

- **Facilitating the reuse of resources for a decarbonized society**
 - Aluminum recycling reduces environmental load -



➤ Promoting a circular economy needed for a decarbonized society

The “era of global boiling” has arrived

Heat waves, torrential downpours, and other effects of climate change are growing more severe every year.

Fierce heat is being reported across the globe. Death Valley in California set a new record of 42.5 °C for the monthly average temperature in July 2024, and Italy also set a new record high temperature of 48.2 °C in the year 2023. And in Japan, the Japanese Meteorological Agency has reported that the summer of 2024 (June through August) snatched the crown from 2023 as the “hottest summer in recorded history.”

In July 2023, UN Secretary-General António Guterres announced that the world has gone beyond mere global warming to enter the “era of global boiling” as he urged the world to avoid the worst-case scenario of climate change. Climate change is predicted to force as many as 216 million people to relocate within their countries by the year 2050, mostly in Africa and the Asia-Pacific regions (according to a 2021 study by the World Bank).

While decarbonization is the most pressing issue faced by our global society, it cannot stop the increase in temperatures.

In response to these urgent circumstances, countries are strengthening their environmental standards in an effort to achieve carbon neutrality. In 2023, for example, the EU enacted the Carbon Border Adjustment Mechanism (CBAM), the world’s first law created to prevent carbon leakage. The law requires businesses to submit data on their carbon emissions and to purchase certificates based on the emissions generated by the production of commodities that they import into the European Union, with the aim of leveling the playing field for industries and promoting climate-change measures in countries and regions with weak regulations.

Currently, five commodities such as aluminum, steel, and cement are subject to CBAM; but once the law is applied in earnest starting in 2026, this number is expected to expand through 2030. CBAM is effectively a tariff that will cause the carbon emitted during production to be reflected in the price of products, which will make low-carbon items more desirable in the future.

As part of its GX (Green Transformation) policy, Japan is also planning to introduce a carbon tax in 2028 that will be levied on significant emitters of greenhouse gases based on their quantity of emissions. In these ways, the preference for low-carbon finished goods is increasing.

While 55% of global CO₂ emissions can be eliminated through the energy transition, the remaining 45% must be addressed by promoting reuse and recycling. Achieving decarbonization will require us to not only switch to renewable energy, but also migrate toward a recycling-oriented society and economy (a “circular economy”).¹ In addition to the traditional 3 R’s (reduce, reuse, and recycle), circular economies involve activities that generate added value through the creation of services while using inventory effectively and constraining consumption and the use of resources.

Sophisticated recycling schemes also keep the energy required for extraction and production in check by limiting the number of new resources that are invested. Further progress toward decarbonization is also realized by reducing the CO₂ emissions generated from the incineration of waste.

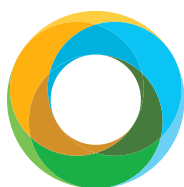
¹ Source: Completing the Picture: How the Circular Economy Tackles Climate Change

LIXIL's Purpose is to **make better homes a reality for everyone, everywhere.**

We do this through actions and innovations designed to create positive impact in the world, today and tomorrow.



LIXIL's Environmental Vision 2050



ZERO CARBON AND CIRCULAR LIVING

Declaring the commitment to “Zero Carbon and Circular Living,” LIXIL aims to become a leading company in environmental sustainability, by reducing CO₂ emissions to net-zero through our business processes, products and services, and passing on the benefits of water and resources for future generations.

Three Focus Areas to Achieve Our Vision

CLIMATE CHANGE MITIGATION AND ADAPTATION

WATER SUSTAINABILITY

CIRCULAR ECONOMY

“Zero Carbon” and “Circular Living” by 2050

In its “Environmental Vision 2050,” LIXIL set a goal of achieving a recycling-oriented lifestyle as well as reaching net-zero carbon emissions in its industrial processes, products, and services by the year 2050.

In our construction-materials business, which produces windows and other components, we are particularly focused on actively promoting our initiatives of “mitigation and adaptation through climate-change measures” and “encouraging the recycling of resources” as important pillars in our drive to achieve our environmental vision.

