# Vehicle Recycling

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Introduction

Toyota Environmental Challenge 2050

To move toward a net positive impact rather than just trying to reduce negative factors to zero, Toyota has set itself six challenges. We are taking on steady initiatives toward the year 2050 in order to realize sustainable development together with society.

“Challenge of Establishing a Recycling-based Society and Systems”

1. Prevent pollution from end-of-life vehicles
2. Eliminate resource risks (depletion, sudden rise and supply)
3. Prevent global warming

We promote two projects by rolling out domestic technologies and systems to the world.

TOYOTA Global 100 Dismantlers* Project

TOYOTA Global Car-to-Car Recycle Project

* Dismantlers: Business operators who disassemble vehicle to collect waste, remove parts, or recover materials.
TOYOTA Global 100 Dismantlers Project

If end-of-life vehicles are inappropriately abandoned or dismantled, these may cause "environmental destruction" and "adverse effects on the health and safety of local residents". To prevent these problems, we promote this project. By using technologies and know-how accumulated in Toyota for treating end-of-life vehicles, we contribute to establish "automobile dismantling facilities" by utilizing Toyota Tsusho or local dismantlers around the world.

We establish a society and systems that can treat end-of-life vehicles appropriately without imposing environmental impact, and collect more resources from end-of-life vehicles.

- **Collection of CFC/HFC**
- **Collection of waste oil and waste fluid**

**Automobile Recycle Technical Center**
(Handa City, Aichi Prefecture)

The center conducts research on efficient dismantling methods for vehicle parts and regionally specific dismantling operations.

**Model dismantling plant in Beijing, China**

In Beijing, China, a Chinese dismantling company, a Japanese dismantling company and Toyota Tsusho jointly established a model dismantling plant in 2014. Approximately 32,000 end-of-life vehicles were properly treated with environmentally sound operation in FY2015.
**TOYOTA Global Car-to-Car Recycle Project**

To realize an ultimate recycling-based society, we promote this project with a focus on eliminating resource risks and preventing global warming, based on the concept of 3R (Reduce/Reuse/Recycle).

**Thorough promotion of 3R and use of recycled materials**

1. Reduction of usage of materials with resource risks
2. Promotion of remanufacturing/reusing the parts originated from repair/replacement and end-of-life vehicles
3. Promotion of using low CO₂ recycled materials

The ultimate goal of this project is closed-loop recycling, the concept that the vehicles parts and materials are recycled into identical parts. While taking step-by-step approach, we gradually raise the level.

**Raise the level in both phases of ‘Recycling’ and ‘Using Recycled Materials’, and promote using recycled materials for products.**

1. **Recycling**
   - Car to Car recycling (closed-loop)
   - Car to Car recycling (other parts)

2. **Using recycled materials**
   - Car to other industry
   - Other industry to car

3. **Product**
   - Raise the level
It is necessary to consider recycling through the entire life cycle of vehicle, from its production to the end of life.

To make more effective use of limited resources, we provide results of these activities into the development and design stages working on creating cars with recycling in mind.
Development and design with the environment in mind

In 1998, Toyota was the first in the auto industry to introduce ISO14001*1 in its design and development area. Since then, it has been assessing recyclability in advance, at the vehicle development stage. From 2005, we introduced the “Eco-VAS”*2 a comprehensive environmental assessment system, which is based on the approach of LCA*3 (Life Cycle Assessment), through the entire vehicle development process.

*1 ISO14001 : The international standard for environmental management systems
*2 Eco-VAS : Eco-Vehicle Assessment System
*3 Life Cycle Assessment (LCA) : The product’s impact on the environment is assessed in each process from development to disposal as a way of selecting production methods or alternative raw materials, which have lower environmental impacts.

Vehicle structure for easy dismantling

To promote material recycling of end-of-life vehicles, we actively adopt easy to dismantle vehicles and easy to disassemble parts in new cars upon visiting the actual dismantling company.

