

# In Pursuit of a Recycling-Oriented Business Model

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Purpose of activities	Activities during fiscal 2021	Self-assessment	Targets/plans for activities from fiscal 2022 onwards
<ul style="list-style-type: none"> <li>Promoting the recycling of fluorine resources (Advanced Products (Electronic Materials &amp; Components))</li> </ul>	<ul style="list-style-type: none"> <li>The amount recycled was 1,850 tons/year, 18% below the plan</li> <li>Material recycling rate was 19%, 6% below the plan</li> </ul>	B	<ul style="list-style-type: none"> <li>Ensure the stable operation of recycling plants and achieve the plan of the amount recycled</li> </ul>
<ul style="list-style-type: none"> <li>Promoting the recycling of tungsten (Metalworking Solutions Business)</li> </ul>	<ul style="list-style-type: none"> <li>Recycling rate increased (by 135% from the fiscal 2018 level)</li> <li>Use more recycling manufacturers (than the current level ⇒ Add one manufacturer)</li> </ul>	A	<ul style="list-style-type: none"> <li>Recycling rate increased (by 97% from the fiscal 2018 level)</li> <li>Stabilize the amount of recycling</li> </ul>
<ul style="list-style-type: none"> <li>Expanding recycling operations (Metals Business)</li> </ul>	<ul style="list-style-type: none"> <li>Optimize the smelting business in response to the expansion of E-Scrap processing</li> </ul>	A	<ul style="list-style-type: none"> <li>Material flow optimization</li> </ul>
<ul style="list-style-type: none"> <li>Steadily processing industrial waste as raw materials (Cement Business)</li> </ul>	<ul style="list-style-type: none"> <li>Consumption of waste plastics increased by 14,189 tons from the previous year</li> <li>Biomass and low-cost alternative thermal energy resources increased by 2,239 tons from the previous year</li> </ul>	B	<ul style="list-style-type: none"> <li>Increase the usage of waste plastic by introducing high-efficiency kiln burners</li> <li>Look for new biomass and low-cost alternative thermal energy resources and expand acceptance of such energy</li> <li>Increase waste utilization through fully automated analytical equipment</li> </ul>
<ul style="list-style-type: none"> <li>Advancement of Home Appliances Recycling</li> <li>Aiming for No.1 handling company of E-Scrap in Japan (Environment &amp; Energy Business)</li> </ul>	<ul style="list-style-type: none"> <li>Technology development for automatic sorting robot</li> <li>Development of technologies for recovering cobalt and nickel from lithium ion batteries</li> <li>Demonstrated advanced recycling of collected items from home appliances recycling by utilizing automobile recycling facilities</li> </ul>	A	<ul style="list-style-type: none"> <li>Expand the home appliance recycling business, promote automation of home appliance recycling, and improve the added value of collected items</li> <li>Verification of technologies for recycling lithium ion batteries and solar panels</li> <li>Stable operation of the incineration fly ash recycling business and the business of producing biogas from food waste</li> </ul>
<ul style="list-style-type: none"> <li>Facilitating the 3Rs as part of aluminum can operations (Aluminum Business)</li> </ul>	<ul style="list-style-type: none"> <li>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</li> </ul>	A	<ul style="list-style-type: none"> <li>Provide lateral support to further improve the aluminum-can recovery rate of Universal Can Corporation</li> </ul>