Regarding the former initiative, for instance, we are working to popularize high-efficiency insulated windows to reduce the carbon emissions produced when buildings are in use. In 2023, we redesigned our entire series of windows for new construction as we work toward our goal of having high-efficiency windows comprise 100% of the components used in new detached homes by FY 2026 (ending March 2026).

Since about 90% of the 50 million existing homes in Japan do not meet energy-saving standards,² we are also working to popularize and promote the updating of their insulation.

One of LIXIL's initiatives for promoting materials recycling is “revia,” a material that incorporates recycled waste plastic. Revia consists of a combination of discarded wood material and practically any type of waste plastic, including the composite plastics that have historically been difficult to recycle and thus been either burned or buried. Because it reuses resources that have traditionally been burned or thermally recycled, one ton of revia reduces CO₂ emissions by approximately 82% (1.93 tons).

LIXIL is also advancing the recycling of aluminum that is used in many of its products.

New aluminum ore comprises the largest percentage of CO₂ emissions of all materials within LIXIL's Scope 3 procurement. To reduce its overall Scope 3 emissions, LIXIL has set a goal of achieving a 100% usage rate of recycled aluminum by FY 2031 (ending March 2031).

² Data from the Construction Subcommittee of the Social Capital Development Council, Ministry of Land, Infrastructure, Transport, and Tourism (2021)

> On the frontlines of aluminum recycling

Aluminum is a key material for decarbonizing our society

Aluminum is a material used across various industries and products, including automobiles, railroads, construction, canning, food packaging, electronic devices, and robots.

For example, transportation vehicles such as cars and trains use a high ratio of aluminum compared to other metals due to its low relative density. By reducing the curb weight of such vehicles, aluminum can improve fuel consumption and thus reduce CO₂ emissions. In addition, the high thermal efficiency makes aluminum the ideal choice in residential and commercial heat pumps, water heaters, air conditioners, fuel cells, and more.

And in the construction industry, aluminum is valued as a strong and durable building material, allowing to not only reduce the weight of structural components, but also lead to direct energy savings by reducing the need for heavy machinery during the building process, lowering costs, and speeding the time to completion.

As the demand for aluminum continues to grow globally, it is expected that production will increase by 50% by 2050, a trend that includes Japan. This rise reflects aluminum's ongoing importance as we work toward a more sustainable future.

However, the refinement of new aluminum ore requires significant quantities of energy, leading to significant CO₂ emissions.

Even if we transition to solar power and other renewable energies that don't generate carbon dioxide, it will be difficult to supply the vast energy needed to refine aluminum.

The key to reducing the environmental impact created by the refinement process is to promote aluminum recycling, which does not use new ore. Aluminum's low melting point compared to other metals allows it to be melted and recycled using minimal energy. The energy needed to recycle aluminum is a mere 3% of that required to extract new ore from the ground. In other words, using recycled material instead of new ore for aluminum products can reduce carbon emissions by 97%. Considering that demand for aluminum will continue to increase, there is also then great potential for contributing to decarbonization.

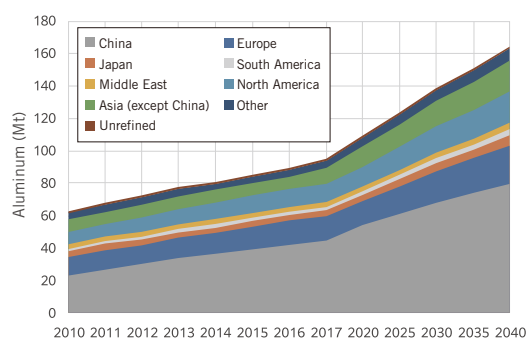
But in recent years, an increasing amount of our valuable aluminum scrap is being exported overseas. In 2022, approximately 440,000 tons of aluminum scrap were shipped out of Japan.¹ This scrap metal is an important resource that can reduce the country's carbon emissions, so we must encourage its domestic recycling.

