotonic drinks, teas, oils, chocolate, coconut, sugarcane juice, wine, fermented and soy milk, cappuccino, among other products.

Build from layers of paper, polyethylene and aluminum – this latter used as a barrier agent - the food that packaging stores are conveyed over long distances and stored for months without refrigeration.

In the case of milk, that packaging has been greatly decisive for food security, mostly for infants, since it is a key food for child development. The benefits of this type of packaging are even more critical for low-income, rural and remotely-located communities.

The so-called Ultra-High Temperature-UHT process, which is applied to package the milk, demands that food is rapidly sterilized at high temperatures (up to 135° C/275o F), followed by filling it in aseptic packaging, thus enabling to preserve food for several weeks, free of food preservatives.

In order words, less waste, healthy food, energy saving and food safety are just some of the benefits these packaging get from aluminum, their greatest ally.

For the coconut water, that package meant a huge waste reduction, by allowing usage in fruit processing.

For orange juice, using it helps preserve vitamin C, meaning that the aseptic packaging has avoided using preservatives for natural juices in their packaging. For wines, such packaging is commonly used in other countries, thus enabling to store the drink in the fridge for up to 30 days, while retaining the aroma and flavor since it blocks the airway.

Aluminum foil is an element of the aseptic package, reaching a thickness of 6 to 9 microns and accounting for nearly 5% of its weight. It mostly works as a barrier against light and oxygen, securing the package's properties, aroma and flavor.

Aseptic packages are recyclable, boosting the circular economy for they serve as raw material for new products. After being separated in the selective collection phase and sent out to specialized recycling industries, the process starts in the paper mills, where paper fibers are detached from the layers of plastic and aluminum.

After separation, the fibers are used to produce recycled paper, then employed to manufacture cardboard boxes. Hence, aluminum and plastic can be separated or reprocessed to turn into new products.

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4.4. Aluminum in green buildings

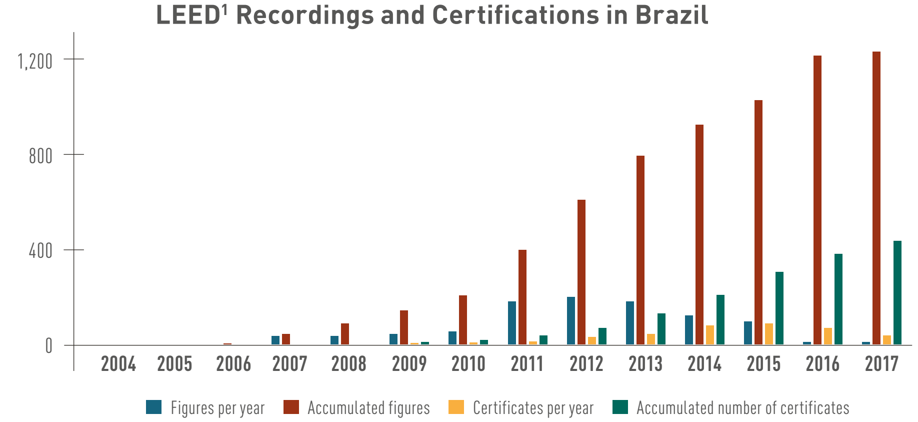
Some figures of the Brazilian Council for Sustainable Construction underscore the global relevance of civil construction for sustainability:

- It uses about 40% of energy and a third of natural resources
- It emits a third of greenhouse gases
- It consumes 12% of drinking water
- It generates 40% of urban solid waste
- It employs 10% of manpower
- It steers 10% of the GDP

In terms of territories, urban areas occupy only 3% of the planet's surface, but they consume nearly two-thirds of the energy generated. The cities produce 50% of the waste, consume 75% of the natural resources and generate 80% of the Gross Domestic Product (GDP). In 2030 they will account for 73% of all the energy consumed by mankind.

Based on such data, the move on green and sustainable buildings, yet very recent, cannot stop advancing. It is over 34000 cities of 188 countries with certified buildings. In Brazil, the figures in the illustration below show that the country has also followed such trend.

LEED[1] Recordings and Certifications in Brazil



(1) LEED (Leadership in Energy and Environmental Design) is a certification granted to sustainable buildings, which has been designed and granted by the American NGO named U.S. Green Building Council (USGBC), according to the guidelines for rationalized resources (e.g. energy, water) a building meets.

Source: Green Building Council Brazil

Green buildings are initiatives to widen positive impacts and mitigate adverse impacts throughout the life cycle of a building, which range from planning and design to construction and operation.

Aspects such as use of energy, water, materials, indoor air quality and impacts of the building on the land and its surroundings must be taken into account.

The survey named *"World Green Building Trends"* of 2016, headed by *Dodge Data and Analytics* have found out that green buildings have already reached 24% of all buildings in the world. In Brazil, the Green Building Council and the *Acqua*

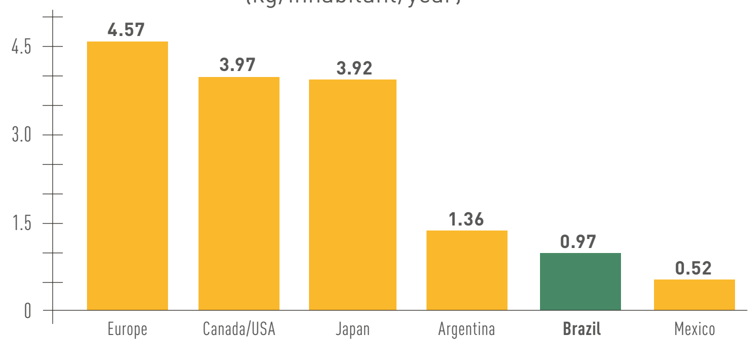
process from the *Vanzolini Foundation* are the most reputed certifications in use for green buildings.

The civil construction market in Brazil demanded about 198,000 tons of aluminum in 2015, which corresponded to nearly 15% of the total aluminum consumed in that year. The world average of this segment represents about 26% of the total aluminum consumed that year.

In terms of *per capita* consumption, the following table shows that Brazil holds still a huge potential for growth, even when it is compared to countries with a similar *per capita* income, like Mexico and Argentina.