Use of Easy to Dismantle Mark

“Disassembly facilitation marks” are added to show key points for disassembly tasks.

Removal of heavy battery components from hybrid vehicle

The time spent on component removal for the fourth generation Prius was further reduced. A new Easy to Dismantle Mark has been added to assist in hoisting heavy components with good balance.

Removal of door trim

The Easy to Dismantle Mark indicates places where the load required for removing the door trim is 30 percent less than usual.

Removal of instrument panel

The positioning of the V grooves makes it easy to remove the instrument panel by pulling it strongly.

Customer needs
- Cost
- CE*4 concept

Environmental performance
- Fuel economy improvement
- Reduction of exhaust gas, noise, and substances of concern
- Recycle
- LCA

Recycling is in mind from planning!

*CE : Chief Engineer
Assessment by Eco-VAS

Vehicle planning
Setting targets that meet environmental performance and customer needs

Design and prototyping
Target attainment

Before start of production
Final confirmation of environmental performance

Information disclosure to customers

Use of pull-tab type ground terminal for wiring harness
The ground terminals can be easily removed by pulling them strongly in a procedure similar to that of opening canned food.

Use of wiring harness visibility improvement tape
By winding recognizable “yellow-green” tape in the vicinity of the place where the wiring harness can be stripped out efficiently, visibility is improved.

Wiring harness layout innovation
The wiring harness can be stripped out without interfering with other components.
**CO₂ emissions reduction activity**

**Development and wider use of plastics derived from plants**

Toyota is curbing CO₂ emissions by other methods besides recycling, to prevent global warming.

- **Petroleum-based plastics**
  - **Plant-derived plastics**

Toyota researched how to use plastics made from plants in cars!

- Curb CO₂ emissions to prevent global warming
- Contribute to reducing the usage of oil resources

### Record of use in cars

| Use of ecological plastic in the "Raum" in May 2003 | Use of ecological plastic*1 in cars |
| Use of new ecological plastic in the "CT200h" in Jan. 2011 | Bio-PET*2 derived from sugar cane is used in new ecological plastic*3 |
| Use of new ecological plastic for interior surfaces in the "SAI" in Nov. 2011 Usage has reached 80% of the surface area of all interior decor components. | Use in components that are difficult with previous ecological plastic Reach the same level of properties, quality, and costs as petroleum-based plastics. |

*1 Ecological plastic: The generic term for plastics developed by Toyota for use in vehicles, which include plants as raw material and achieve better heat resistance, impact resistance, and other properties than general plant-derived plastics

*2 Bio-PET: PET that is manufactured by replacing the monoethylene glycol that is one of the raw materials of polyethylene terephthalate with biological raw material derived from sugar cane

*3 New ecological plastic: Plastic that provides far better heat resistance, durability, expansion and contraction resistance, and other properties than other plant-derived plastics

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**Pioneering Use of Biosynthetic Rubber in Engine and Drive System Hoses**

Toyota became the world’s first automaker to use biohydrid rubber,* jointly developed with Zeon Corporation and Sumitomo Riko Co., Ltd., in vacuum sensing hoses (engine and drive system hoses).

Biohydrid rubber is manufactured using plant-derived bio-materials instead of epichlorohydrin, a commonly-used epoxy compound. The first vehicles to use the new vacuum sensing hoses will be produced in May 2016, with usage expected to be rolled out to all models manufactured in Japan by the end of the year. Toyota plans to expand the use of biohydrid to other high performance rubber components, such as brake hoses and fuel line hoses.

* Since plants absorb CO₂ from the atmosphere during their lifespan, such bio-materials achieve an estimated 20 percent reduction in material lifecycle carbon emissions compared to conventional petroleum-based hydrid rubber.