1 Source: <https://www.aluminum.or.jp/publication/alumi-age/pdf/199.pdf> *Japanese

**Driven by building and structural materials,
demand for aluminum continues to grow due to its light weight and workability**

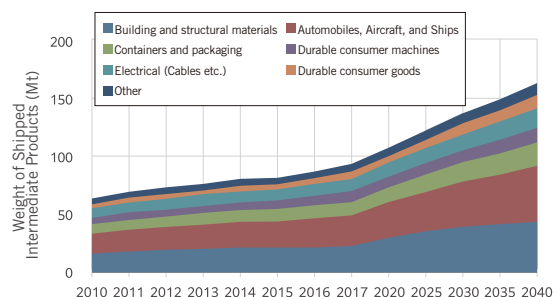
Aluminum demand by region and use case

Past data and future predictions of global aluminum demand



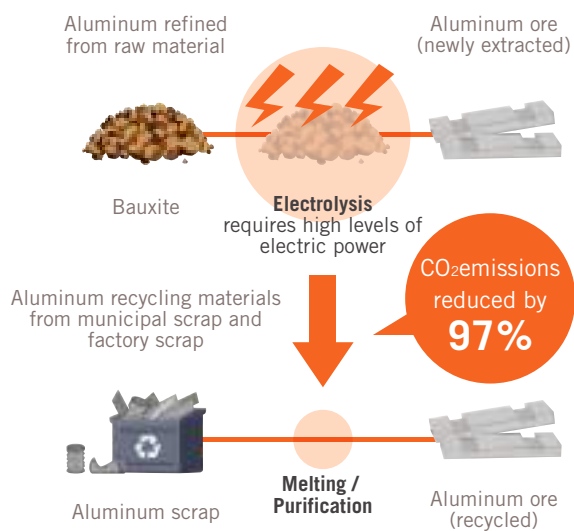
Source: Created by the NEDIO Technology and Innovation Strategy Center based on Regional Aluminum Flow Model 2017 (International Aluminium Institute, 2019)

Past data and future predictions of the shipped weight of aluminum intermediate products globally



Source: Created by the NEDIO Technology and Innovation Strategy Center based on Regional Aluminum Flow Model 2017 (International Aluminium Institute, 2019)

Aluminum recycling is energy efficient because it doesn't require electrolysis!

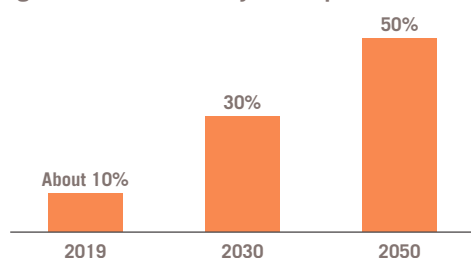


The recycling rate of expanded material in the Japanese aluminum industry is only 10%

* As of 2019

* Expanded material: the form of aluminum used in building materials etc.

Targets for the use of recycled expanded material ³



Aluminum recycling requires advanced technology

While aluminum beverage cans have established recycling schemes that push their recycling rates up to 97.5%, other aluminum products such as those used in the construction industry are currently nowhere close to that number.

Increasing the rate of aluminum recycling will require us to promote the recycling of expanded material used in things like buildings and automobiles.

“Expanded” means that the metal has been subjected to pressure to form it into a shape. Expanded material is therefore metal that has been processed in this way. However, only 10% of expanded material is recycled for use in new expanded material. In its long-term vision, the Japan Aluminum Association has established a goal of increasing this rate to 30% by 2030 and 50% by 2050.³