Per capita consumption - The Civil Construction Market - 2015

(kg/inhabitant/year)



Source: International entities and ABAL's calculation

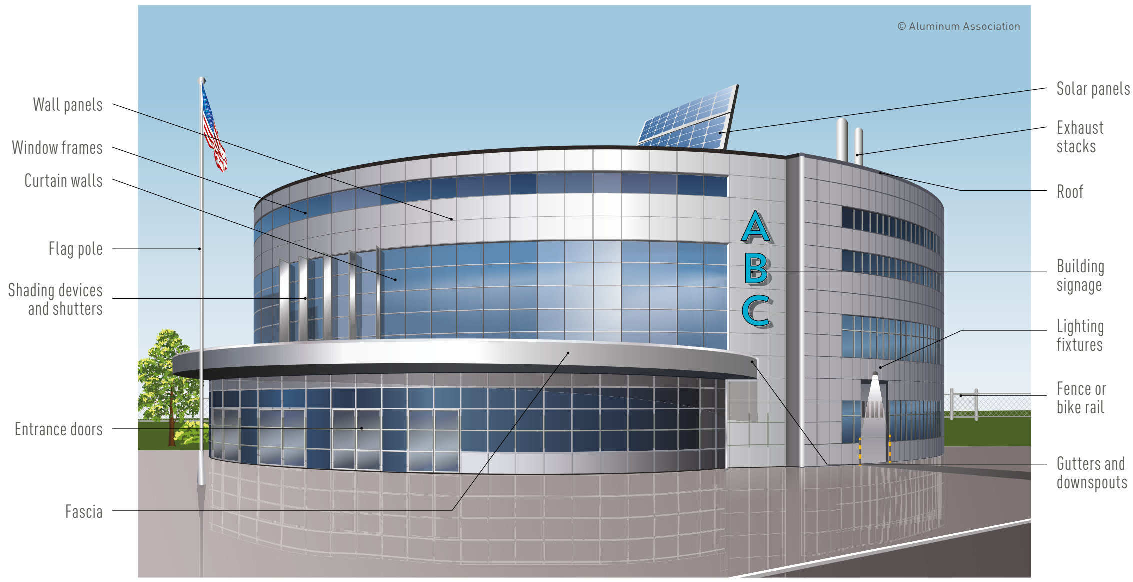
The benefits of Aluminum to civil construction

Before 1920, using aluminum in construction was too scarce. The first building known for having larger use of aluminum applications for structure and finishing works was the Empire State Building, which was completed in 1931, the world's highest building at the time.

Nowadays, it is rather common to link the use of aluminum in civil construction with modern skyscrapers, exhibiting large glazed areas in valued urban regions. Besides, aluminum stands out for being versatile and featuring assorted solutions. Its properties make it a notable material for the civil construction industry for:

- It is both lightweight and sturdy, which favors its use in structures.
- It is durable and corrosion resistant, not only for the natural oxidation of its surface, but also for accepting application of other types of treatment.
- It is flexible and can be manufactured in any shape or size.
- It is reflective, both light and heat, making it a material that strongly favors energy saving.
- It is safe. Using it in construction does not pose risk neither to the environment nor to people.
- It is endlessly recyclable, saving 95% of energy when it is exploited, in contrast to primary aluminum.

Aluminum in civil construction



Source: Aluminum in Green Buildings - A Guide to Green Building Development and Certification with Aluminum Products - Aluminum Association, 2015

Adding aluminum to facades, roofs, windows, pipes, panels and systems for generating renewable energy such as photovoltaic panels, helps optimize energy efficiency, air quality and acoustic comfort while buildings are in use. It further offers appropriate balance among cooling, ventilation, lighting and noise level.

Civil Construction and Sustainable Development Goals - SDG 11

11 SUSTAINABLE CITIES AND COMMUNITIES

Goal: Make cities and human settlements safe, inclusive, safe, resilient and sustainable.

Targets: By 2030

- Ensure access for all to adequate, safe and affordable housing and to basic services and upgrade slums.
- Reduce the adverse *per capita*l environmental impact of cities, including by paying special attention to air quality and municipal waste management.
- Provide universal access to safe, inclusive, accessible, green and public areas, in particular for women and children, older persons and people with disabilities.
- Substantially increase the number of cities and human settlements by adopting and implementing policies and integrated plans for inclusion, resource efficiency, mitigation and adaptation to climate change and resilience to disasters.

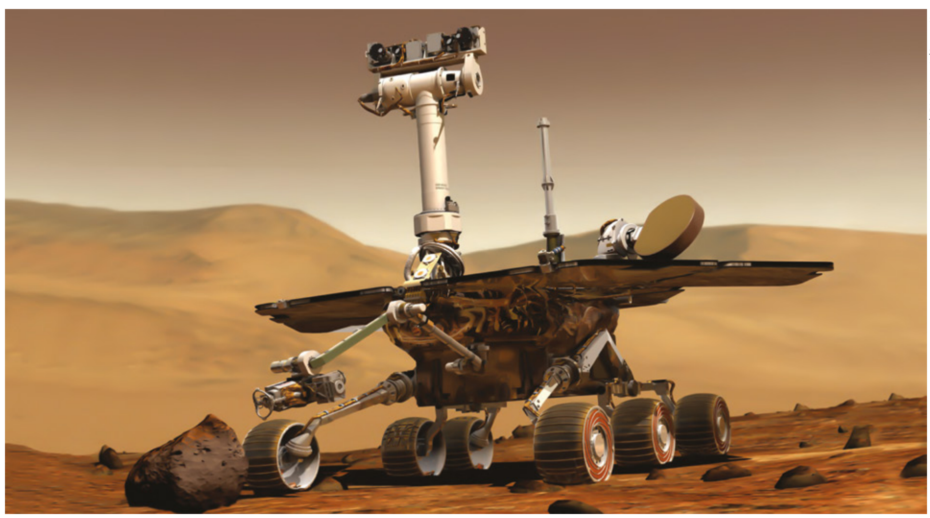
Learn more:

Aluminum applications - civil construction

4.5. The metal for mobility

Aluminum is usually recalled as being the metal that has made modern commercial aviation possible. What just a few people know is that it was already used in aviation before planes were invented. It was the case of airships, the most famous of them being the Zeppelin, which was equipped with an aluminum-alloy structure.

And aluminum's usefulness is never ending, as shown by the *Rover Curiosity*, a robotic vehicle, the size of an average car, that contains aluminum even in its special wheels designed to get around the planet Mars. *Rover Curiosity* was designed, produced and transported by NASA in 2012 to carry out research on the planet's surface.



© NASA/JPL-Caltech/Cornell.

Artistic concept for one of Mars' exploiting vehicles placed on the surface of that red planet.

Accomplishing mobility is one of today's major milestones in modern civilization, allowing access to assets and opportunities. However, mobility also poses a few challenges. One of them is how transports have directly added to greenhouse gas emissions and climate change.

These days, governments, businesses and hundreds of organizations in civil society are seeking solutions that strengthen the so-desired mobility, while shrinking the impacts on climate and the environment.

Such is the case of the standards provided for in fuel consumption and vehicular emission acts such as the *Corporate Average Fuel Economy (CAFE)* in the USA and the Regulation no. 443/2009 of the European Community setting up CO_2 emission targets of 95 grams per kilometer for new cars by 2021. In Brazil, specialized advisory firms have projected that that value is around 130 grams/km.