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

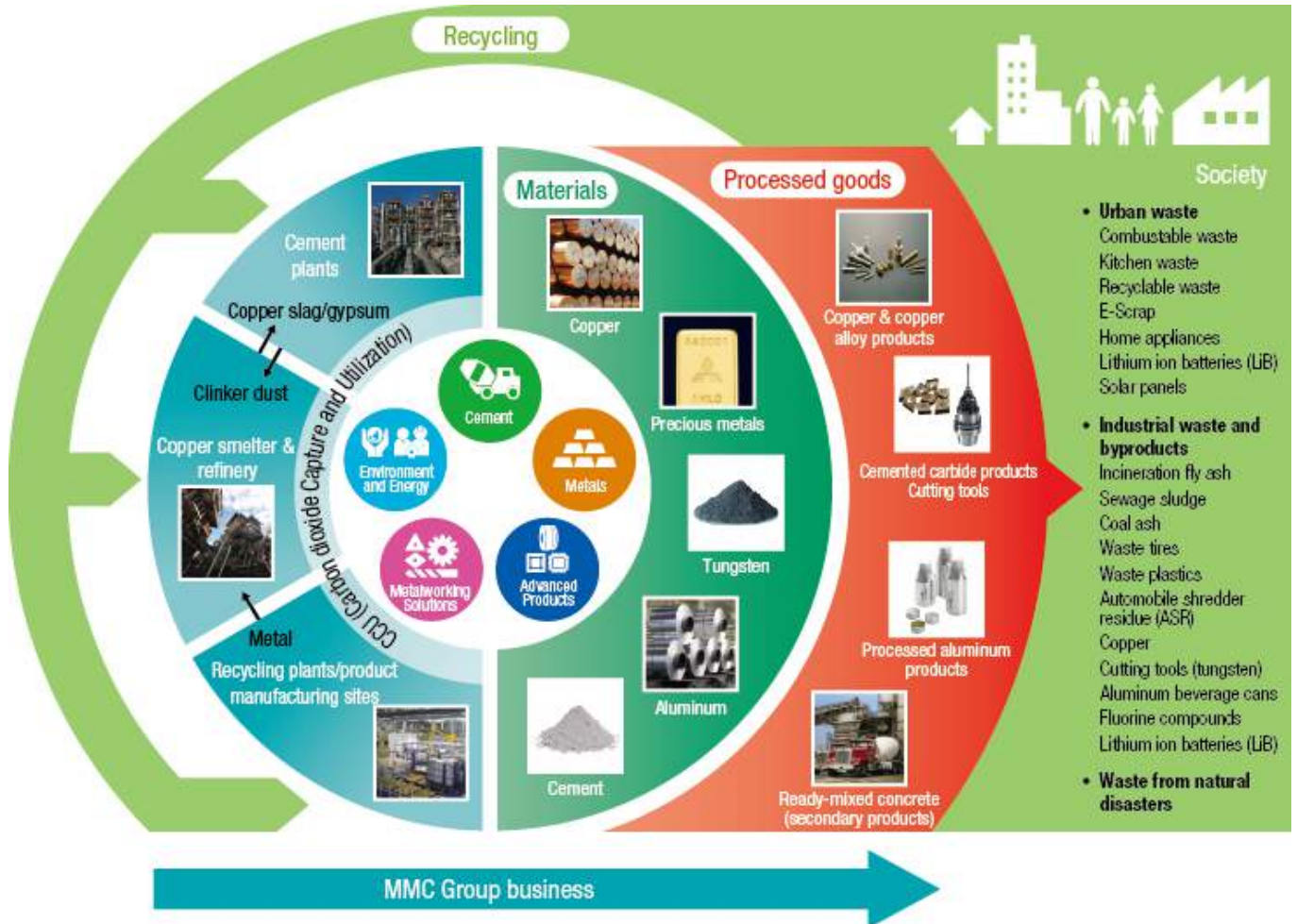
## Recycling-Oriented Business Model

### 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 (Circular Economy).

■ Recycling-oriented business model of the Group



# Recycling-oriented value chain

## Recycling in Individual Businesses

### Advanced Products (Electronic Materials & Components)

#### ■ Recycling Fluorine Resources

We manufacture a range of fluorine compounds at the Group company Mitsubishi Materials Electronic Chemicals Co., Ltd., including materials for use in semiconductor manufacturing, flame retardant and antistatic materials, and hydrofluoric acid. Since fiscal 2007, we have been engaged in the recycling of fluorine resources in which we recover calcium fluoride waste emitted by companies using fluorine compounds and recycle it back into fluorine resources that can be used as alternative raw materials for fluorite. We will promote the recycling of fluorine resources through further technical innovation.

### Metalworking Solutions

#### ■ 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

### Metals

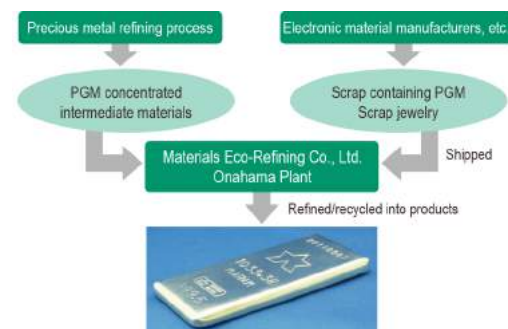
#### ■ Recycling Rare Metals

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.

