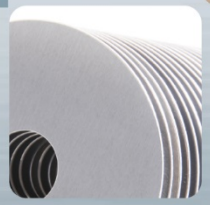
Aluminium VISION 2050








Summary

September, 2020

JAPAN ALUMINIUM ASSOCIATION

Key Points of VISION 2050

Recycling rate of aluminium wrought products in 2050

50 %

The current recycling rate is around 10%.
New recycling innovations are being in progress.

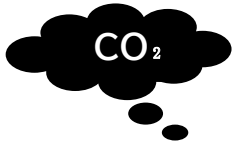
Recycling rate of aluminium products overall in 2050

75 %

The recycling rate of cast products is 100% even currently.
In aluminium products overall, aim for 75% by 2050.

CO_2 emissions reduction rate by 2050

-78 %



Saving energy in manufacturing and a recycling rate of 50% will perform 78% reduction of CO_2.
(Incorporates improved CO_2 intensity for primary aluminium)

Innovations to realize potential functions of aluminium

Aluminium can be reborn.
Aluminium is in reality strong.
Aluminium conducts heat without loss.
Aluminium works well with other materials.

Estimate of demand for aluminium in Japan in 2050

6.02 million tons

Greater growth in aluminium centered on automobiles, construction, beverages
(Reference) Demand in 2019 was 4.22 million tons

Industrial strategy for aluminium to 2050

Aim at zero accidents in industrial safety
Compliance, work style reforms, BCP
Strengthen domestic manufacturing basement, and secure international competitiveness

Contents

1. Basic approach toward 2050

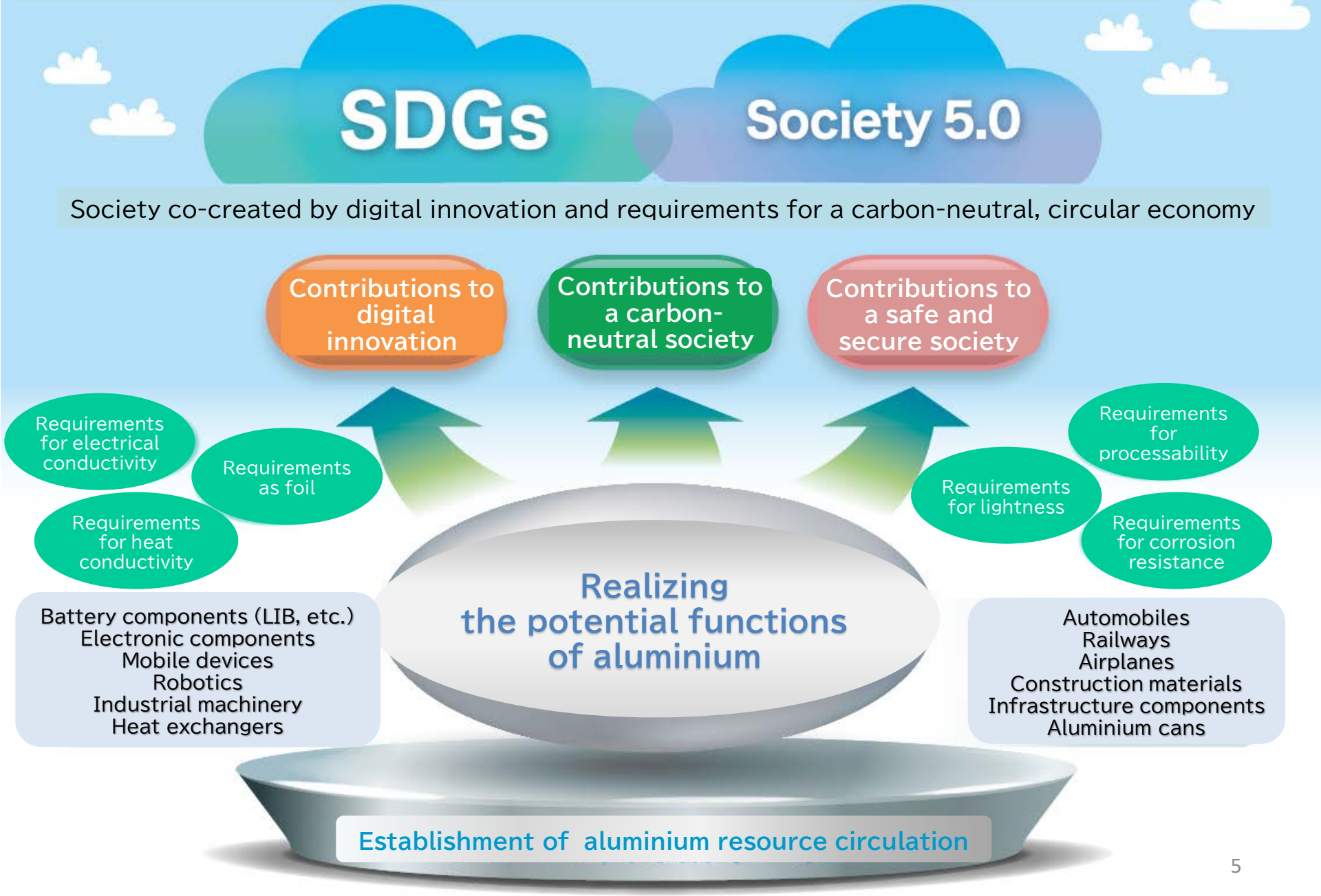
- What aluminium is aiming at

- 2050 will bring the realization of a society, advocated as the SDGs by the UN, and depicted as Society 5.0 by Japan's Science and Technology Basic Plan. In other words, it will be a "Society co-created by digital innovation and the requirements for a carbon-neutral, circular economy."
- Aluminium has not only advantages as a material in terms of lightness, corrosion resistance, processability, and conductivity, it also has excellent circulation properties. It is exactly the metal that the age needs.
- We see it as our mission to lead an aluminium industry that will form a part of the year of 2050, to provide the society with aluminium in specific forms that make use of these advantages and properties.
- The key words toward 2050 are:

"Aluminium can be reborn." And:

"Recycled again and again, aluminium always remains aluminium."