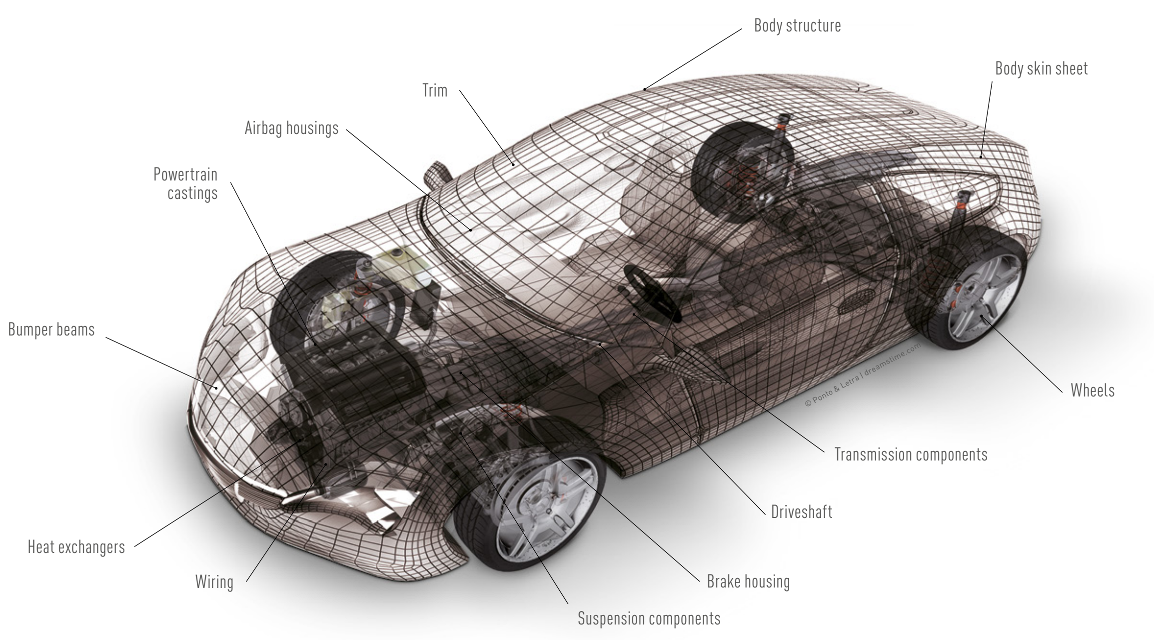
The *New Energy Finance* published by Bloomberg estimates that by 2024, close to 40% of vehicles will be electric ones.

How acceptable will the autonomous vehicles be, mainly the hybrid and electric ones undergoing testing, that have somewhat had a share in brand-new auto sales? How about the performance of automakers that have redefined themselves as suppliers of mobility solutions, which are partnering up with car-sharing application companies?

We still do not have answers for all those questions, yet projections have somewhat shown an increased use of aluminum in vehicles, making them safer and more efficient.

- **Safety:** given aluminum resistance and outstanding energy absorption during a collision, all aluminum-intensive vehicles that have so far undergone impact testing by the National Safety Highway Traffic Safety Administration (NHTSA) in the United States, attained the maximum 5-star score.
- **Efficiency:** aluminum has about one-third the weight of the steel, which means the parts can be resistant while reducing the weight of vehicles, boosting fuel efficiency, minimizing operating costs and greenhouse gas emissions.

Where can aluminum be used in automobiles?



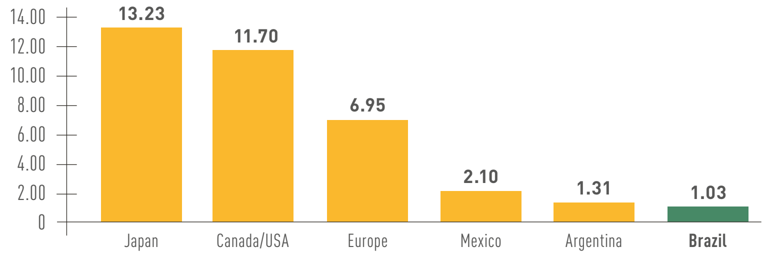
Lighter electric vehicles consume less energy, require more compact battery systems, thus decreasing their final cost. Worldwide, global manufacturers of automotive aluminum have built strategic partnerships with automakers to devise new alloys and designs that encourage recycling at the end of the vehicles' life cycle.

Yet promising, the transport market in Brazil demanded nearly 210,000 tons of aluminum in 2015. Whilst this segment accounts for nearly 26% of the total aluminum consumed worldwide, in Brazil, it has accounted for 16% of the domestic consumption of aluminum.

As for *per capita* consumption, the following table shows Brazil being still at a large potential for growth, even when it is compared to countries with similar *per capita* income like Mexico and Argentina.

Per capita consumption in the Transport Market – 2015

(kg/inhabitant/year)



Source: International entities and ABAL's calculation

Aluminum in electric and hybrid vehicles

Electric and hybrid vehicles are here to stay. Silent and emission-free, that type of vehicles has begun to be part of the solutions for a low-carbon future.

Combined factors have driven the growth in such market. They are:

- Being aware of the role of cities in climate change and the policies that set targets for emissions;
- Laws and energy efficiency programs for vehicles, such as the Proconve and the Inovar-Auto, which the government launched in 2012;
- Bidding guidelines and sustainable purchases by the public bodies, which are paramount for city buses, including the BRTs (Bus Rapid Transit) , as an example;
- The moves towards smart cities and sustainable mobility;
- Policies encouraging electric vehicles and the advent of their manufacturing in Brazil.

Presently, such vehicles account for about 0.2% of the global fleet in operation, though all projections have pointed to a huge growth in the coming years. An example has been the recent announcement by Dutch, French and British bodies towards banning the marketing of gasoline and diesel models in the coming decades. In Norway, 37% of new vehicles are electric. On the other hand, achieving such a growth involves a few challenges that are:

- The concern on where electric power comes from. Brazil has been favored by the fact that its energy predominantly results from water sources. Even when they are compared to ethanol-driven vehicles, electric vehicles are more advantageous.
- The high cost of batteries, which can impact in 50% of the total vehicle cost, energy density i.e. the amount of energy stored per volume, their weight, life cycle and reuse. Surveys made towards getting the best performance are still in course, having aluminum as a decisive ally to overcome those challenges, since it provides lighter and resistant structures for vehicles. Using aluminum in vehicle's body structure, closing panels (e.g. doors, fenders, luggage rack, roof and hood), and battery housing increases rigidity and lowers the weight of the vehicle, allowing smaller batteries, greater self-reliance and lower acquisition costs.

- Modern vehicles have managed to enhance energy efficiency thanks to technology development and application such as engines with variable valve control, three cylinders, direct fuel injection, automated transmission with varied speeds, reducing losses in electric steering, among others, that thus rely on imported components and systems. In the pursuit to energy efficiency, aluminum has further been an undeniable add-on, providing even better results through weight reduction.
- Another issue to be overcome is the implementation of battery recharging stations in urban areas and highways.
- Lastly, a look at tax issues and incentives to devising and implementing such technology in our country is a must.