\* Platinum Group Metals

The rare metal recycling process

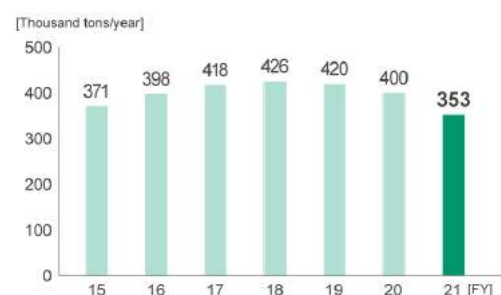


## ■ Recycling Scrap

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



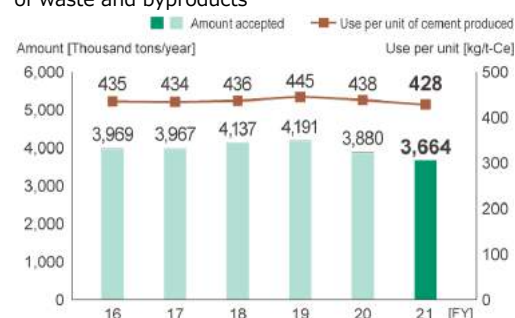
## Cement

### ■ 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



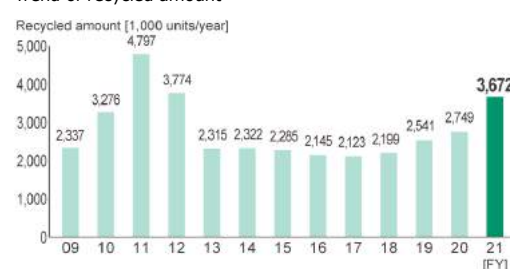
## Environment & Energy

### ■ 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 processes 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 2021, we recycled 2,987 thousand units of home appliances at six plants of our five affiliated companies (6 companies, 7 plants, 3,672 thousand units) \*. Recycling of this volume could reduce landfill disposal equivalent to approximately 120 thousand tons.

\*There are 6 companies and 7 factories for home appliance recycling, but 5 companies and 6 factories are subject to LCA evaluation.

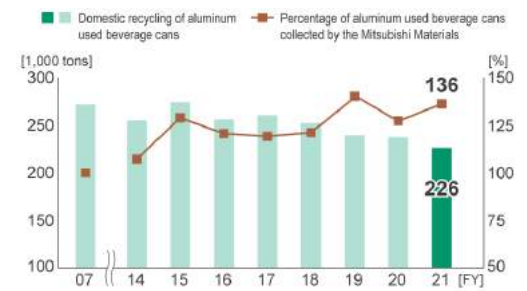
Trend of recycled amount



### ■ 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%)



## TOPICS

### Aluminum Beverage Can Recycling that Responds to the Need to Conserve the Global Environment

Aluminum beverage can recycling has its long history. At the Mitsubishi Materials Group, we proactively recycle aluminum beverage cans, thereby contributing to the conservation of the global environment.

According to a survey by Japan Aluminum Can Recycling Association, the recycling rate of used aluminum beverage cans in Japan has remained high for more than 10 years, exceeding 90% (94.0% in fiscal 2021). Some used beverage cans are exported overseas even where they are reused appropriately.

A little less than 70% (71.0% in fiscal 2021) of aluminum beverage cans recycled in Japan are reused as new aluminum beverage cans (Can-to-Can recycling). This rate is outstandingly higher than that of PET-to-PET recycling, which has been the 20% range (24.3% in fiscal 2020: Data from The Council for PET Bottle Recycling).

The amount of energy consumed to recycle used aluminum beverage cans into new aluminum ingots is much lower, at only approx. 3% than that consumed to make new ingots through the process of smelting and refining aluminum ores (bauxite). Accordingly, CO<sub>2</sub> emissions from the generation of electric power needed for recycling are quite low.

As seen above, aluminum beverage can recycling, which is already established as a stable social system, is a versatile approach to reducing waste, conserving resources and energy, preventing global warming, and presenting solutions to the recent concerns over marine plastic pollution.





# 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.

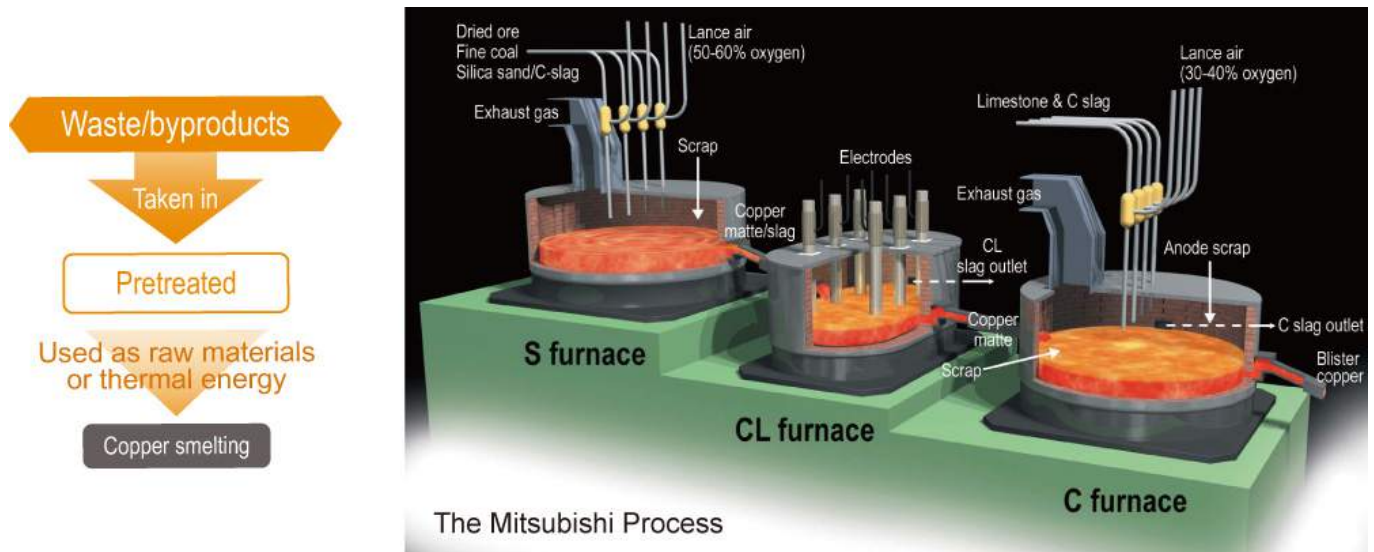
Making the most of this system, which enables us to process E-Scrap, used home appliances, scrap vehicles, batteries and various other types of waste, we have also started to recycle difficult-to-treat waste such as rubble from disaster areas and waste plasterboard. We use unique technologies at our 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.



