

» Maintaining Stable Supplies and Recycling Materials and Products

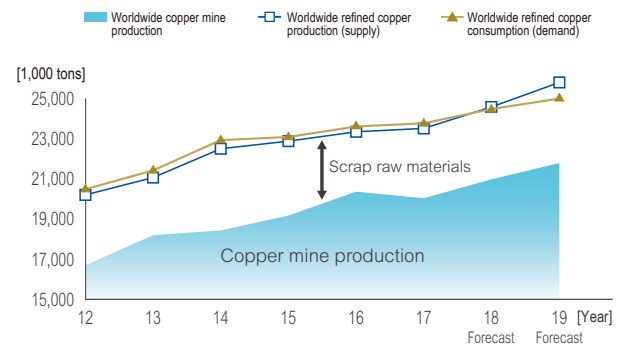
International Issues Surrounding Resources and Our Role

Worldwide Demand and Restrictions on Resources

Of all the base metals, copper in particular is used for a wide range of purposes. In spite of risks such as short-term metal prices and exchange rate fluctuations, demand is expected to continue growing over the long term, not least due to infrastructure development in emerging economies.

As the main mines are unevenly distributed between a handful of resource producing countries however, we are starting to see tighter restrictions surrounding resources. That includes certain countries adopting policies that limit market entry from foreign companies, or increasing taxes on the mining industry.

■ ICSG* worldwide copper demand forecast



* Actual figures for 2012-2017, forecasts for 2018-2019

Source: Figures adjusted by Mitsubishi Materials based on data published by ICSG in March 2016

* ICSG: International Copper Study Group

The Growing Importance of Developing “Urban Mines”

Mechanisms and technologies to enable us to efficiently recycle resources are becoming increasingly important, in terms of securing stable supplies of metal resources and enabling the sustainable development of society as a whole.

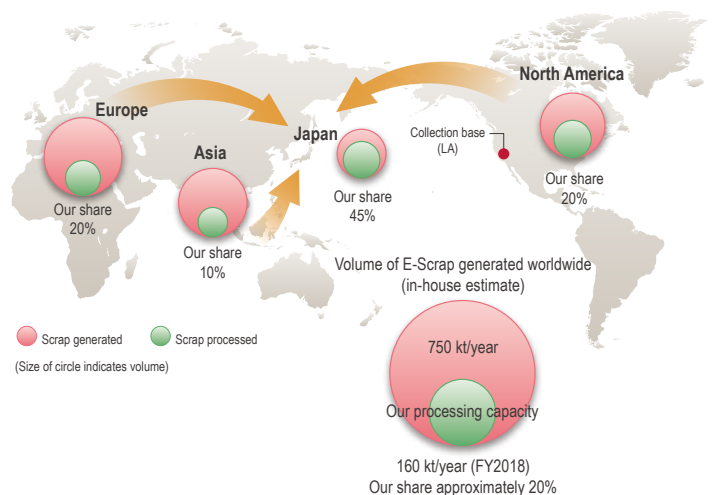
In particular, waste electrical and electronic equipment (WEEE), such as televisions and computers, cellular phones contain large quantities of valuable metals such as precious metals and rare metals. These “urban mines”* are being thrust into the spotlight because they enable efficient extraction (recycling) of resources with minimal impact on the environment and local communities compared to natural mines.

In addition to the smelting and refining technologies the our group has built up over more than a century, for copper and other nonferrous metals, we have a wealth of expertise in recycling, and continue to actively work on recycling of E-Scrap (recyclable materials picked out from dismantled and crushed WEEE, mainly printed circuit boards).

Alongside our high-level operational expertise and the “Mitsubishi Process,” a unique continuous copper smelting and converting process developed exclusively by Mitsubishi Materials, we have established a global collection network, and are constantly working to improve and reinforce processing capacity, as well as services such as our online booking system. Between the Naoshima Smelter & Refinery (Kagawa prefecture) and the Onahama Smelter & Refinery (Fukushima prefecture, Onahama Smelting & Refining Co. Ltd.), we are currently able to process E-Scrap on a world-leading scale of approximately 140,000 tons annually.

We are also scheduled to complete construction of a sampling plant in the Netherlands before the end of 2017, handling activities such as intake, inspection and sampling of E-Scrap. This will increase the group’s annual E-Scrap processing capacity to approximately 160,000 tons.