Aluminum has helped overcome a decisive restriction in electric vehicles: self-reliance. Nowadays, more cutting-edge models have managed to reach 200 kilometers (124 miles) at full charge, a figure that could otherwise be lower in severe traffic or uneven topography in big cities.

That is the reason why the lowered weight that aluminum adds to vehicles is so paramount. Less weight means less energy demanded to move around, strengthened self-reliance, smaller batteries and decreased cost.

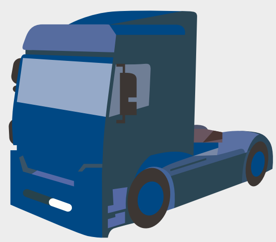
Batteries take up more space than a common fuel tank; they must have good thermal dissipation and be protected from impacts and water contact. Given its lightness and strength, aluminum is the material chosen for housing batteries.

It is estimated that the average in Brazil is at 55 kilos (121.25 pounds) of aluminum per vehicle, the same average in the American industry back in 1992. It means a gap of 25 years. Each pound of aluminum, replacing another heavier material, can prevent the emission of up to 20 kg of CO_2 over the lifetime of a vehicle, or up to 80 kg of CO_2 on trains.

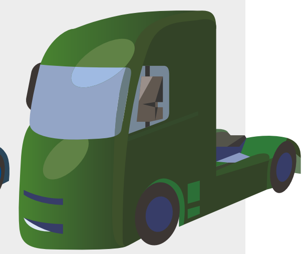
Safety in road load transport

Many are the benefits of aluminum to the safety of drivers and third parties, such as:

- Lowering a vehicle's overall weight helps deplete emissions, while enhancing air quality and people's health;
- In Brazil, where many roads are seen in precarious conditions or restricted access, boosting the load capacity in trucks ensures decreasing the amount of trips and the risk of accidents;
- Another benefit is the preservation of road's asphalt, which further strengthens safety;
- In tanker trucks, aluminum application minimizes the risk of explosions in the transport of flammables, since it does not produce sparks in contact with the asphalt, in case of accidents.



Flat-head trucks



A crash box-equipped truck

Another breakthrough is the aluminum crash-boxes for flat-head trucks, which may weaken the severity of accidents and save lives, with a design that boosts energy absorption in the event of a collision. Using aluminum in impact absorption systems consumes double the energy per unit of weight, in the event of a collision, when compared with steel. Studies carried out in Europe have found out that installing aluminum crash boxes in those trucks might save 300 lives a year. Despite having a competitive cost, such system has been still under trial for approval by the European authorities, for it weights nearly 10 kg and fails in lowering the load capacity of existing trucks.

Transport and the Sustainable Development Goals - SDG 11

11 SUSTAINABLE CITIES AND COMMUNITIES

Goal: Make cities and human settlements safe, inclusive, safe, resilient and sustainable.

Target: By 2030, provide access to safe, affordable, accessible, and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older people.

Learn more:

Applications of aluminum - automotive and transport systems

5 The industry's environmental performance

In 2014, ABAL launched an initiative for consolidating environmental performance indicators for the industries in this sector, which was intended to broaden another action then aimed for the primary aluminum plants.

Gathering, consolidating and assessing the major environmental performance indicators on a periodic and standardized fashion would enable achieving three targets:

- support companies in mapping their performance towards the average for each segment;
- communicate the outcome to stakeholders;
- advise on positioning the sector before the governments and the society.

Although it might seem a simple task, it is an effort posing a number of challenges on which the Association and those members of the Sustainability Technical Committee have jointly worked. Among them are:

- The several production phases (i.e. mining, refining, primary aluminum production, processing and secondary production) are at different levels of maturity in their environmental management system, which can be seen from in the level of participation in the survey.
- Securing data confidentiality for those segments still having a low number of companies or businesses of very distinct size.
- Lack of skilled personnel given the now shrunk capacity of the sector.
- The sense of how much those consolidated indicators may account for the average performance of the given segment.

The aluminum industry in Brazil realizes that improving its environmental management even more is required. All its production steps shall be effective in using natural resources and minimizing waste and effluents. It is expected that the environmental indicators, which are shown herein for the first time, might help speed up our industry's environmental progress.

During 2017, the initiative has started its third yearly cycle, when data relating to 2016 will then be gathered. The outcome shown herein refers to year 2015.

It is worth noting that the figures shown were consolidated per production phase, and they account for the data the companies have provided, with no further review made by ABAL or any external entity.

The environmental aspects in the survey refer to the most substantial ones to our industry, for they comprise the use of natural resources and the emissions in need of environmental management. The reported data solely refer to that given step and cannot be compared with data deriving from life cycle studies. They are:

1. Disturbed and rehabilitated bauxite mining areas, shown in hectares (ha)
2. Total energy consumption and type in Giga Joule (GJ)
3. Greenhouse gas emissions in tons of equivalent CO_2 (ton CO_2e)
4. Use of water, in thousand cubic meters (a thousand m³)
5. Waste generation and disposal in tons (ton)

In short, the productive stages in the survey included:

- **Bauxite mining:** in this first step of the aluminum production process, a thorough and environmentally-planned removal of vegetation and organic soil is carried out. The ore is then removed and processed for use in refineries.
- **Alumina refineries:** in this step, known as Bayer process, the alumina, a high-purity aluminum oxide, is obtained by processing the ore, both chemically and physically.
- **Primary aluminum production (includes anode manufacturing):** processing alumina into aluminum is made at high-temperature electrolytic pots, a process patented in 1886 by Hall-Heroult. The aluminum in metal form is conveyed to furnaces for manufacturing ingots, slabs and billets, which are then processed into finished products.
- **Aluminum processing:** this stage comprises data from the flat-rolled (e.g. plates and sheets) and extruded processes, wires and cables.
- **Secondary aluminum production:** this phase includes data from the remelting and recycling processes.

The companies having more than one productive phase reported their data, then showing each single phase.

In order to be as representative as possible, the survey was based on the volume produced at each stage of production in year 2015. So, as an average it attained 95%, against a result of 100% for refineries and primary aluminum production.