As biodiesel fuel is produced by chemical processing on oil palm, the raw material of palm oil, bio glyciner is generated as a by-product. The bio glyciner can be used to manufacture bio epichlorohydrin. (Roundtable on Sustainable Biomaterials certification as a plant-derived raw material has been confirmed.)
Promotion of effective use of resources

Recycling of carbide tools (tungsten)

By sorting and collecting end-of-life cemented carbide tools generated at Toyota Plants, Toyota recovers and reuses 100 percent of the tungsten they contain in collaboration with Sumitomo Electric Industries Ltd.

We received an honorable mention for the 1st Rare Metal Recycle Award in “Awards for Resource-Recycling Technologies and Systems” in FY2013.

Activity towards reduction of discarded materials

We promote resource loss reduction activities to cut waste from the plants. In particular, we are tackling yield improvement measures and waste reduction to steadily cut down the amounts of waste treated by outsourced recyclers.

Resource Flow

(Internal and intra-process recycling)

Recycling rate in FY2015: 99.6%

Waste generation amount in FY2015 is reduced by 55% compared to 2001.
Recycling at the sale stage

Collecting discarded bumpers from dealers and recycling of plastics

Since discarded bumpers are made of polypropylene that allows easy to recycle, we actively collect and recycle them through Toyota dealers nationwide.

We have advanced the technology built up by recycling bumpers, developing recycled material from end-of-life vehicle bumpers as raw material.

- Thorough removal of foreign material, such as grit adhering to bumpers
- Ensure quality through detailed adjustment of constituents
- Start applying to defectors

We also established technologies that allow eco-plastics and recycled plastics to be used for 20% of all plastic components in 2013.

New technology development towards use of recycled plastic materials from discarded bumpers

- Decision of the target components and track of progress
- Removal of coating fragments, which reduce impact resistance

Reuse of used parts

Handling of used parts by e-commerce (electric commercial transactions) began nationwide in 2001 in order to effectively use components through expand use of used parts and supply of remanufactured parts.

Supply of remanufactured parts* and new parts (FY2015)

<table>
<thead>
<tr>
<th>Part name</th>
<th>No. of parts supplied in FY2015</th>
<th>Used parts and remanufactured parts</th>
<th>New parts (reference)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remanufactured parts</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Automatic transmission</td>
<td>2,056</td>
<td>66</td>
<td></td>
</tr>
<tr>
<td>Power steering</td>
<td>4,287</td>
<td>2,288</td>
<td></td>
</tr>
<tr>
<td>Torque converter</td>
<td>1,655</td>
<td>5,070</td>
<td></td>
</tr>
<tr>
<td>Used parts</td>
<td>35,498</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Remanufactured parts: Disassembled or cleaned parts that have been replaced as equivalent quality of new parts on an as-needed basis

How e-commerce works

Customer

Wants to use used bumpers

Repair consultation and request

Vehicle repair

Parts request

Dealer

Parts distributor

Access

Parts

Delivery

Inventory information database

Used parts dealer A

Used parts dealer B

Used parts dealer C

Shipping instruction

Search and order

Product (Delivery via home-delivery service)

Parts distributor: Company for the distribution and sale of car repair parts and accessories, established with joint investment from Toyota Motor Corporation and local dealers. 34 companies nationwide
Activities to Test Recycling of Bumper Covers and Scrap Parts for Waste Reduction

Toyota’s North American Parts Operation (NAPO) is working to reduce waste by recycling damaged bumper covers and scrap parts. Working with business partner Boles Parts Supply (BPS), the program uses a methodology called “National Scrap Program” devised in 2014 to process various kinds of parts that previously could not be reused into plastic pellets of various sizes that can be reused.

The program was first verified at Toyota’s two largest parts centers in Ontario, California and Hebron, Kentucky. In the first 15 months, the program recycled over 40,000 pounds of cloth and foam, two materials that in the past were incinerated or sent to landfills.