■ Rolling out E-Scrap recycling operations globally



* “Urban mines”: Electronics devices and other industrial products from which we can obtain valuable resources such as those extracted from natural mines.

Acting as a Responsible Partner in International Resources Recycling

In recent years, we have been disposing of large quantities of electronic devices that have outlived their useful lifespan as WEEE. While these devices still have potential value as urban mines, there are concerns that they could also cause environmental contamination from lead, mercury or other harmful substances if they are processed inappropriately. The European Union (EU) is taking these concerns very seriously, and in 2003 introduced a directive to limit volumes, and promote the reuse and recycling of WEEE.

Within the EU, a certification scheme is being put in place for companies throughout the recycling chain, to encourage them to handle WEEE in an appropriate manner. In fall 2016, we became the first company in Japan to obtain certification under the Standard on End-Processing of WEEE Fractions (E-Scrap) at the Naoshima Smelter & Refinery and Onahama Smelter & Refinery (Onahama Smelting & Refining Co. Ltd.).

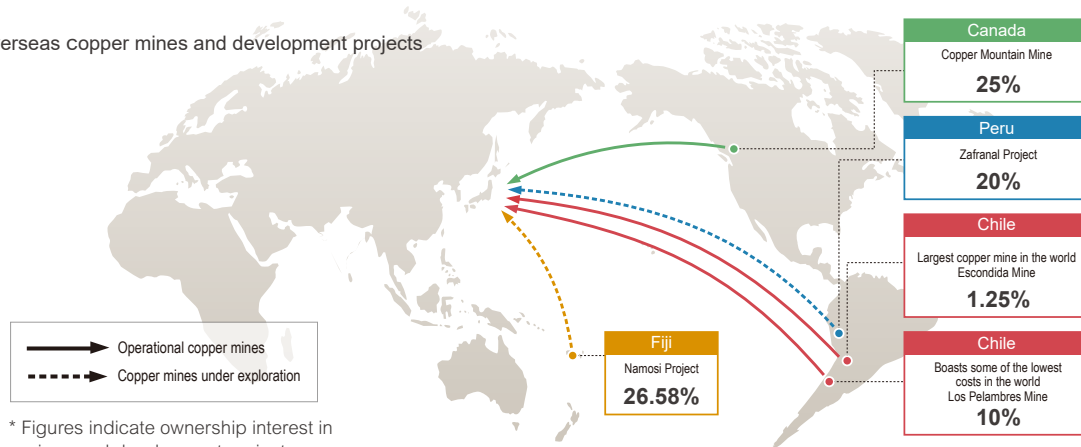
We will continue to build on the technologies and expertise, so that we can contribute to the sustainable development of society as a whole through international resource recycling, as a leading partner in responsible E-Scrap recycling.

Securing Stable Products Supplies: Copper Products

Since the closure of our Akenobe Mine in 1987, we have been reliant on imports from overseas mines for copper concentrate*, the main raw material used in our products. To ensure stable procurement, we have therefore continued to invest in overseas mines. Depending on our level of investment, we also assign personnel to mines in other countries, and provide support to ensure that mines are developed sustainably in the best interests of the environment and the local community.

* Copper concentrate: Once "ore" has been extracted from a mine and dressed, the grade of copper is then improved to produce "concentrate." Materials imported domestically are known as "copper concentrate."

Overseas copper mines and development projects



For a Stable Supply of Cement

To achieve a stable supply of cement, the stable operation of cement production equipment is crucial. In particular, it is important to ensure the long-term stable operation of the cement kiln (90 m length, 5 m diameter, lined with fire brick), which fires cement raw materials at 1450°C to produce the intermediate product clinker. The cement industry has previously sought to expand the processing of a range of industrial waste, and in recent years, the use of waste plastic, which can replace thermal heat in the cement kilns, has increased. In connection with this, the lifespan of the fire brick inside the kilns has become shorter, making repairs necessary twice annually.

In an effort to prolong the refractory brick's lifespan, we are continuously working on the development of techniques to analyze mechanical stress which causes damage to refractory bricks, the measures against faults that reduce the fluctuations in thermal load accompanied by faults, and the selection of suitable refractories. In fiscal 2018, one of the five cement kilns at the Kyushu Plant (Kanda District) achieved one year operation without requiring any repairs to the refractory bricks. We plan to expand this practice to the other cement kilns in fiscal 2019.