5.1 - Disturbed and rehabilitated areas in bauxite mining

	Balance between disturbed and rehabilitated areas - 2015	ha
1	Total disturbed and not rehabilitated area: accumulated result for up until the previous year. It covers mining areas, office and operating infrastructure and support facilities.	9,036
2	Area disturbed throughout the year	941
3	Area rehabilitated throughout the year	940
4	Total disturbed and not rehabilitated area – balance (1 + 2 – 3)	9,036

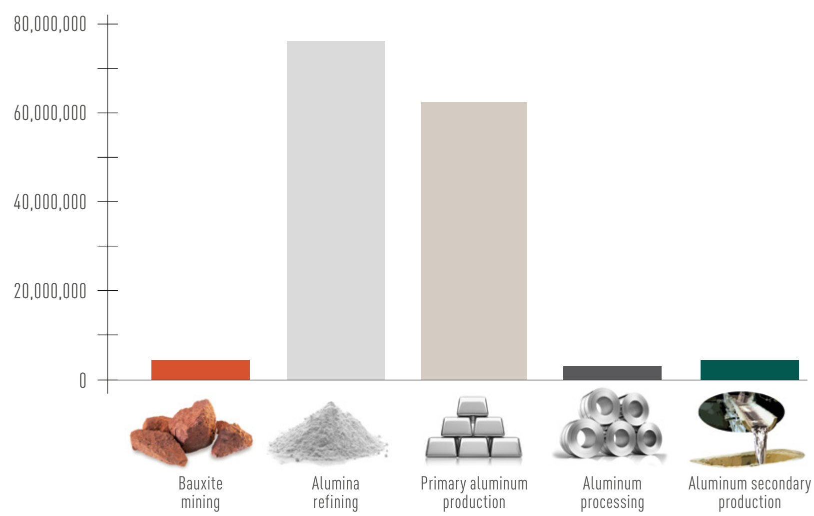
Source: The sector's companies

The companies in the survey accounted for 97% of the bauxite production in Brazil and ended 2015 with a balance of 9,036 ha of disturbed areas, but not yet rehabilitated, covering mining areas, administrative and operating infrastructure, plus support areas.

Throughout the year, nearly 940 ha underwent rehabilitation, thus sustaining the 1:1 ratio between disturbed and rehabilitated areas per year.