The Society in 2050 aluminium is aiming at



- Aluminium will support achieving the SDGs

- We think aluminium is a leading solution as a material for the sustainable society advocated as SDGs, because of its unique properties such as lightness, high specific strength, and corrosion resistance.
- Reducing CO_2 impacts in transportation (e.g. automobiles, rail, airplanes) will of course depend on technological innovation for transportation vehicles themselves, but use of aluminium to reduce weight can also make a significant contribution.
- We estimate, for example, maximizing use of aluminium in automobiles can reduce their weight by approx. 70 kilograms, improving fuel consumption by 0.75 km/L, and reducing total CO_2 emissions for the lifetime of an automobile by 6%.
- In addition, aluminium is very recyclable. Recycled aluminium has 1/30th the CO_2 impact compared to primary aluminium. By maximizing aluminium's recyclability, we can contribute even more to the SDGs.
- Innovation in materials design technology (e.g. structural control) may make it possible to use aluminium for new applications, contributing to better energy efficiency and longer equipment life.

Examples of aluminium wrought products used in Japanese-made automobiles

Toyota Prius

Nissan GT-R

Honda Legend

Toyota Lexus LS

Mazda Roadster

Subaru Levorg

Aluminium rolling stock for Tokyo Metro

- All 2,716 of Tokyo Metro's rolling stock are made from aluminium. (As of the end of March 2020)
- Aluminium can reduce the weight of rolling stock, contributing to less energy used to travel, and unified types of aluminium alloy can improve recyclability when scrapped.

(Photo description)
- Latest train used on the Hibiya Line (13000 series)
- Began use in 2017
- Maximum design speed: 110km/h
- Uses a double-skin design to maintain strength while lightening it. Manufactured in aluminium using advanced extrusion technology.

2. Initiatives for resource circulation

- A high level of resource circulation of aluminium is already happening in Japan.
- Out of the production output of aluminium in Japan in 2019 (3,448K tons), the refined aluminium used was 52% (1,807K tons), meaning 48% was recycled aluminium.
- Aluminium products are divided into wrought and cast; virtually 100% of cast products are made from recycled aluminium. However, use of recycled aluminium for wrought products is around 10%. Expanding use of recycled aluminium for wrought products is a facing issue.
- Problems in use of recycled aluminium for wrought products are the unavoidable mixing of different types of aluminium alloys in the scrap collection stage (there are many types of aluminium alloys), and the degradation of purity due to the mixing of different metals.
- Up to now, it was impossible to use recycled aluminium with degraded purity in wrought products, but recent innovative technologies are beginning to make it possible. Conditional on the use of these innovative technologies, we will work to reform the aluminium circulation system, including constructing horizontal circulation systems for each product.

Examples of horizontal circulation
(shinkansen train to shinkansen train)

- All the shinkansen (Japan's high-speed railways) rolling stock are made from aluminium.
- The luggage racks and other internal parts at new type trains (N700S) that began service in July 2020 are made from recycled aluminium from old shinkansen trains that finished just under 20 years of service.
- Up to 2022 they will be used for 40 trains (640 cars).
- Normally, waste aluminium from shinkansen trains was sold as scrap (to be recycled as cast products after sale), but this was the world's first case in high-speed railways of achieving horizontal circulation, from shinkansen train to shinkansen train, and from wrought products to wrought products.