Securing Stable Products Supplies: Cemented Carbide Products

Over 80% of worldwide demand for tungsten, the main raw material used in our cemented carbide products, is supplied by China. Although the balance of supply and demand has eased somewhat for the time being, due in part of changes in the external environment with regard to resource policy, the scarcity of tungsten as a rare metal remains largely unchanged. We remain committed to expanding recycling initiatives in the future too.

» In Pursuit of a Recycling-Oriented Business Model

| Purpose of activities | Activities during fiscal 2018 | Self-assessment | Targets/plans for activities from fiscal 2019 onwards |
|--|--|-----------------|---|
| <ul style="list-style-type: none"> Steadily processing industrial waste as raw materials (Cement Business) | <ul style="list-style-type: none"> The amount of waste plastic processed increased by 140% after reinforcing the equipment Biomass and inexpensive thermal energy increased by 158% from the previous year | A | <ul style="list-style-type: none"> Increase waste utilization through fully automated analytical equipment at the Kyushu Plant, completed in 2018 Develop and expand acceptance of new alternatives to biomass and cheap thermal energy Expand acceptance of municipal waste incineration fly ash with the operation of KitaKyushu Ash Recycle Systems Co., Ltd. |
| <ul style="list-style-type: none"> Expanding recycling operations (Metals Business) | <ul style="list-style-type: none"> Operate sampling facilities in the Netherlands (MMMR) with an eye to expanding E-Scrap processing | B | <ul style="list-style-type: none"> Expand high-grade E-Scrap collection and processing |
| <ul style="list-style-type: none"> Promoting recycling of tungsten (Advanced Materials & Tools Business) | <ul style="list-style-type: none"> Since November 2017, new facilities have been completed and we are identifying issues and measures to ensure stable operations (Japan New Metals Co., Ltd.) | A | <ul style="list-style-type: none"> Stabilize the scrap-processing capacity of Japan New Metals Strengthen relationships with re-refiners |
| <ul style="list-style-type: none"> Promoting recycling of fluorine resources (Electronic Materials & Components Business) | <ul style="list-style-type: none"> Used 2,463 tons/year, compared to the projected 2,115 tons Used 18%, compared to projected 15% | A | <ul style="list-style-type: none"> Work to steadily recycle the full volume as client operating rates are high and the volumes brought in are expected to exceed projected volumes |
| <ul style="list-style-type: none"> Facilitating the 3Rs as part of aluminum can operations (Aluminum Business) (3Rs = Reduce, Reuse, Recycle) | <ul style="list-style-type: none"> Continued to provide internal support for Universal Can Corporation in line with the Japan Aluminum Can Recycling Association's third voluntary action plan to promote the 3Rs via aluminum beverage cans | A | <ul style="list-style-type: none"> Provide lateral support to further improve the aluminum-can recovery rate of Universal Can Corporation |
| <ul style="list-style-type: none"> Advancement of Home Appliances Recycling Aiming for No.1 handling company of E-Scrap in Japan (Environment & Energy Business) | <ul style="list-style-type: none"> Increased productivity by 50% by developing an air-conditioner indoor unit disassembly machine Demonstrated advanced recycling of collected items from home appliances recycling by utilizing automobile recycling facilities | A | <ul style="list-style-type: none"> Promotion of labor saving and efficient recycling by developing dismantling technologies Promotion of advanced recycling of items recovered at home appliance recycling plants Achieve greater synergy between home appliance and automobile recycling |

Self-assessment grades A: Target achieved B: Target mostly achieved C: Target not achieved