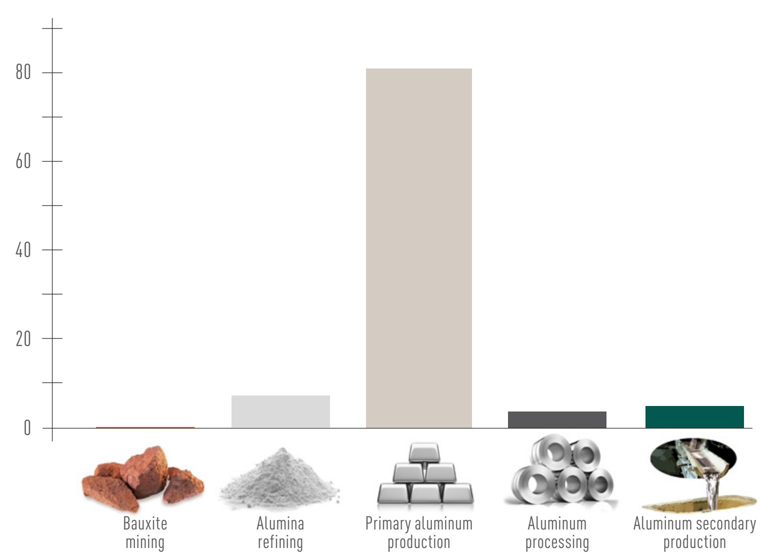
5.2 - Energy consumption - 2015

5.2.1 - Total power consumption - GJ



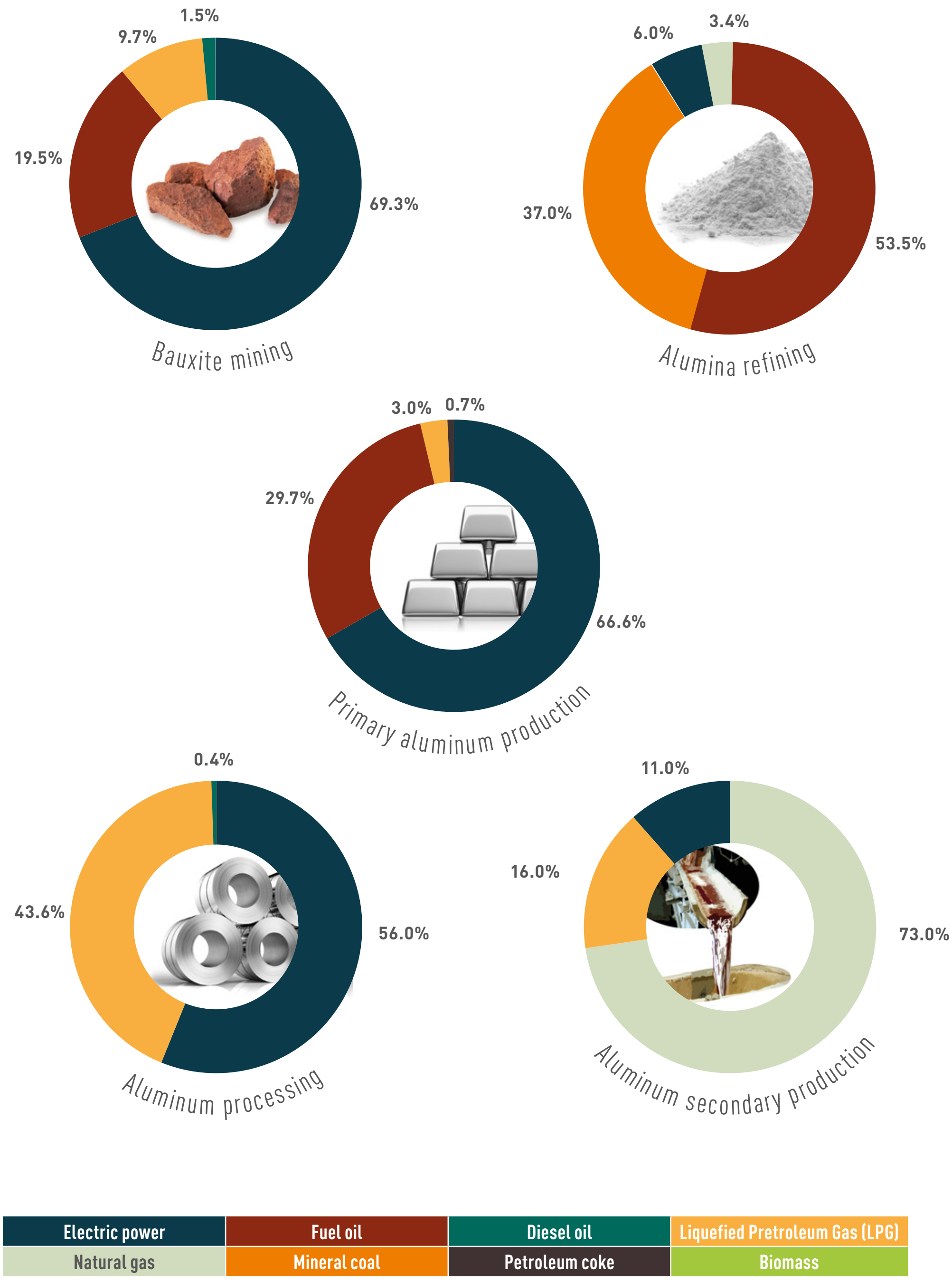
Source: The sector's companies

5.2.2 - Intensity in energy consumption – GJ/ton



Source: The sector's companies

5.2.3 - Energy Mix - %



Source: The sector's companies

5.2.4 - Notes and comments

- The outcome of that survey verified that the greater intensity of energy consumption lies in producing primary aluminum at 80.85 GJ/ton of aluminum, and then followed by Refinery production at 7.27 GJ/ton of alumina.
- Alumina refineries beat Smelters, turning today into the largest energy consumers in the aluminum chain in Brazil.
- Nevertheless, when we compare the 2010 data with 2015 for those two phases in production, by applying the equivalent intensity achieved in 2015, it turns out that the sum of consumption showed a 26% drop, moving from 186,889 TJ to 138,402 TJ.
- Comparing the survey findings with international data provided by the International Energy Agency in 2009 (table below), it is observed that production phases in Brazil involve an energy intensity that is lower than the world average, in particular for Refineries, which are more advanced and efficient.

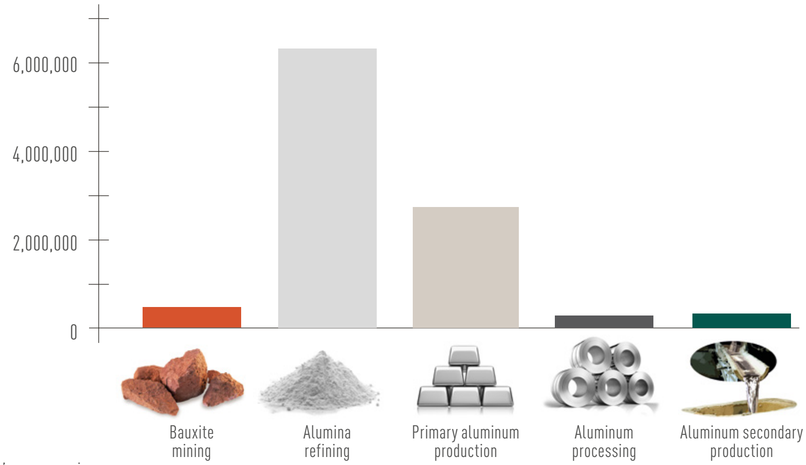
Production phase	Brazil average GJ/ton	Global average GJ/ton (IEA)
Bauxite mining	0.12	0.15
Alumina refining	7.27	16.00
Aluminum primary production	80.85	117.00

Source: ABAL and the International Energy Agency

- However, the specific electric power consumption in primary aluminum production in 2015 remained at 14.95 MWh/ton, about 5% higher than the world average of 14.23 MWh/ton, according to IAI's data.
- Secondary aluminum production in Brazil consumes about 6% of energy in the primary aluminum production, which is close to the data provided by the International Aluminium Institute (IAI) that is at 5%, thus reinforcing the relevance of recycling.
- The energy mix used in the processes of the aluminum industry in Brazil underlines some significant points:
    - Electric power accounts for about 67% of energy consumption in Smelters. Such power, which in Brazil is predominantly water source, provides the Brazilian aluminum with a carbon footprint that is around 60% lower than the world average, as per the **study published by ABAL** in 2010.
    - The relevance of initiatives in energy efficiency for the processes named upstream processes (i.e. Mining, Refining and Smelting processes).
    - The availability of natural gas for the largest Refining and Smelting plants located in the State of Pará, an old query of the segment, would cause a substantial impact on depleting emissions.
    - Using natural gas in the processing and secondary production undertakings that are centered in the Southeast region in Brazil has already contributed to lower emissions in those production phases.

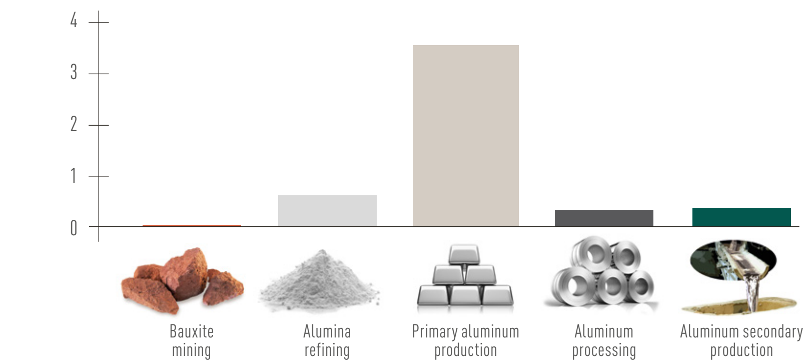
5.3 - Greenhouse gas emissions - 2015

5.3.1 - Total emissions, scopes 1+2 - ton CO_2e



Source: The sector's companies

5.3.2 - Emission Intensity, scopes 1+2 - ton CO_2e/ton of product



Source: The sector's companies

5.3.3 - Notes and Comments

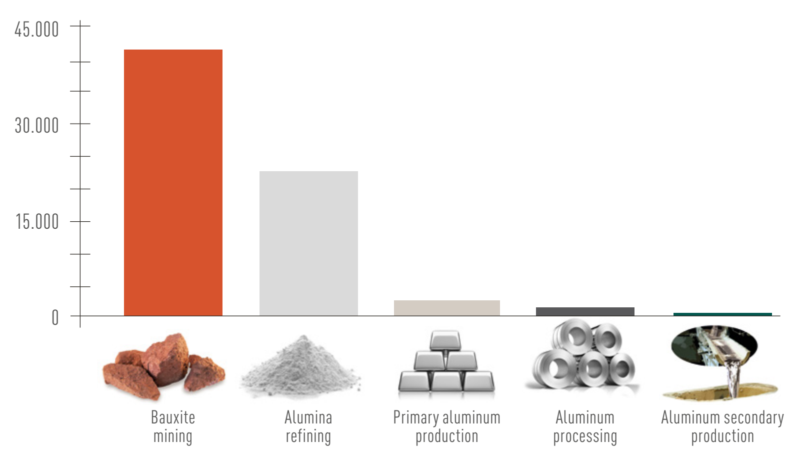
- **Scope 1** – It involves those direct greenhouse gas emissions stemmed from sources that belong to or are controlled by the companies.
- **Scope 2** – It refers to those indirect greenhouse gas emissions resulting from the acquisition of electric and thermal energy consumed by the company. The energy purchased is defined as the one purchased or brought into the company's organizational premises.
- In the smelting process, the figures shown correspond to the sum of emissions for the sort of greenhouse gases present in the aluminum electrolytic smelting process (CO_2, CF_4 and C_2F_6).
- The survey findings show that the highest intensity of GHG emissions in the aluminum chain, considering direct (scope 1) and indirect (scope 2) emissions, lies in the primary aluminum production showing 3,512 ton CO_2e/ton of aluminum, then in the refinery production at 0.601 ton CO_2e/ton of alumina.