N700S

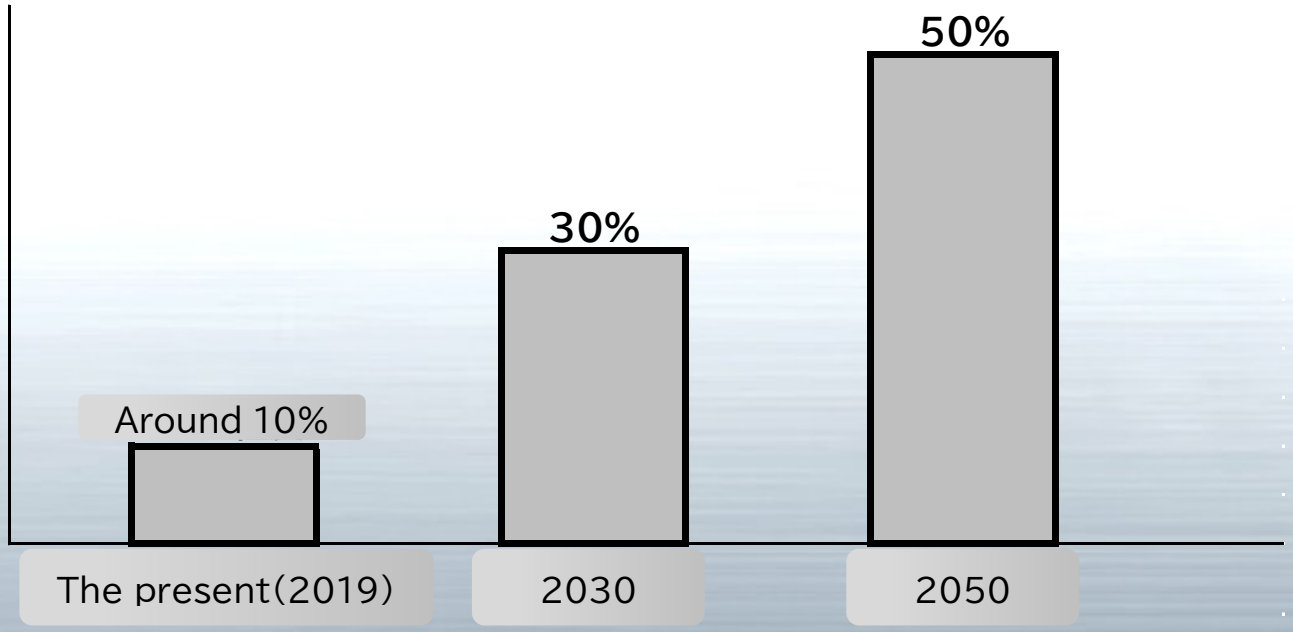
Cabin

Luggage racks

Setting targets for complete aluminium resource circulation

- The ideal situation is complete resource circulation of aluminium.
- The following percentages of recycled aluminium as material for wrought products (circulation rates) are set as intermediate targets toward complete resource circulation of aluminium.

Targets for circulation rate in wrought products



Challenges to achieve the targets for circulation rate in wrought products

・The circulation system for aluminium must be improved to attain the targets. There are five challenges to achieve this:

(1) Technological innovation in scrap processing technology

- Establish new systematized techniques to enable use of recycled aluminium in wrought products. (advanced R&D project underway)

(2) Construction of horizontal circulation systems for each demand sector

(Example: Shinkansen train to Shinkansen train)

- Create standards based on guidelines between involved parties, set opportunities to reconcile opinions for cooperation
- Examine methods to identify materials at disassembly, develop easy-disassembly designs and technologies

(3) Appeal of the recyclability to society

- Actively use environmental labeling in order to appeal of the recyclability of aluminium and to let consumers consider

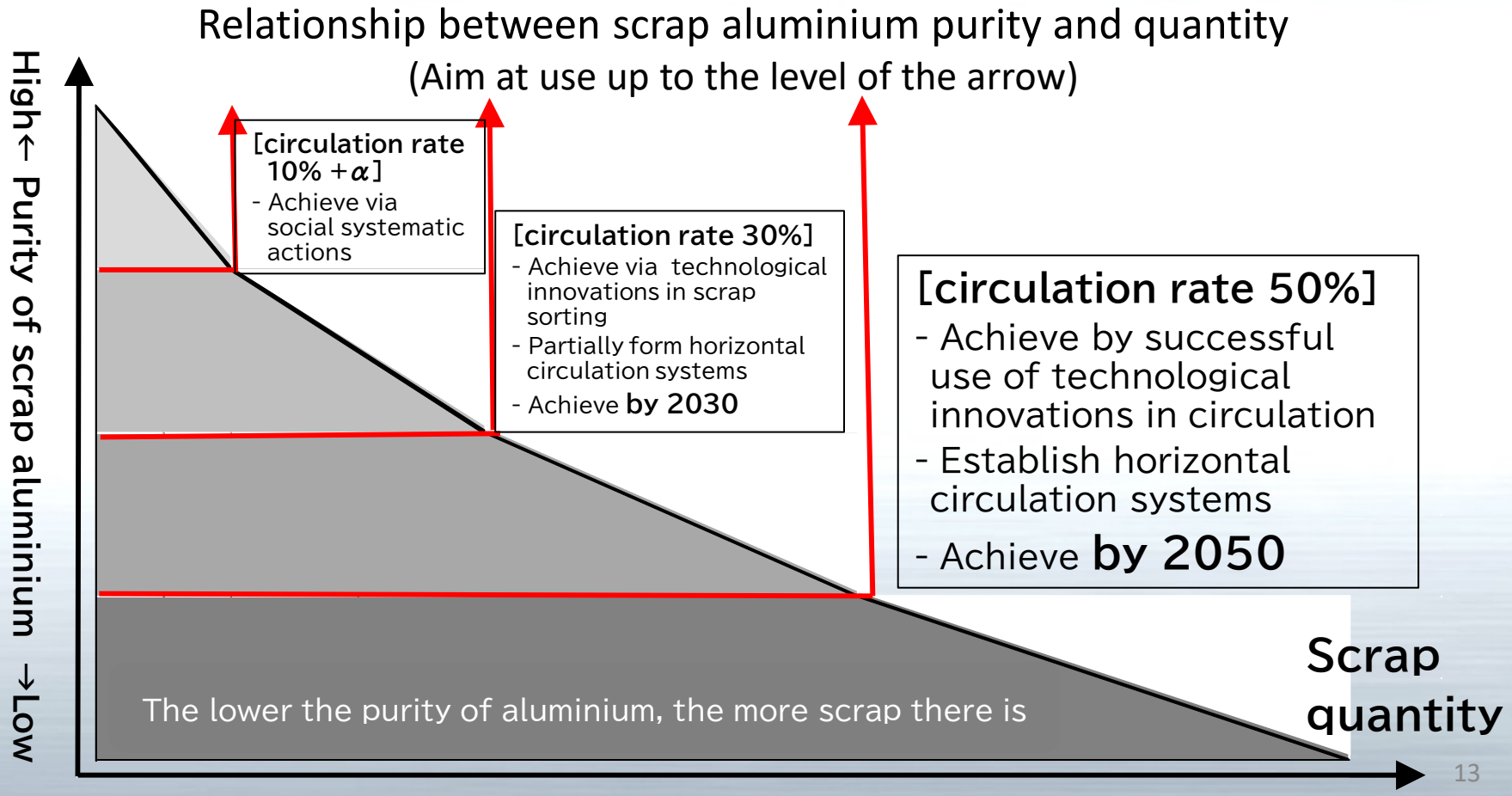
(4) Improvement of predictability of quantity and quality of scrap