The program was then expanded to six parts distribution centers in Cincinnati, Los Angeles, San Francisco, and Portland. This move resulted in the recycling of over 88,000 pounds of parts, accounting for 92 percent of previously non-reusable parts. BPS has so far succeeded in recycling more than 14 types of waste generated by Toyota. The recycled pellets are also sold to fabric makers and other vendors who manufacture car bumpers, and become part of the materials used to create new vehicle parts.

Damaged bumper covers are recycled into plastic pellets.

Juliana Dee, manager of the program at NAPO, states, “We’ve been enormously pleased with the success of this program. Thanks to our partner BPS, we are giving a second life to things that used to be trash and making a real improvement in our recycling rate. . . . It means fewer raw materials are used and less waste is being disposed—a real win-win for the environment.”

NAPO confirmed that its overall recycling rate in FY2015 had improved by 3 percent over the previous year and that the parts center in Ontario in particular had improved its recycling rate by an amazing 11 percent.

Toyota is currently reviewing the program for potential rollout to remaining parts distribution centers by the end of FY2017.

BPS President
Jerry Boles

"Toyota is such an outstanding client, and these guys are truly focused on environmental performance. . . . We are very proud of this success."
General overview of the recycling

Recycling conditions of end-of-life vehicles

Window (Glass) → Raw material for cement
Engine (Steel, aluminum) → Engines, aluminum products
Wiring harness (Copper) → Copper products, engines (cast aluminum reinforcement)
   Introduced on page 21
Engine oil → Alternative fuel for boilers and incinerators
Radiator (Copper, aluminum) → Gunmetal ingots, aluminum products
Coolant (Alcohol) → Alternative fuel for boilers and incinerators
Bumper (Resin) → Interior parts, tool boxes, etc.
Battery (Lead) → Batteries
Transmission (Steel, aluminum) → General steel products, aluminum products

Body (Steel) → Vehicle parts, general steel products
Seat (Urethane foam, fabric) → Raw material for cement and heat source
HV battery → Batteries, rechargeable batteries
   Introduced on pages 19 and 20
HV motor magnet → Magnets, catalysts
   Introduced on page 21
Catalytic converter (Rare metal) → Catalytic converters
Suspension (Steel, aluminum) → General steel products, aluminum products
Wheel (Steel, aluminum) → Vehicle parts, general steel products, aluminum products
Tire (Rubber) → Raw material for cement and heat source

*1 HV : Hybrid Vehicle
Recycling/recovery route for end-of-life vehicles (Japan)

End user → Collecting companies → Dismantling companies → Shredding companies → ASR recycling companies → ASR landfill, etc.

- Collecting companies: Approx. 3.6 million units/year
- Dismantling companies
- Shredding companies
- ASR recycling companies

Vehicle recycling/recovery rate: over 99%

ASR material composition (Wt%)
- Wiring harness 4
- Glass 7
- Non-ferrous metal 5
- Non-combustible 4
- Resin 33
- Combustible 16
- Fabric 15
- Rubber 7
- Wood 8
- Paper 2

Ferrous metal
Non-ferrous metal
Copper, slag, electricity, etc.

Engines, transmissions, catalytic converters, tires, batteries, oils, fuels, Freon, airbags, etc.

Star-marked three items are required to be taken back by vehicle manufacturers under the Automobile Recycling Law!

*2 Recycling/recovery rate: Weight sent for recycling divided by the total weight of end-of-life vehicles
Efforts for proper treatment

Proper treatment of Automobile Shredder Residue (ASR)

In 1993, Toyota started working jointly with Toyota Metal Co., Ltd. to develop ASR recycling technology. We started operating a unique recycling plant in August 1998, recycling on a mass production basis (capacity: approximately 2,000 tons of ASR per month).

![Toyota Metal Co., Ltd.](image)

Development and utilization of ASR sorting technology

In order to use automobile shredder residue completely, it is necessary to recycle it into the basic materials of products. Since separation of constituents is required to raise their purity, we developed special sorting technologies for ASR recycling plants using wind and magnetism to make shredder residue reusable.