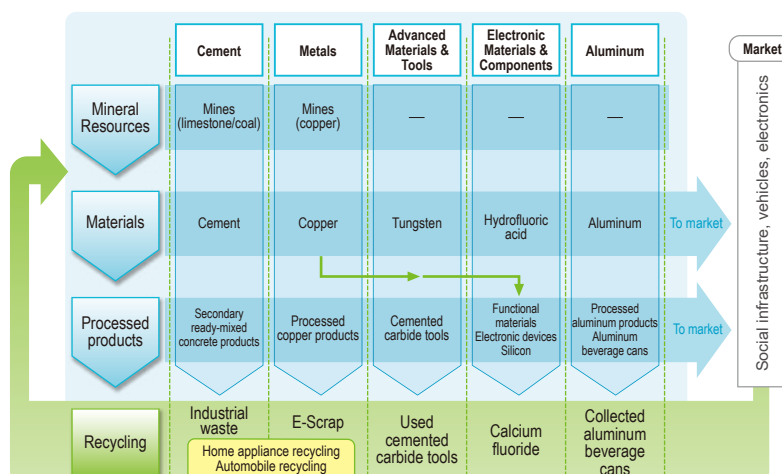
Recycling-Oriented Business Model

Overview of our Recycling-Oriented Business Model

The Mitsubishi Materials Group is a complex corporate entity encompassing a wide range of technologies and expertise, from resources upstream to materials midstream to processed products downstream. We have continued to make the most of those capabilities on a groupwide scale, in an effort to establish a recycling-oriented business model based on recovering resources from a wide range of waste products.

We strive to create cyclical value chains in each of our businesses, so that resources and materials are processed into products and then recycled back into materials. As well as enabling sustainable growth, this also helps to promote recycling-oriented social systems.

Recycling-oriented business model (by segment)



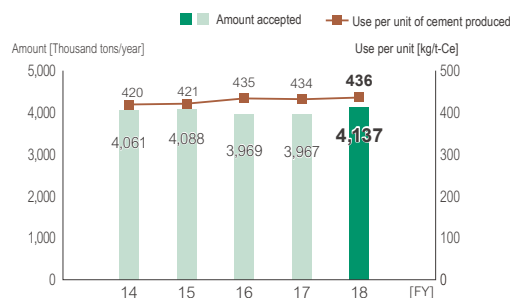
Recycling in Individual Businesses

Cement Recycling Industrial Waste and Byproducts

Using a burning process that reaches temperatures of 1,450°C, our cement plants detoxify and make effective use of industrial waste and other difficult-to-treat materials without generating any waste. As well as using substances such as construction sludge, coal ash, copper slag byproducts from copper smelters, and gypsum as raw materials, we also turn materials such as plastic, tires and wood back into cement, by using them as a source of thermal energy.

To deal with chlorine contained in waste products, which can affect plant operations and the quality of cement, we have installed and continue to upgrade high performance chlorine bypass facilities at each of our plants. To further promote the effective use of waste products meanwhile, we are committed to strengthening the capabilities of our waste processing facilities, through measures such as upgrading pre-treatment facilities for waste plastic and processing facilities for waste gypsum board.

Amount accepted and volume of per unit production of waste and byproducts

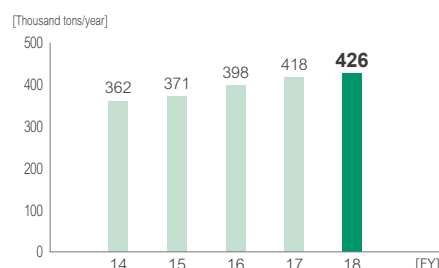


Metals Recycling Scrap

We use smelting technology for the purpose of recycling at our smelters and refineries. We take in a wide variety of scrap, including shredder dust and used batteries from sources such as used home appliances or scrap vehicles, and E-Scrap from sources such as used substrates and connectors. We then recycle scrap, by using it for raw materials or thermal energy, and recover valuable metals.

We also take in clinker dust, as a byproduct from our cement plants, and use components such as calcium as auxiliary raw materials for smelting. After use, clinker dust turns into copper slag, which is then recycled back into raw materials at our cement plants.

Volume of scrap processed



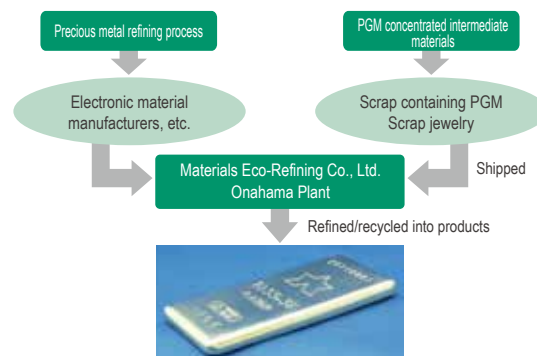
Metals Recycling Rare Metals

PGM* are rare metals that are found in copper concentrate. Group company Materials Eco-Refining Co., Ltd. refines PGM intermediate materials obtained from our Naoshima Smelter & Refinery, to create products such as metals and chemical compounds.