- Formulate highly accurate and reliable scrap estimates, in order to improve predictability of aluminium circulation business.

(5) Improvement of standards and practices for more efficient aluminium circulation

The roadmap to raise the circulation rate of aluminium wrought products

Action 1 : Gradually achieve circulation rates over 10% via social systematic actions.
Action 2 : Aim at circulation rates of 30% by 2030 via technological innovations in scrap sorting.
Action 3 : Aim at circulation rates of 50% by 2050 via successful use of technological innovations in aluminium circulation.



3. Initiatives for global warming countermeasures

[Achievements so far and initiatives to 2030]

- We are working on Voluntary Action Plans to reduce CO_2 in the aluminium rolling process. The energy consumption rate per rolling is employed as the target metric. Targets so far are as follows.

  1997 plan: Improve by 11% or better vs 1995 for the 2008-2012 average.

  2013 plan: Reduce 0.8 GJ/t vs 2005 in 2020. Reduce 1.0 GJ/t vs 2005 in 2030.

  2018 plan: Reduce 1.0 GJ/t vs 2005 in 2020. Reduce 1.2 GJ/t vs 2005 in 2030.

- Calculating reductions of CO_2 emissions (electricity is not included), we achieved a 30% reduction over these 20 years in annual CO_2 emissions in the aluminium rolling process.

[Direction to 2050]

- The government has also set long-term goals to reduce greenhouse gas emissions by 80% in compliance with the Paris Agreement. Taking this into account, we have set the direction it must take to 2050 as follows.

  Direction to reduce CO_2 emissions in aluminium wrought product manufacturing including the base metal manufacturing stage