<table>
<thead>
<tr>
<th>ELV Shredder Plant (End of Life Vehicle)</th>
<th>ASR Recycling Plant (Automobile Shredder Residue)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary shredder</td>
<td>Trommel</td>
</tr>
<tr>
<td>Main shredder</td>
<td>Crushing</td>
</tr>
<tr>
<td>Pneumatic sorting</td>
<td>Non-ferrous sorting</td>
</tr>
<tr>
<td>Magnetic sorter</td>
<td>Aluminum</td>
</tr>
<tr>
<td>Shredded ferrous metal</td>
<td>Glass</td>
</tr>
<tr>
<td></td>
<td>Ferrous metal</td>
</tr>
<tr>
<td></td>
<td>Pneumatic sorting</td>
</tr>
<tr>
<td></td>
<td>Melt-solidification</td>
</tr>
<tr>
<td></td>
<td>Rotating sieve</td>
</tr>
<tr>
<td>Steel scrap (Toyota plants)</td>
<td>Urethane foam/ fibers</td>
</tr>
<tr>
<td></td>
<td>Copper</td>
</tr>
<tr>
<td></td>
<td>Resin/rubber</td>
</tr>
<tr>
<td></td>
<td>Electric furnace material/heat source</td>
</tr>
</tbody>
</table>

World’s first integrated operation of shredding and ASR recycling
Use of resin as a heat source for electric steel furnaces

Electric steel furnaces use heat sources and carbon additives when they melt steel scrap to turn it into steel products.

By adding an appropriate amount of the resin sorted out from ASR, it has become possible to use the resin as an alternative to heat sources and carbon additives.

The Automobile Recycling Law calls for the ASR recycling/recovery rate to be raised to 70% by FY2015, but Toyota already reached that target in FY2007.

ASR material recycling

With the aim of the material recycling of resin and proceeding with the material recycling of ASR-based resin, Toyota implemented a sorting device with the use of water for the first time in 2015. We also started working on copper and aluminum removal of non-ferrous metals in impurities mixed in resins and rubbers, and using them as a recycled resin base material.
Proper treatment of HV batteries

We provide information on end-of-life HV batteries so that they can be removed from vehicles safely, and collect them through a collection network to perform proper treatment.

Safe removal

Precautions for safe removal of batteries from vehicles by dismantling companies are available on the following website.

Toyota Motor Corporation Official Corporate Site

http://www.toyota.co.jp/jpn/sustainability/environment/challenge5/battery-recycle/index.html#title02

Collection system

For end-of-life battery collection in Japan, Toyota has built a unique network, and the Toyota HV Call Center receives collection requests nationwide via the Internet. This collection network also uses returning delivery trucks of Toyota service parts to reduce CO₂ emissions.

Battery collection network in Japan

Outline of the Overall Collection Network

- Dismantling companies
- Dealers
- Toyota Recycle Corporation
- Service parts logistics company
- Toyota Chemical Engineering Co., Ltd.
- Consolidate
- Parts distributors
- Toyota HV call center (24 hours a day)

Proper treatment

In Japan, reduction process is applied to the collected batteries to achieve zero voltage and harmless electrolytes. We are also considering a proper treatment method for lithium-ion batteries.
Proper treatment of FCV (Fuel-Cell Vehicle)

Toyota’s FCV, MIRAI, can travel with its motor alone with use of electric power both FC stack (fuel cell battery) and HV battery. It is an environment-friendly and zero emission vehicle that only generates water during traveling and using hydrogen gas as fuel.

MIRAI uses two tanks made of carbon fiber reinforced plastic (CFRP) that store high-pressure hydrogen gas at a charging pressure of 70 MPa (equivalent to 700 atmospheric pressure).

When dismantling FCV, it is required to dispose the remaining hydrogen gas in the tank, and process (scrap) the tank so it cannot be reused (High Pressure Gas Safety Act).

Along with launching MIRAI, Toyota created an operation manual to roll out various precautions, including releasing gas from the hydrogen tank and scrapping, removal of the HV battery and FC stack, and recovery procedures.