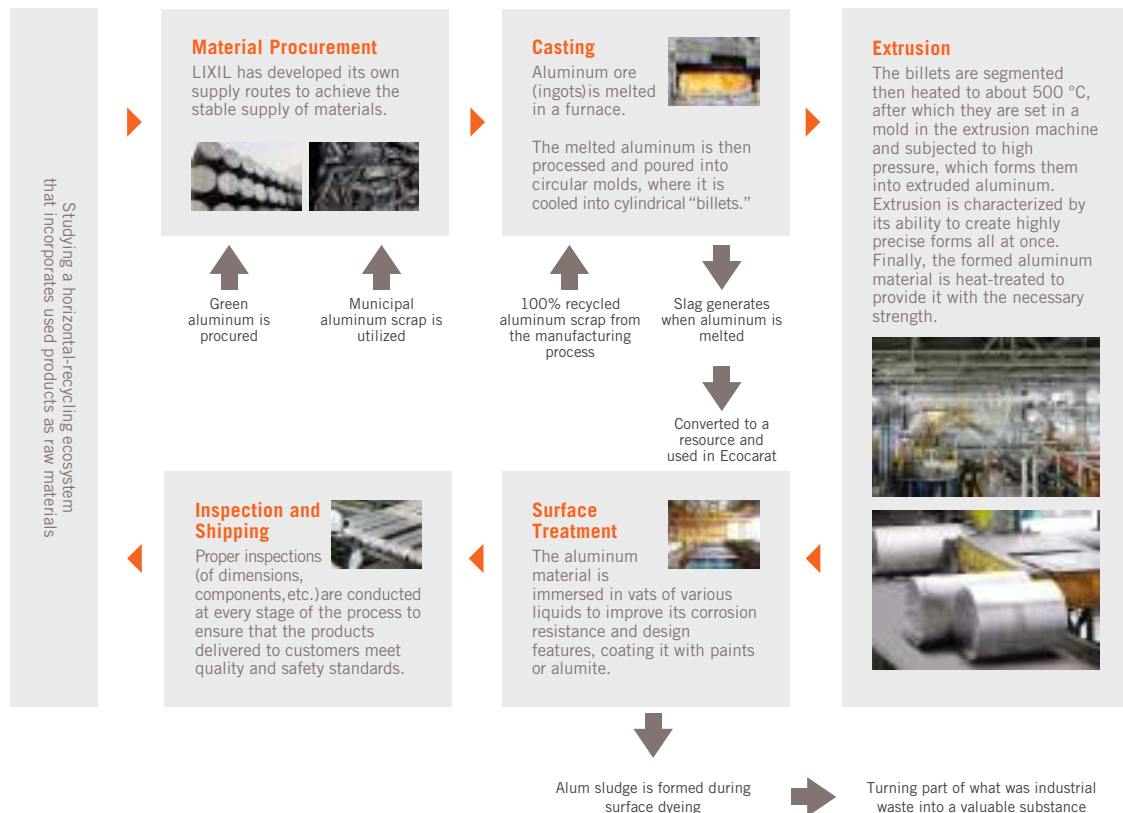
One of the main reasons given for the stagnant recycling of expanded material is that separating out the aluminum scrap needed for recycling is difficult.

To collect it, the scrap must first be extracted from huge masses of industrial waste. Such waste includes large quantities of screws and handles used in finished products as well as glass, tape, and other foreign matter. These impurities must be sorted out so that only the aluminum scrap remains. Moreover, the cleaned aluminum scrap consists of many different metal alloys, which must be sorted according to their characteristics. This sorting process requires sophisticated technologies.

² Source: Japan Aluminum Can Recycling Association (<https://www.alumi-can.or.jp/pages/98/>)*Japanese

³ Source: Japan Aluminium Association VISION (<https://www.aluminium.or.jp/vision2050/>)*Japanese

➤ LIXIL's goal for closed-loop aluminum recycling



Achieving a closed-loop system for aluminum recycling with LIXIL's proprietary technology

Amidst this backdrop, LIXIL has achieved a 78% usage rate for recycled aluminum in its products (FY 2024; 6063 alloy¹).

We have world-leading knowledge and technology related to aluminum recycling, built from over 25 years of experience. This isn't limited to melting technologies, but includes casting, extrusion, surface processing, and other methods suitable for recycled aluminum. Securing high-quality aluminum scrap is also essential for increasing the usage of recycled aluminum. LIXIL is working with its business partners to build collective knowledge and construct a solid supply chain throughout the collection, dismantling, and sorting processes.