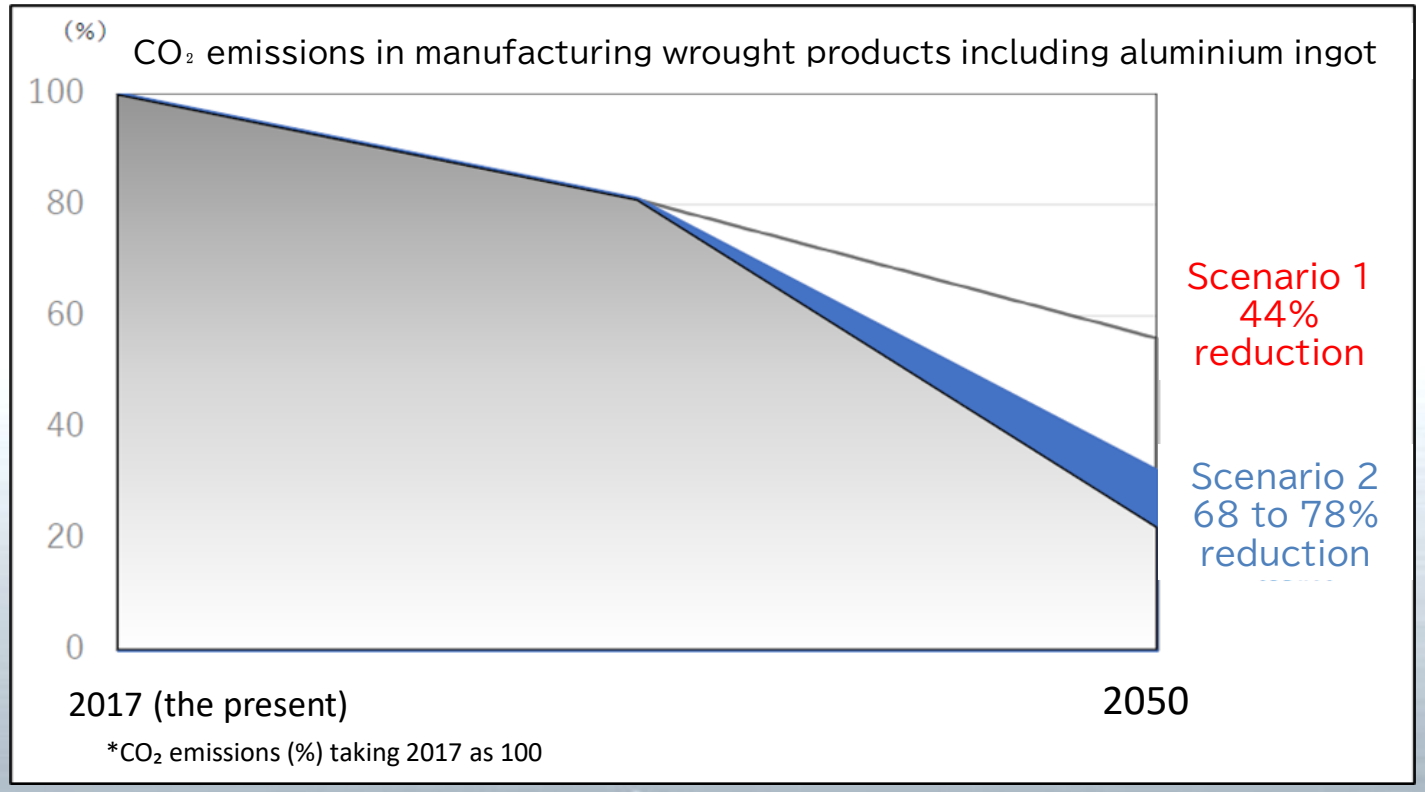
  Reduce 68-78% vs 2017 by 2050

Long-term direction of CO_2 emissions reduction in aluminium wrought products

CO_2 emissions in manufacturing wrought products including aluminium ingot in 2050 will be reduced as follows in comparison to 2017.

Scenario 1 (reduction efforts during manufacturing of aluminium wrought products)
: 44% reduction
Scenario 2 (expecting innovations in primary aluminium smelting in addition to the above)
: 68 to 78% reduction

Note: This is formulated with awareness of the government's long-term target of an 80% reduction by 2050.



Initiatives to achieve expected reductions by 2050

1) Scenario 1: Reduction efforts during manufacturing of wrought products

1. Efforts in aluminium wrought product manufacturing processes
   - Fuel: 100% introduction of waste heat recovery (regenerative burner) (currently 60%)
     100% fuel conversion (fuel oil to LNG) (currently 95%)
     Also shifting 50% of LNG to non-fossil fuels (hydrogen, bio, electricity)
   - Electricity: Use 50% renewable energy
2. Realizing a high level of aluminium circulation
   - The proportion of recycled ingot used as raw material for aluminium wrought products is set at 50%

2) Scenario 2: Expecting innovations for global warming countermeasures in primary aluminium smelting worldwide

- The International Aluminium Institute's estimates indicate the need to reduce CO_2 emissions in global aluminium smelting by 80 to 90% by 2050, in order to achieve the Paris Agreement. The current initiatives assume a 50 to 70% reduction by 2050 in CO_2 emission intensity of primary aluminium imported from abroad.

3) Contributions in products

- Contribute to CO_2 reduction in cars and a wide range of industrial sectors in stages where aluminium is used by leveraging its qualities like lightness and high conductivity (heat and electricity).

Note: Calculations for long-term direction of CO_2 reduction does not include contributions in products.

4. Initiatives for technological innovation - Three main lines of action

1. Technological innovation in aluminium resource circulation

-"Aluminium is able to be reborn."

To enable use of recycled aluminium in wrought products, with technological innovation we will establish new systematized techniques for aluminium resource circulation: (1) solid-state sorting, (2) removal of impurities in a molten state, (3) impurity-tolerant continuous cast and rolling process, and (4) fine dispersion of intermetallic compounds due to impurities.

2. Technological innovation in design of aluminium metallographic structure

-"Aluminium is in reality strong", "Aluminium conducts heat without loss"

Technology to design the optimum metallographic structure for each use in advance and manufacture will be established. Predict the metallographic structure (e.g. grain size), mechanical properties and time dependence performance (e.g. fatigue characteristics, corrosion rate), enable new application in automobiles, robotics, constructions, heat exchangers, heat radiating components, and electronic equipment. Technology to evaluate material characteristics and processing characteristics will be established by use of new equipment as wide field observation, 3D non-destructive observation and in-situ observation, via Spring-8, synchrotron radiation or positrons, and by use of materials informatics via IoT, big data, and AI.

3. Technological innovation in joining of aluminium

-"Aluminium works well with other materials"

In order to utilize the multi-materials the joining is essential. Technological issues: (1) Technology to predict characteristics of bonded joints (materials informatics and materials integration) (2) Improvement of material control technology (3) development of Joining technology databases, and establishment of standards for quality control and quality assurance. Those technological innovation in aluminium joining make possible to promote the multi-materials for automobiles, robotics, and constructions.