Platinum and palladium in particular are key materials in the automotive, electric and electronic sectors. With that in mind, we applied to register our brand with the London Platinum and Palladium Market (LPPM), as a means of offering market assurance, and successfully obtained certification in September 2012. We are determined to keep on improving the quality of our products, and make every effort to ensure stable supplies of rare metals.

* PGM: Platinum Group Metals

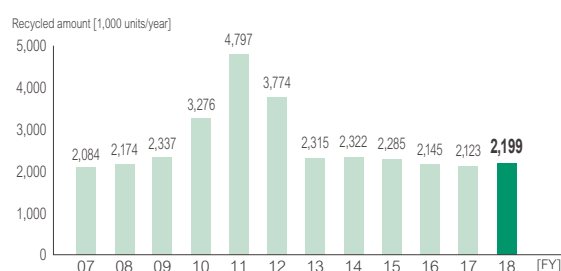
The rare metal recycling process



Environment & Energy Home Appliances Recycling

Home appliances are made by combinations of various materials such as glass, plastic and rubber as well as metals such as steel, aluminum, and copper. Home appliances are first of all disassembled manually, then crushed and sorted at our home appliances recycling plants. We have adopted several advanced sorting process for components and materials, and are always trying to create more value from recovered materials and to improve recycling efficiency. We recover copper and other precious metals from recovered copper-based materials and printed circuit boards in our copper smelting process. Thus, we maximize the effect of synergies within our group. In fiscal 2018, we recycled 2,199 thousand units of home appliances at six plants of our five affiliated companies. The recycling of this volume could reduce landfill disposal equivalent to approximately 100,000 tons.

Trend of recycled amount



Advanced Materials & Tools

Recycling Tungsten from Urban Mines

Waste containing rare metals is often found in the form of “urban mines,” which contain such a high percentage of rare metals that it is possible to extract them more efficiently than obtaining metals from natural resources. A prime example is tungsten, the main raw material used in cemented carbide products. Making the most of the Mitsubishi Materials Group’s comprehensive capabilities as a manufacturer, from raw materials through to finished products, we are currently focusing on recycling used cemented carbide products in an effort to secure stable supplies of raw materials.

Electronic Materials & Components

Recycling Fluorine Resources

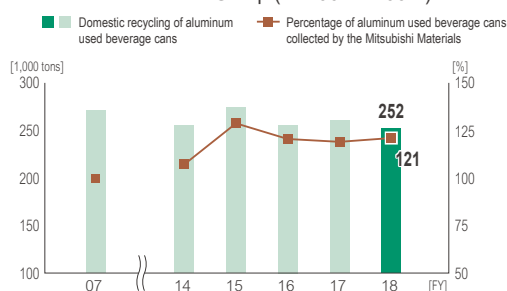
We manufacture a range of fluorine compounds at Group company Mitsubishi Materials Electronic Chemicals Co., Ltd., including materials for use in semiconductor manufacturing, and materials that function as flame retardants and antistatic agents, as well as hydrofluoric acid. We also recover calcium fluoride sludge produced by companies using fluorine compounds. We have been recycling sludge back into fluorine resources that can be used as alternative raw materials for fluorite ever since fiscal 2007, and are now able to substitute a high percentage of resources as part of our operations. We remain fully committed to recycling fluorine resources in the future, through continued technical innovation.

Aluminum Business

Recycling Aluminum Beverage Cans

We have been operating a total CAN TO CAN recycling system within the Mitsubishi Materials Group (Universal Can Corp. and Mitsubishi Aluminum Co., Ltd.), based on a cycle of can manufacturing, collecting, melting, casting and rolling, for over 40 years now. Our system is uniquely integrated within the group and enables us to process used beverage cans (UBC) on a leading scale domestically, thereby helping to conserve aluminum resources. We also do our bit to prevent global warming by manufacturing slabs of recycled aluminum from UBC. As this only requires about 3% as much energy as manufacturing aluminum from scratch, it enables us to substantially reduce energy consumption, and it also enables us to contribute to preventing global warming.