LIXIL is engaged in a variety of initiatives aimed at promoting aluminum recycling.

First, when procuring aluminum, we don't just focus on "green aluminum" from new ore—we also actively promote the recycling of municipal scrap metal, as mentioned previously. In the aluminum manufacturing process, the waste generated is seen as a problem. LIXIL is working to achieve a 100% recycling rate for the aluminum scrap produced by this process, of course, but we are also striving to reuse material that was previously treated as industrial waste and turn it into a valuable commodity.

Furthermore, we are studying the viability of a horizontal-recycling ecosystem in which the aluminum collected from repaired items etc. is recycled and used to produce aluminum material, which can then be utilized to manufacture new items.

Through such efforts, LIXIL aims to achieve closed-loop aluminum recycling² that leverages its proprietary technology.

¹ Based on the definition of the Japan Sash Manufacturers Association (<https://www.jsma.or.jp/>)*Japanese

² Collecting the material from your own company's used products and reusing them to create more of your own products

The circular low-carbon aluminum material PremiAL



Realizing the first 100% rate of recycled aluminum in Japan

Using its proprietary aluminum-recycling technology, LIXIL developed a recycled low-carbon aluminum material called PremiAL.

The PremiAL series consists of two products: PremiAL R70, which uses at least 70% recycled aluminum, and PremiAL R100, which uses 100% recycled aluminum.

PremiAL embodies our commitment of the “spirit of wasting nothing” that we inherited from our predecessor.

LIXIL’s journey for aluminum recycling began over 25 years ago, long before the phrase “carbon neutral” had become mainstream. At the time, there was an internal discussion about the fact that discarding the window frames and other aluminum components from demolished buildings was a waste, and we wondered whether they could be reused for new products.

But as we’ve stated, a stable supply of aluminum scrap is a key pillar of aluminum recycling.

By establishing solid partnerships with knowledgeable suppliers and jointly developing sorting technologies over many years, LIXIL has succeeded in realizing a stable supply of aluminum scrap.

We have also developed high-precision sorting technology to ensure we are well-equipped to receive aluminum scrap efficiently.

Moreover, LIXIL has created proprietary recycling technology for everything from the management of raw materials to melting and post-processing. Thanks to many years of research, the quality of recycled aluminum is now on par with that of new ore.

The PremiAL series has been certified by a third party (SuMPO EPD; formerly EcoLeaf), indicating that it has a quantifiable impact on the building materials of construction and thus contributes to improving the environmental value of buildings that use low-carbon materials. Compared to products that use new ore, PremiAL R70 reduces CO₂ emissions by 55%, while PremiAL R100 reduces emissions by about 80%.

Currently, only two companies in the world are capable of manufacturing new products made entirely from recycled aluminum: LIXIL and a major extruded-aluminum firm in Scandinavia.³ Highly praised for its positive impact on the environment, PremiAL is now being used in many different stores and facilities, and even in various industrial products outside the construction industry.

³ Based on LIXIL’s research

Turning the aluminum slag from casting into a resource

Creating the technology to recycle high-purity aluminum hydroxide

Within the oxides that form when aluminum is melted, the components that cannot be reprocessed have traditionally been treated as industrial waste (aluminum slag).

Increasing the usage of recycled aluminum will also increase the quantity of aluminum slag, a material that generates heat and ammonia gas when it gets wet. This makes it extremely difficult to handle; managing it is time-consuming, and there aren't many companies that can process it. There are also limits on the amount of aluminum slag accepted by those companies, so finding a reliable and long-term solution is challenging.

On the other hand, LIXIL uses high-purity aluminum hydroxide as a raw material for its products.

We therefore took up the challenge of separating highly pure aluminum hydroxide from aluminum slag, which contains a lot of foreign matter and had thus been treated as industrial waste.