5. Estimates of demand in 2050

-Estimates for aluminum demand in Japan

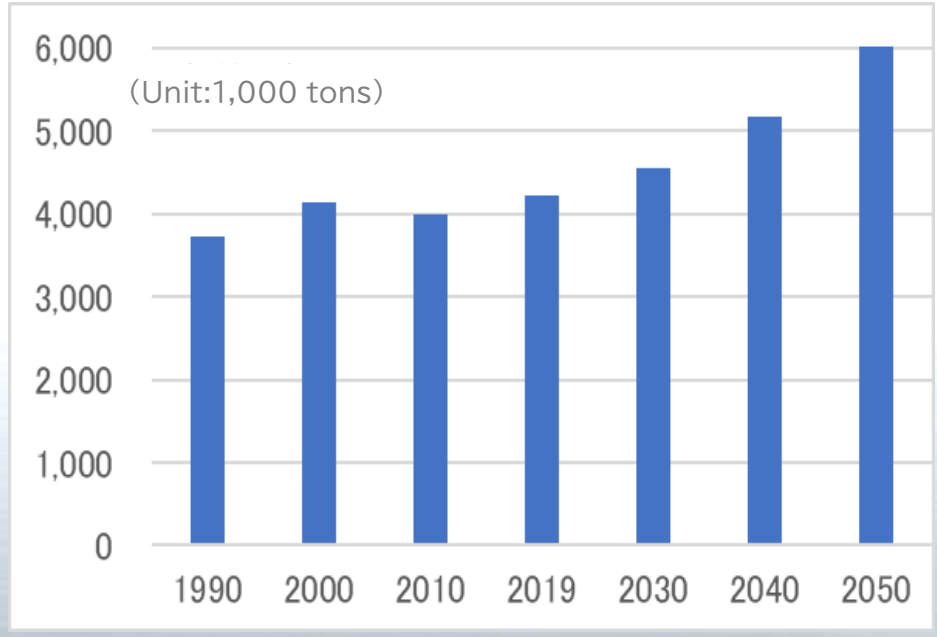
- Collect the impressions of industry and outside experts on expected future aluminium demand.
- Selectively survey automobiles, construction, and cans. Also focus on revealing demand for robotics, mobile communications, storage batteries, semiconductor manufacturing equipment, and heat exchangers.

Calculation results

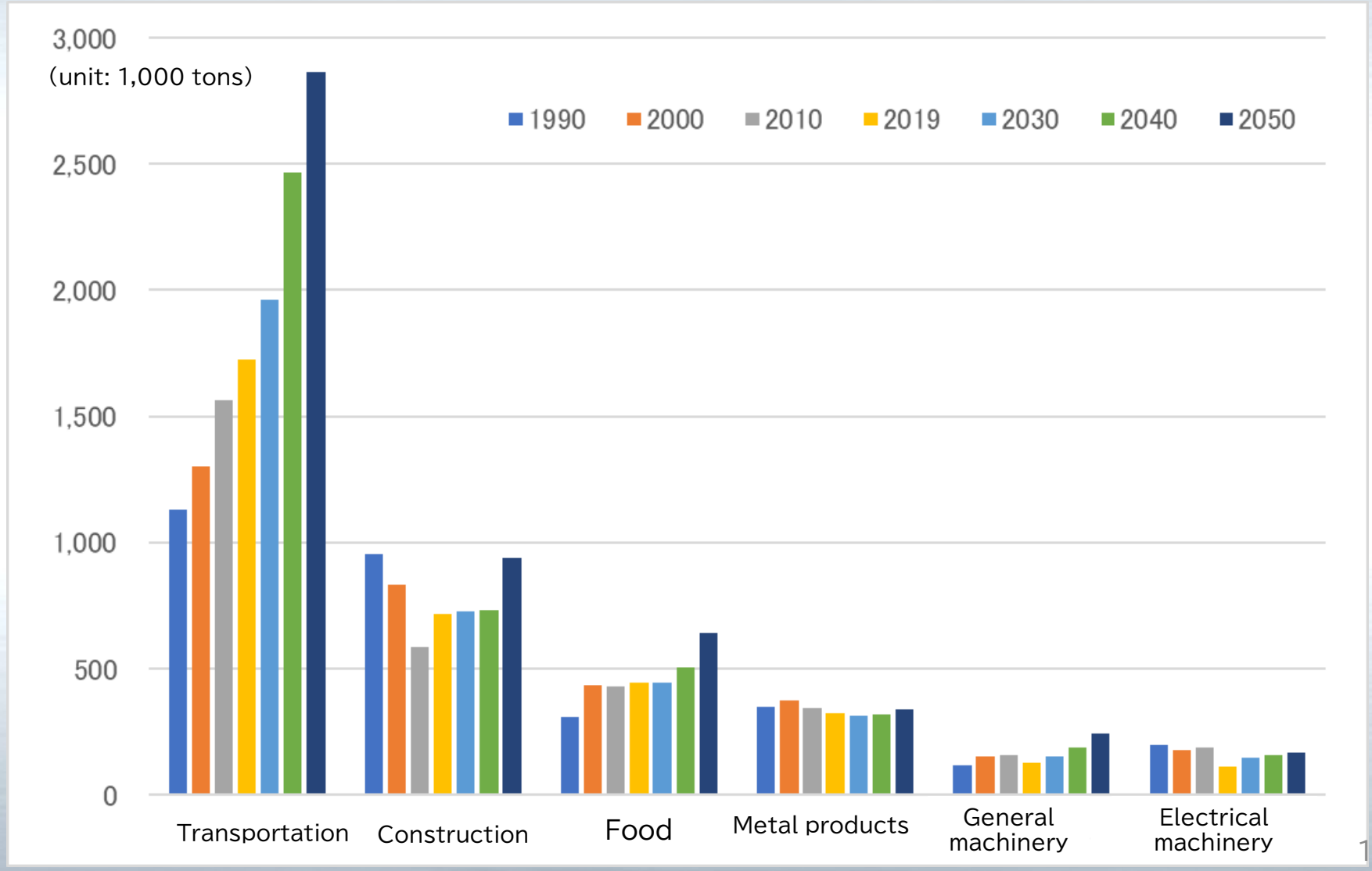
・Total demand for aluminum
  2019 : 4,218K tons (actual figure)
  2030 : 4,550K tons
  2040 : 5,180K tons
  2050 : 6,020K tons