Domestic recycling of aluminum used beverage cans and the percentage of those cans collected by the Mitsubishi Materials Group (FY2007 = 100%)



» Smelting and Cement Recycling System

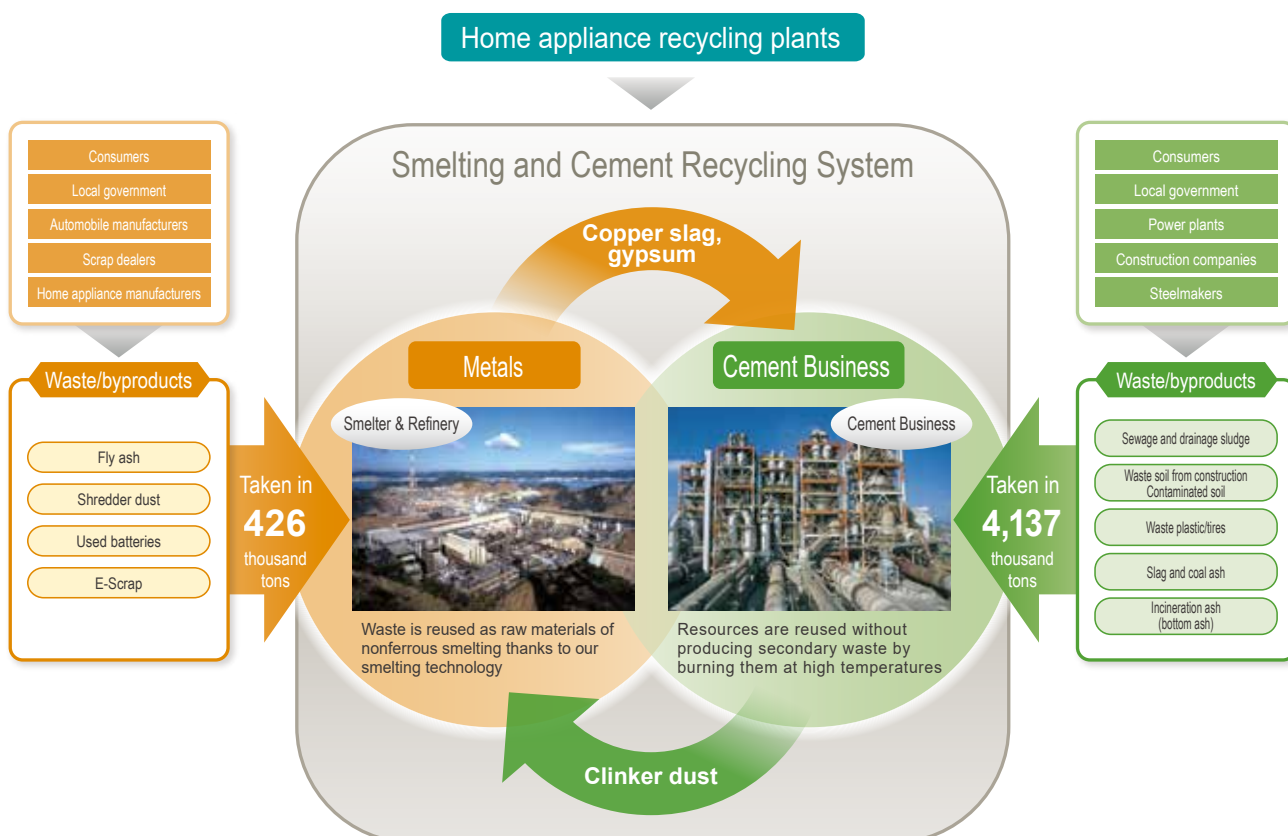
Recycling Resources with No Need for Landfill Sites

Operating our Smelting and Cement Recycling System

As a result of an increasing volume and variety of waste products, Japan is facing issues such as a growing percentage of difficult-to-treat materials, and pressure on landfill sites. Recovering and recycling waste without producing secondary waste has therefore become a top priority.

As one of very few companies in the world that has both nonferrous smelting and cement plants, we run a combined smelting and cement recycling system as part of our environmental recycling operations here at the Mitsubishi Materials Group, in an effort to help establish a recycling-oriented society. Our smelting plants use byproducts generated by our cement plants as raw materials, and vice versa, enabling us to recycle waste without any need for landfill sites. One of the byproducts we generate at our smelting plants is copper slag, which is increasingly being used as an aggregate for heavyweight and other concretes, as part of construction work to better prepare Japan for tsunamis and other natural disasters.