Start of Recycling of MIRAI Hydrogen Tanks in Europe

Leasing of the MIRAI has also begun in Europe. Therefore, it is imperative to properly dispose end-of-life hydrogen tanks. Toward commercialization of a recycling operation, Toyota conducted a pilot program in Europe, and the program recently reached the point of ensuring proper recycling of end-of-life hydrogen tanks, resulting in Toyota’s decision to sign a subcontracted recycling agreement with a local company. From now on, the hydrogen tanks from the MIRAI that reach their end of life in Europe will be locally recycled. For example, carbon-fiber-reinforced plastic (CFRP) will be removed from these tanks and reused as a recycled material.
Efforts for recycle/reuse

Necessity for recycling rare metals and rare earths

In recent years, vehicles have come to use numerous motors and circuit boards. Compared to conventional vehicles, hybrid vehicles, in particular, have increasing numbers of components, such as batteries and motors that use rare metals*1 and rare earths*2.

Toyota is working on rare metals to provide its customers with stable supply of good vehicles

Procurement risks

- The potential extraction period*3 is short.
- Production is concentrated in a few countries.
- Procurement is easily affected by economic and political changes.
- Prices are extremely volatile.

Countermeasures

① Recycle resources from urban mining.
② Develop the technology both alternative materials and reduce the quantities of materials.
③ Stabilize procurement by opening up new routes.

Leading producing countries of non-ferrous metal resources (2015)

Source: USGS

Periodic table of the elements

- Rare metal
- Rare earth
Recycling of HV batteries

In October 2010, Toyota started the world’s first ‘battery-to-battery’ recycling operation in partnership with other related companies. It extracts nickel*1 from used nickel-metal hydride batteries and recycles it as a raw material for batteries. In other words, complete recycling of rare metals has moved into the final validation phase*2.

Until now
Recycled as scrap for raw material for stainless steel.

Development of advanced sorting and extraction technologies

In future
Recycle as raw materials for new batteries. Extract Nickel and Cobalt*3.

>1 Nickel: Rare metal
>2 Validation phase: Studying the problems of a newly-developed product or technology by using it in real situations for practical use
>3 Cobalt: Rare metal

Recycling of lithium-ion batteries

Compared to nickel metal hydride (NiMH) batteries, lithium-ion batteries use less metal resources to produce the same capacity. Toyota is developing technologies to recycle rare metals and non-ferrous metals from lithium-ion batteries same as NiMH batteries.
Remanufacturing/reuse of HV batteries

Toyota inspects and remanufactures end-of-life NiMH batteries removed from hybrid vehicles. We have been reusing them as stationary rechargeable batteries since 2013, and as supply batteries for vehicles since 2014 for the ecological renewable energy. After reuse, the material is recycled and used for new batteries again.

- Remanufactured and sold as supply batteries for vehicles after inspection (the second generation Prius) since 2014
- Remanufactured and sold as stationary rechargeable batteries (firstly, shop use…dozens of units have already been installed) since 2013

Sustainable energy business in Yellowstone National Park

In June 2014, the partnership among Toyota, Indy Power Systems, Sharp USA SolarWorld, Patriot Solar, National Park Service, and Yellowstone Park Foundation, end-of-life Toyota Camry Hybrid nickel-metal hydride battery packs that store energy generated by solar panels in the distributed energy system started operation in Yellowstone National Park. Renewable electricity that was generated by solar panels is stored in the 208 used Camry Hybrid NiMH battery packs (with a capacity of 85kWh), and is used as emergency power supply for lodges in the park.

- Solar panels for solar power generation
- NiMH battery storage system

Yellowstone National Park
Recycling of magnets

Magnets used in HV motors include two types of rare earths elements, neodymium and dysprosium*. Toyota is working on the research and development of motors that use as little rare earths as possible, and it recycles the extracted neodymium and dysprosium into new magnets in cooperation with Shin-Etsu Chemical Co., Ltd. Furthermore, we have started Car-to-Car recycling system that enables magnets to be recycled into additives for catalysts in collaboration with Sanwa-yuka Industry Corporation.