・Average rate of increase (annual rate)
  2019 – 2030 : 0.7%
  2019 – 2050 : 1.2%

○ Total demand for aluminum figures and expectations



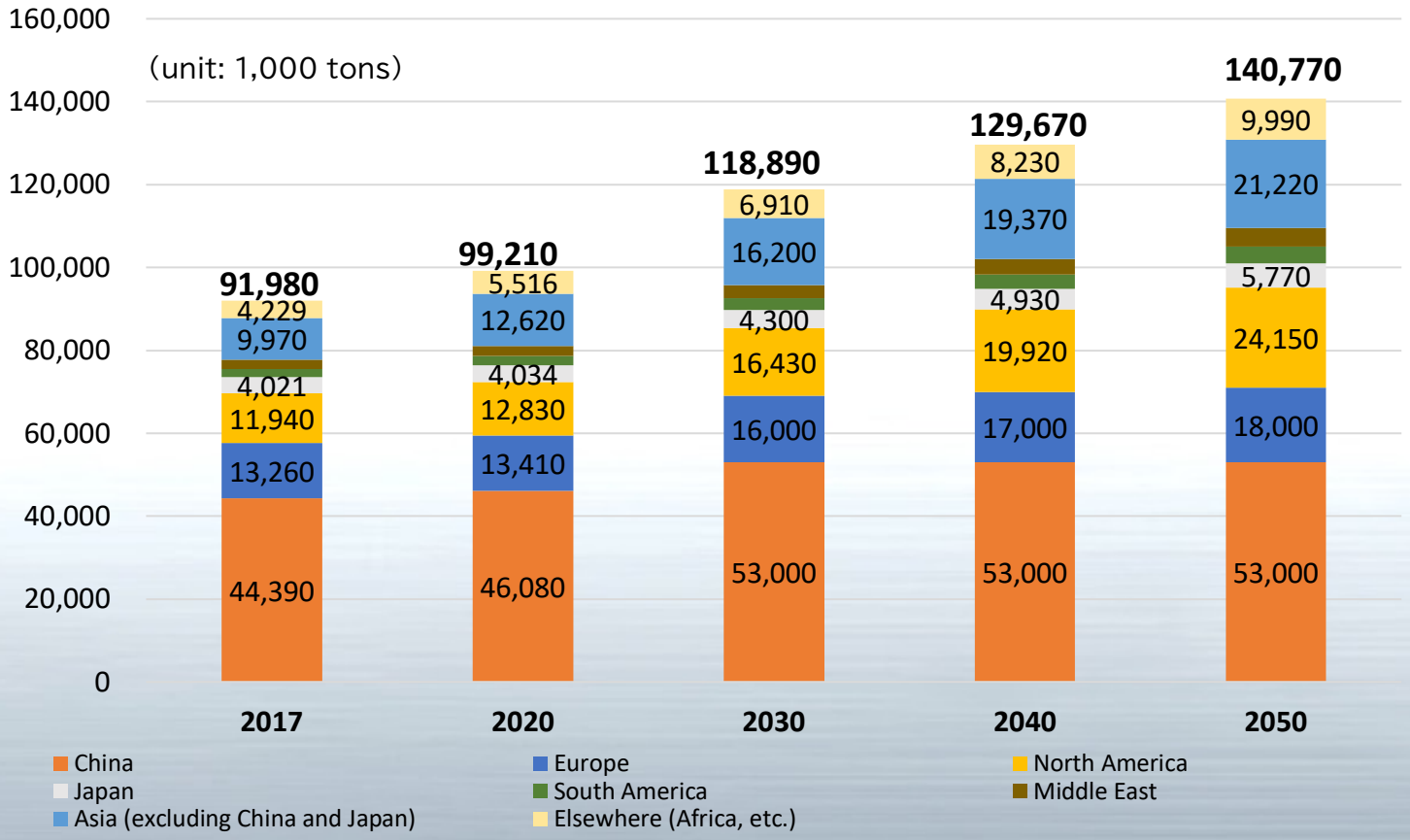
- Estimates by sectors for aluminium demand in Japan



- Estimates for global aluminium demand

- Global aluminium demand (primary and recycled) was approx. 92 million tons in 2017, and is estimated to increase over 50% to around 140 million tons by 2050.
- China's consumption will peak around 2030, further major growth in aluminium consumption from 2030 is expected in Southeast Asia, India, and Africa (the share of these regions will increase from 15% in 2017 to 22% in 2050).

Note: Exports are not included in demand by countries to prevent items being counted twice.
This is why the figure for Japan is different to the total demand.



6. Industrial management strategy for aluminium

We will engage in securing compliance, reforming work styles, fulfilling BCP, and the following issues, in order to be an industry playing its part in 2050.