Through much trial and error, we finally succeeded in developing the technology to pretreat aluminum slag before melting it, which allows us to effectively manage the ammonium gas and separate out the aluminum hydroxide with minimal impurities. What's more, we realized that this extracted aluminum hydroxide could be reused as the raw material for Ecocar, a deodorizing and humidity-controlling material for interior walls.

This goal of making a resource out of aluminum slag, which most companies treat as industrial waste, is also rooted in the "spirit of wasting nothing."

The "spirit of wasting nothing" turns aluminum slag into a resource



Separating and recycling high-purity aluminum hydroxide

Making the alum sludge generated by surface treatment into a valuable commodity

Turning industrial waste into a valuable material that helps the environment

When color is added to an aluminum surface, it generates an inorganic substance called “alum sludge” that has a high moisture content and contains many impurities.

In the past, LIXIL paid to have this alum sludge processed as industrial waste and reused as a raw material for cement.

To reduce our industrial waste, we partnered with other companies to construct a framework in which alum sludge is a valuable material. This material is mixed with slaked lime to create a product that renders harmless the toxic substances produced when garbage is incinerated, and it is currently being used by several municipal governments for that purpose.



Turning industrial waste into something valuable serves to both reduce the emissions of the waste itself and contribute to environmental conservation by removing toxins when trash is burned.

Procuring “green aluminum”

Contributing to Scope 3 decarbonization

As LIXIL aims to achieve a 100% usage rate of recycled aluminum, we have focused on the production of aluminum billets made from aluminum scrap that we melt down ourselves. Currently, we have achieved a 78% usage rate for this type of product.

The more the usage rate increases, however, the more difficult the technological hurdles are to overcome. Although we are still forced to acquire new ore at present, we are actively working to procure “green aluminum” with low CO₂ emissions whenever possible.

Green aluminum generally refers to aluminum material (such as billets or the new ore used in expanded material) produced with renewable energy (solar or hydroelectric power at 4 kg-CO₂/kg).

Previously, we were using the aluminum billets we made ourselves for subsequent processes like extrusion and surface processing; but procuring green aluminum created new challenges in manufacturing technology that we hadn't encountered with our own billets.

To conquer these challenges, we developed new technology specifically for the green aluminum we procure.

Further increasing our procurement of green aluminum ore in the future will contribute to Scope 3 decarbonization.



➤ LIXIL's vision for the future of aluminum recycling

Achieving a circular economy

Both with Japan and abroad, regulations are being enacted one after another to encourage the transition to a circular economy.

The EU created the Ecodesign for Sustainable Products Regulation, which requires all companies to consider recycling when designing their products—including intermediate products such as aluminum and steel. The Japanese government has also held cabinet meetings related to the advancement of a circular economy. As these developments unfold, LIXIL is enhancing its usage of recycled resources like aluminum.

We are looking to expand our PremiAL series of products globally.

In addition to our three domestic plants, we are now also able to supply products from our overseas production facilities in Thailand and Vietnam, enabling to serve international markets.

This will allow us to better respond to future demand outside of Japan, including locations in Europe, America, and Southeast Asia.

Through the recycling of municipal scrap to produce the PremiAL series, the procurement of green aluminum, and the reuse of industrial waste generated in its factories, LIXIL is actively working on first-of-their-kind initiatives to create new environmental value and develop a closed-loop recycling system via its proprietary technology.