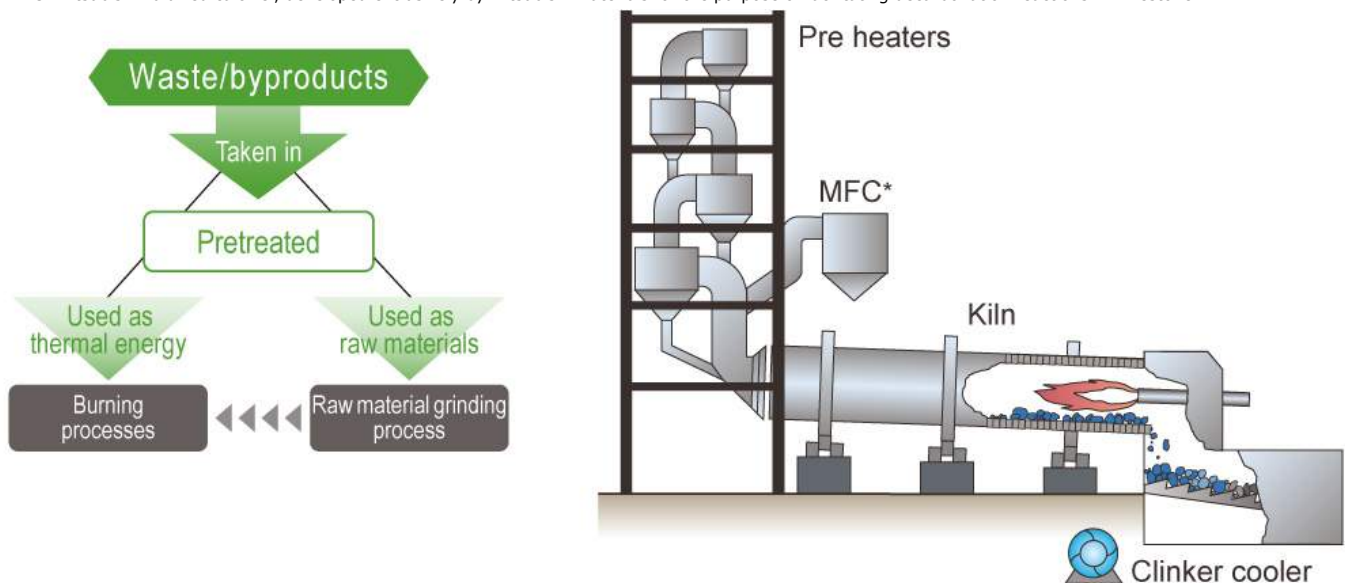
### Cement plants:

#### Taking in, decontaminating and stabilizing 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.

\* MFC: Mitsubishi fluidized calciner, developed exclusively by Mitsubishi Materials for the purpose of facilitating decarbonation reactions in limestone



### ■ 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 (seven plants operated by six companies) :

### Used home appliances are disassembled and some recovered items are supplied as materials

#### ■ Reduction in environmental impact due to recycling home appliances (LCA analysis for FY2021)

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

Recycling process of refrigerators

	Effect	Total
<b>Compared to sending used appliances to landfill and manufacturing new materials from natural resources</b>	Reduction in CO <sub>2</sub> emissions	145,000 tons
	Reduction in consumption of natural resources	152,000 tons
	Reduction in energy consumption	70,000 tons
	Reduction in waste sent to landfill	129,000 tons



The above table does not take into account the impact of recovering fluorocarbons. Expressed in terms of CO<sub>2</sub> emissions, recovering approximately 581 tons of fluorocarbons would equate to a reduction of approximately 1,490,000 tons.

\* There are 6 companies and 7 plants for home appliance recycling, but 5 companies and 6 plants are subject to LCA evaluation.