- As a comparison, the average in emissions from Smelters in China is 16.50 ton CO_2e/ton of aluminum as listed in the article "GHG emissions from primary aluminum production in China: Regional disparity and policy implications", published by Han Hao, Yong Geng and Wen Hang in *Applied Energy*, Volume 166.
- In short, each tone of primary aluminum that is not produced in Brazil and is otherwise produced in China has a footprint 4.7 times higher, which also increases the footprint for the products using it.
- The impact of direct emissions (scope 1) on the total emissions for each production step is shown below:

% of direct emissions – scope 1	
Bauxite mining	96%
Alumina refining	98%
Primary aluminum production	61%
Aluminum processing	80%
Aluminum secondary production	95%

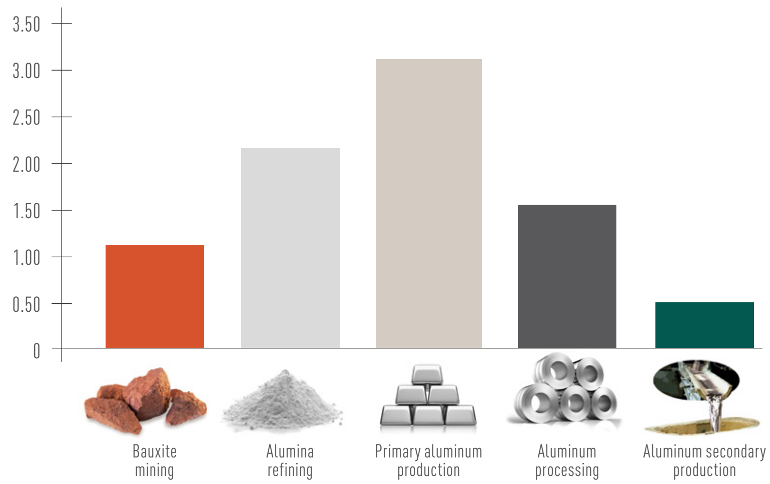
5.4 - Water use - 2015

5.4.1 - Total water use - thousand m³



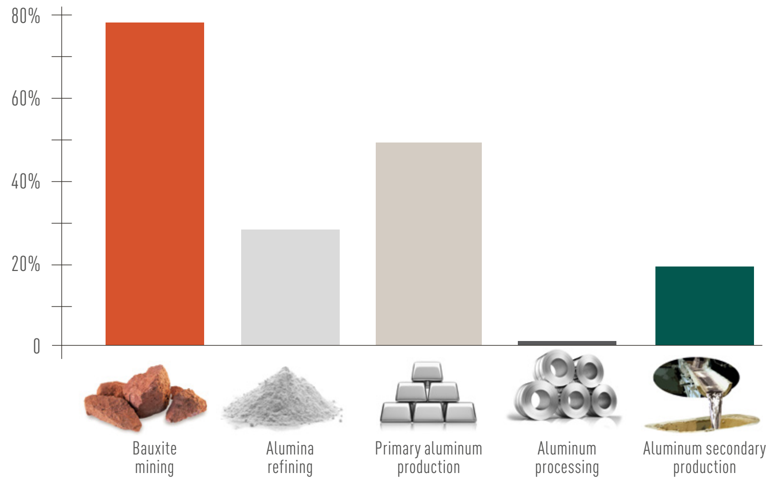
Source: The sector's companies

5.4.2 - Intensity of water use - m³/ ton of product



Source: The sector's companies

5.4.3 - Reuse of water - %



Source: The sector's companies

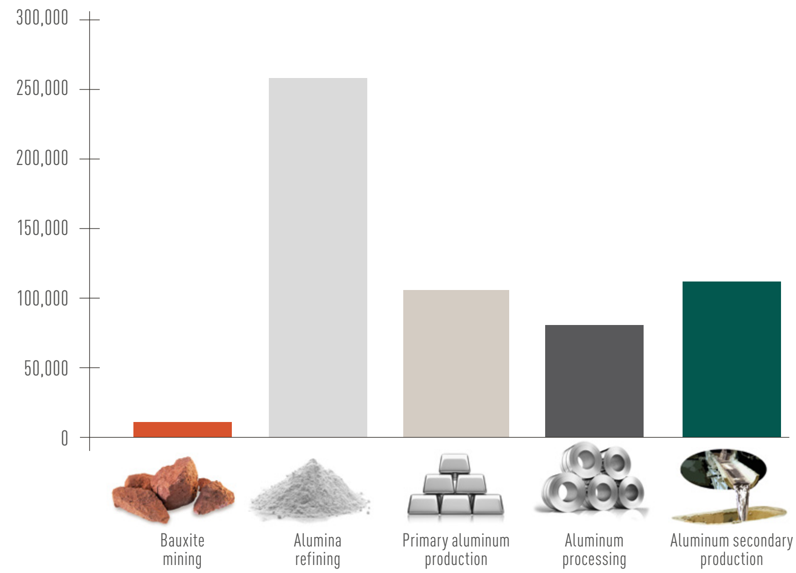
5.4.4 - Notes and Comments

- The water use total above includes collection of surface and underground water, water acquired from public suppliers and use of external effluents.
- Mining and refining process phases account for respectively 61% and 33% of the total water used in the aluminum production chain.
- Roughly 36% of the total water collected for use in Brazilian refineries comes from reusing wastewater and rainwater, thus reducing the demand for natural resources.

- As for intensity, the primary aluminum production phase uses 3.11 m^3/ton, then followed by Refinery production using 2.15 m^3/ton.
- Bauxite mining reuses 78% of the water collected.