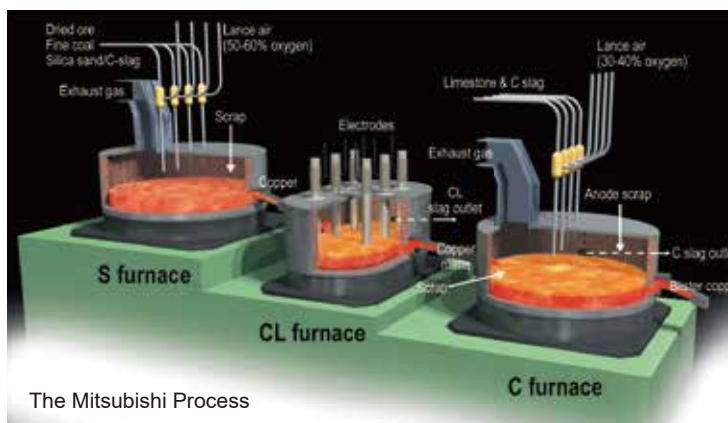
Making the most of this system, which enables us to process E-Scrap, used home appliances, scrap vehicles, batteries and various other types of waste, we have also started to recycle difficult-to-treat waste such as rubble from disaster areas and waste plasterboard. We use unique technologies at our cement plants in particular to recycle waste plasterboard into raw materials for cement, and are working to reinforce our processing capabilities even further.



Smelter & Refinery Recycling resources from urban mines

The Mitsubishi Process

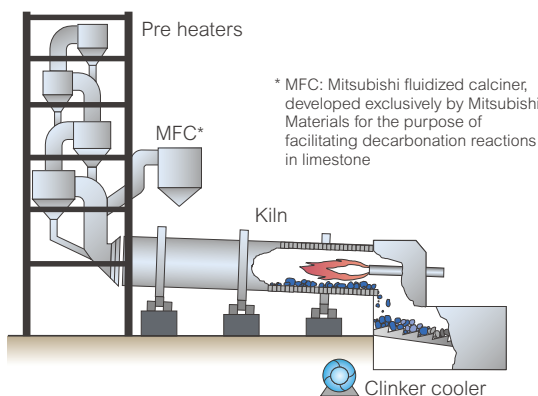
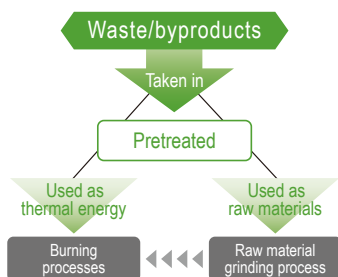
Our unique Mitsubishi Continuous Copper Smelting and Converting Process (Mitsubishi Process) is a highly efficient copper manufacturing process that has exceptionally low environmental impact. We put copper concentrate through a series of three connected furnaces connected by pipes to produce blister copper (98.5% purity). The required facilities are compact and also help to save energy and cut costs.



Cement plants Taking in, decontaminating and stabilizing Cement plants difficult-to-treat waste from other industries

High Temperature Burning Process

Raw materials (including wastes and byproducts) are prepared during the raw material grinding process and then sintered at high temperatures to produce a hydraulic mineral during the burning process. Once the raw mixture has reached the maximum temperature (1,450°C) and a series of chemical reactions are completed, it is quickly cooled into an intermediate product called clinker.



[Key features of waste treatment at our cement plants]

- Capacity to treat large volumes of waste
- Detoxification of waste products
- No secondary waste (extending life span of landfill sites)

Home appliance recycling plants Used home appliances are disassembled and almost all of the recovered items are supplied as materials.

Reduction in Environmental Impact due to Recycling Home Appliances (LCA analysis for FY2018)

If recycling home appliances, so that resources are recovered from used appliances and reused as new materials

| | Effect | Total |
|--|---|--------------|
| Compared to sending used appliances to landfill and manufacturing new materials from natural resources | Reduction in CO ₂ emissions | 117,000 tons |
| | Reduction in consumption of natural resources | 118,000 tons |
| | Reduction in energy consumption | 54,000 tons |
| | Reduction in waste sent to landfill | 101,000 tons |



Recycling process of refrigerators

The above table does not take into account the impact of recovering fluorocarbons*. Expressed in terms of CO₂ emissions, recovering approximately 470 tons of fluorocarbons would equate to a reduction of approximately 1,250,000 tons.

* Fluorocarbons refrigerants used in air conditionings, refrigerators and washing machines, and fluorocarbons insulation materials used in refrigerators