1. Strengthen manufacturing basement in Japan
   1) Industrial safety: Continue to focus on constructing systems to achieve zero accidents, starting from zero fatal accidents
   2) Quality assurance: Continue to earnestly work on ensuring quality
   3) Make the supply chain more robust
   4) Toughen management of important technologies
   5) Deal with the changes brought by digitalization

2. Secure international competitiveness
   1) Selection and concentration, diversification, globalization, strategic partnerships, active interaction with users
   2) Technological innovation
   3) Human resources development

3. Promote international rollout
   - Actively promote international rollout in a form emphasizing interaction with users
   - Consider establishing statistics on overseas production to share a real feeling of global activities in the aluminium industry

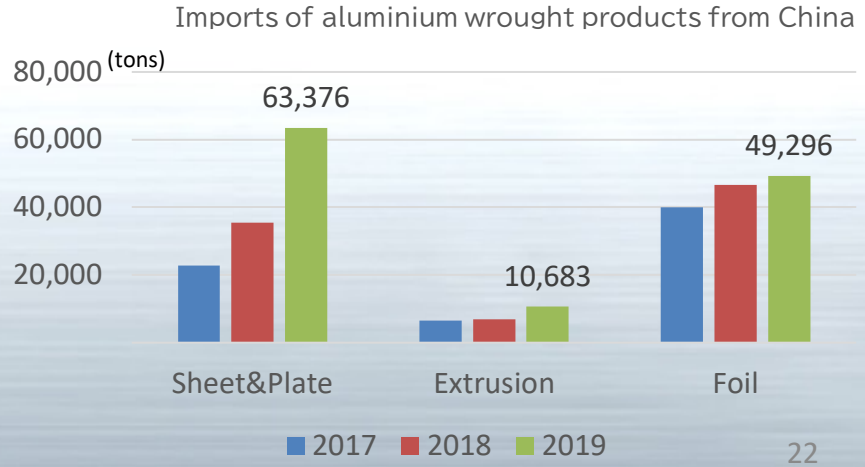
4. Steadily secure material resources
   - Securing resources for aluminium materials and resource circulation are like veins and arteries; use an integrated strategy
   - Continue to make efforts in the overseas aluminium smelting business

7. Coping with trade issues

- We believe that a free and fair trade environment encourages healthy competition, and realizes a suitable distribution of resources and industry. We are firmly opposed to unfair government subsidies and other market distorting behavior.
- Recently the world aluminium market has problems such as excess capacity and tariffs in certain countries, distorting the structure of trade.
- Our basic strategy on trade issues toward 2050 is to closely collaborate with government and play a suitable role in concert with other global aluminium associations, and to establish and use suitable international rules starting with the WTO to secure a level playing field in the aluminium market.

(Reference) Structural changes in aluminium trade at the present

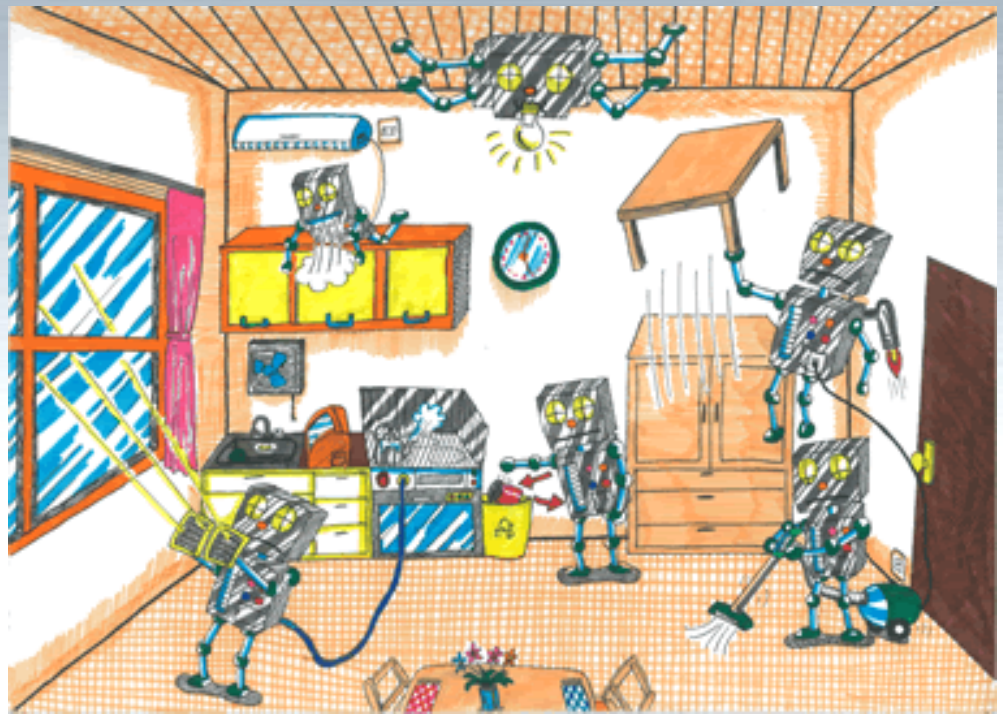
- Structural changes are occurring to aluminium trade due to excess capacity and tariffs.
- In Japan imports of aluminium wrought products from China have markedly increased. This applies to sheets in particular, tripling in the two years from 2017 to 2019.
- The US and certain other countries are taking protective measures (e.g. AD tariffs) against aluminium wrought products from China. Japan is now one of the few aluminium product-producing countries that have not taken protective measures.



(Source) Ministry of Finance trade statistics

Aluminium and the Future

6th: Aluminium Bridge Connecting the World



1st: Lightly recycled robot that conducts electricity and transmits heat

7th: Aluminium Balloon House of the Future

8th: Super Aluminium City

Aluminium and the Future
Picture contest
Works that won the
Chairman's Award
(Picked from the last nine awards)