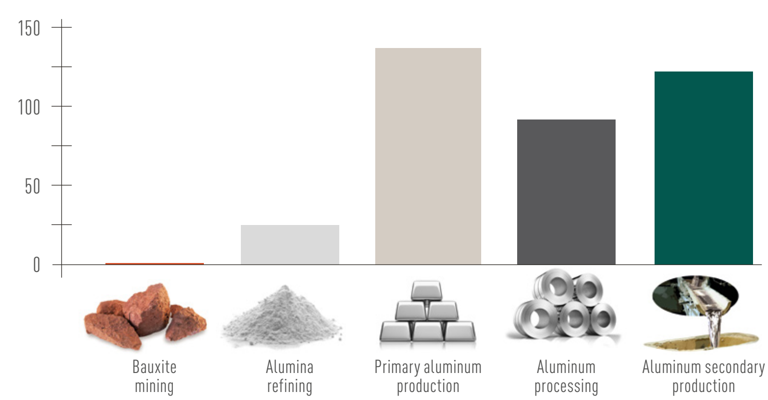
5.5 - Waste generation and destination - 2015

5.5.1 - Total waste generated - ton



Source: The sector's companies

5.5.2 - Waste generation rate - kg/ton



Source: The sector's companies

5.5.3 - Notes and Comments

- The figures shown in the tables above include hazardous (class I) and non-hazardous waste (class II).
- Clay is the scrap free of chemical additive that results from bauxite washing tailings. For its volume and operating features that make it hard to standardize estimates or measure volume, it has not been included in the above data. It is pumped into reservoirs where it is compacted; part of its reclaimed water is then reused in the process. It is worth noting that those tanks are in full compliance with the regulations provided for in the National Security Policy for Dams.
- The Refining-resulted bauxite residues are not part of the total figures above, having reached a total of 9,147,000 tons in 2015. Those residues are sent to Bauxite Residue Disposal Areas (BRDAs) that are licensed by environmental agencies, designed and built to meet the best safety standards in the industry. In such case, after successive washing and filtering in Refinery facilities, that water stored in the Bauxite Residue Disposal Areas (BRDAs) and still showing traces of alkalinity is returned to the process.
- Refineries and Smelters respectively account for 45.5% and 18.6%, of the total residues generated in the aluminum production chain.
- The aluminum primary production is the one showing the highest residue generation rate at 136.5 kg/ton, and then the aluminum secondary production at 122 kg/ton.

6 Recycling: beyond the obvious

Recyclability is an intrinsic trait of aluminum. Still, it might only reach full potential if a given value chain is capable of benefiting from industrial scrap and its post-consumption stage, thus turning it into new products that generate 95% of energy savings and low emissions.

No one doubts that recycling is hugely advantageous; yet going beyond the obvious in this chain that relies on social, economic and environmental aspects might be troubled.

The Aluminium Stewardship Initiative (ASI), of which ABAL is a member, provides for in its Principle 4 of the ASI Performance Standard approved in December 2014 relating to the aluminum value chain that: "The Company is committed to take a life cycle perspective and to promote resource efficiency, collection and recycling of aluminium within its operations as well as within the value chain".

Furthermore, those life cycle assessment techniques still barely in place in Brazil, along with the concept of circular economy, clearly demonstrate the relevant role of recycling in minimizing impacts and carbon footprint on new products and the economy itself.

The Brazilian industry is provided with the skills and the facilities for aluminum recycling, having as the greatest example the Pindamonhangaba center (look under "learn more").

So, we'll the address two aspects that are also key to recycling:

- Economic incentives
- Recycling measuring

Economic incentives - not all aluminum is the same

Aluminum begins to differentiate itself in the market for its environmental attributes.

Some manufacturers have devised brands that point out the source of the metal and its lower carbon footprint, whether for its recycled content or its energy source, which must preferably be renewable.

Those alternatives are attractive for customers looking for low carbon footprint in products, who are willing to pay a differentiated price for it.

That is the case of *RenewAl™ – World's first certified low CO_2 aluminum* by Rio Tinto or the Alcoa *SUSTANA™* line.

Endless recyclability, an intrinsic trait of aluminum, stands out in Brazil. Still, it might only arrive at optimum potential if the industry makes a move toward measuring and understanding how paramount it is to further reduce the carbon footprint of our products.

In order to offer such alternatives to the market, the companies have carried out emission inventories and received third-party certifications, assuring to customers that the information is accurate.

Seeing it from a systemic perspective, the economic activity for recycling in Brazil would deserve a more equitable tax structure in place, which should take all massive benefits it brings into account. That does rely on the efforts ABAL has devoted to interact with tax authorities, aiming to grab their awareness about the matter and have them turn the current context around, as it involves a tax burden over the entire chain, hence impacting on final products and encouraging informal practices.

Another relevant fact is the carbon leakage that occurs when aluminum products imported from countries which have carbon footprints bigger than those for the products made in our country land here, without providing that information to customers. That issue could be minimized by defining a global carbon pricing along with a proper labeling system.

Measuring recycling

ABAL has published two recycling indicators on a yearly basis. They are:

- the recycling rate for aluminum beverage cans, which in 2015 reached 97.9%, thereby sustaining Brazil's leading standing in global ranking for over a decade;
- the indicator of ratio between recovered scrap and domestic consumption of aluminum products, which achieved 46% in 2015 and remained far above the world average of 27%.

The fact that 75% of the entire aluminum produced is still in use helps figure out how limited that indicator is, which then may lead to a potentially-vague finding that 54% of that aluminum has not been recycled.

Finding out the recycling rates and the average recycled volume for each aluminum product, so as to allow their related carbon footprint is assessed is needed. It would require hard-working efforts to devise a mass flow template able to monitor and obtain those indicators, which is not yet available.

Recycled aluminum content

In early April, the Brazilian Association of Technical Standards (ABNT) published the standard **ABNT NBR 16598: 2017- Aluminum and its alloys - Definitions and Calculation methods for defining recycled content in extruded, flat-rolled and cast products**.

The new standard shall be a critical tool for buildings seeking some certification like the seal LEED (Leadership in Energy and Environmental Design), for example, which is aimed at sustainable enterprises, involving both the use of natural resources, the use of solar power, natural ventilation and other aspects that reduce ecological impacts.

It will enable standardize those definitions for boundaries in process flows, by determining the generation of three types of metal waste that are: Run Around Scrap (RAS), pre-consumer recyclable material and post-consumer recyclable material.

The standard also comprises self-declaration models of aluminum recycled conten.

Standard in Performance from *Aluminium Stewardship Initiative* (ASI)

Principle 4 Criteria:

Criterion 4.4: Aluminum process scrap: The Company shall minimize the generation of aluminum process scrap within its own operations and where generated, target 100% of scrap for collection and subsequent recycling and/or re-use. Companies shall seek to separate aluminum alloys and grades for recycling.

Criterion 4.5: Collection and recycling of products at end-of-life (Consumer/Commercial goods suppliers): The Company shall implement a recycling strategy, including specific timelines, activities and targets. The Company shall also take a lead role in engaging with local, regional or national collection and recycling systems for their products containing aluminum at end-of-life to support accurate measurement and the increase of recycling rates in their respective markets.

Criterion 4.6: Collection and recycling of products at end-of-life (Value chain engagement): The Company shall engage with relevant stakeholders to support efforts to increase recycling rates.

Recycling and Sustainable Development Goals - SDG 12

Goal: Ensure sustainable production and consumption standards

Targets: By 2030: substantially reduce waste generation through prevention, reduction, recycling and reuse.

By 2020: achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment

Learn more:

ABAL's website - Recycling

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BRAZILIAN ALUMINUM

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Acknowledgements:

To all the companies and sponsors for this report, along with those ABAL's professionals and member companies engaged in reviewing this report.

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October, 2017

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