LIXIL's 25 Years of Progress in Aluminum Recycling

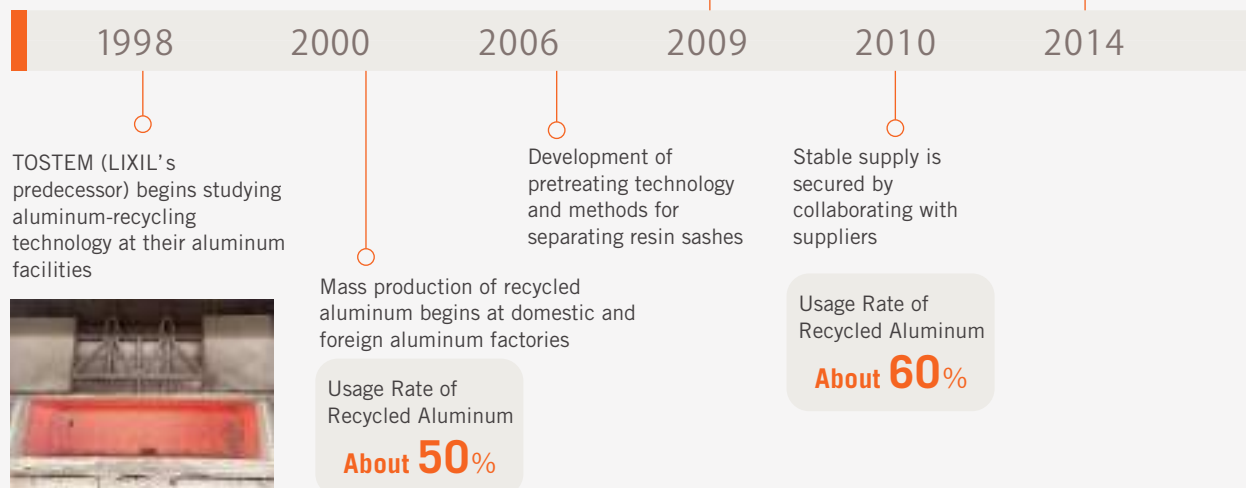
Changes in LIXIL's usage rate of recycled aluminum in its products

* Average of aluminum factories (includes foreign locations)
* 6063 alloy

2009-2012

Researched sorting technology for removing foreign matter from used aluminum window frames in collaboration with Waseda University and others as one of the projects subsidized by NEDO (New Energy and Industrial Technology Development Organization)

Development of briquette melting furnaces improves yield usage rate of recycled aluminum; begin to capture all internal scrap



Creating new environmental value through the “spirit of wasting nothing”

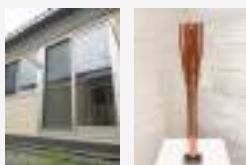
Naoki Ikegami, Director of LIXIL's Housing Technology Materials Division

The engineers at TOSTEM, which was LIXIL's predecessor, worked hard for over 25 years under the “spirit of wasting nothing.” Now, the idea of environmental value has finally been recognized and is attracting attention. Achieving decarbonization within our society will require the advancement of aluminum recycling, which has tremendous potential for reducing CO₂ emissions. If it's true that focusing on what's in front of us

could help us overcome our current environmental challenges, then we want to tackle the issues with a long-term perspective rather than making decisions based solely on what is financially attractive over the short term.

We believe that this is the mission of LIXIL, for which aluminum is the chief commodity. Leveraging our technological prowess and expertise developed over more than a quarter of a century, we will continue to face the challenges of aluminum recycling from all angles and become a company that can lead the industry forward.

Aluminum waste from the temporary housing constructed after the Tōhoku earthquake was used to create the torch for the 2020 Olympic and Paralympic relay



Expansion of PremiAL R100, which is guaranteed to contain 100% recycled aluminum and is certified by the third party SuMPO EPD (formerly EcoLeaf)



Usage rate of recycled aluminum in 2023

About 78%

100% by 2030

2015

2019

2022

2023

2024

Technology for recycling aluminum is standardized at domestic and foreign aluminum factories

2022
Usage Rate of
Recycled Aluminum

About 74%

PremiAL R70, which is guaranteed to contain 70% recycled aluminum, is certified by the third party SuMPO EPD (formerly EcoLeaf)



PremiAL R100 is awarded honorable mention at the 7th EcoPro Awards





About LIXIL

LIXIL makes pioneering water and housing products that solve everyday, real-life challenges to make better homes a reality for everyone, everywhere. Through the world-leading technology and innovation built into our many product brands including INAX, GROHE, American Standard, and TOSTEM, which are rooted in the traditions of manufacturing, we contribute to helping people live better lives. With approximately 53,000 employees in more than 150 countries worldwide, LIXIL supports the lives of over one billion people every day by providing products that are designed from the consumer perspective.