* Neodymium and dysprosium: Rare earth elements used in the production of powerful permanent magnets

Recycling of wiring harness (copper)

Mineable copper used in power transmission and wiring is expected to last roughly 40 years. On the other hand, large amounts of copper are loaded and used in the next-generation vehicles such as hybrid vehicles, which become increasingly popular in the years to come. Toyota has therefore been developing Car-to-Car recycling technology in cooperation with affiliated companies. Recycled copper trial production started in the HQ plant from 2013. After a three-year trial production, we completed development of technology to separate less refining copper from 99.96% purity copper.

Recycling of FC stack

The FC stack (fuel-cell battery) loaded in the Mirai initiates chemical reaction by hydrogen gas supplied from the hydrogen tank and oxygen in the air taken from outside the vehicle, and produces a high voltage of over 300 volts.

FC stack uses metals of high scarcity value. Along with the sales launch of Mirai, Toyota has established the world’s first FC stack collection and recycling system.
Specific efforts

Disposal

R&D on resource recycling

Research into efficient removal and recovery technologies
We are conducting research on efficient dismantling technologies for wide use of heavy dismantling equipment and vehicle structure for easy dismantling.

![Heavy dismantling equipment](image1)
![Removal of a wiring harness with heavy dismantling equipment](image2)
![Motor removal](image3)
![Motor disassembly](image4)

Research into technologies for disassembling parts that use precious metals
We are conducting research on technologies for the efficient disassembly of electronic circuit boards and sensors, which are considered as urban mining* resources, and technologies for the removal of components containing precious metals.

- **Engine ECU**
  - Before disassemble
  - After disassemble

- **O2 sensor**
  - Before disassemble
  - After disassemble

*Urban mining: The process of reclaiming compounds and elements from end-of-life vehicles, batteries and electric devices which would otherwise be left to decompose as landfill

Research on resin recycling
We are considering the possibility of reusing resin vehicle parts recovered from end-of-life vehicles, as a way of promoting the further recycling of resin.

- e.g.) Bumper material from end-of-life vehicles → Reused in resin body components

We are also working on R&D towards realizing of bumper-to-bumper recycling in the future.

![Vehicle resin parts](image5)
Development of FCV dismantling technologies

Assuming the occurrence of end-of-life FCVs in the future, Toyota started considering the operation procedures and construction methods of dismantling a few years prior to sales launch. Furthermore, a dismantling demonstration was performed for Japan ELV Recycle Association in view of Article 3 of the Automobile Recycling Law: “Provide Information of Automobile Structure”.

Flow of the FCV dismantling operation (standard pattern)

1. Gas drainage (hydrogen gas drainage from the medium pressure port)
2. Liquid drainage
3. Collection of airbag and CFC/HFC
4. Removal of HV battery, etc.

5. Removal of hydrogen tank and FC stack assembly
   - Car body (parts removed)
   - Go to A press
   - [FC stack assembly]
   - [Hydrogen tank]

6. Scrapping of hydrogen tank and disassembly of FC stack assembly
   - Opening
   - Water filling
   - Drainage and scrapping

7. Transportation of hydrogen tank and FC stack
   - Precious metal recycling
   - Proper treatment

Dismantling demonstration

Gas drainage
Unloading tank and stack
Recycling research site for end-of-life vehicles

Toyota has conducted extensive research to enhance the dismantlability of end-of-life vehicles and the recyclability of parts.

To further advance dismantling and recycling technologies and commercialize and incorporate them in vehicle designs based on the technologies and expertise gained from this research. Toyota established the Automobile Recycle Technical Center in Toyota Metal Co., Ltd. in 2001.

Positioning of the Automobile Recycle Technical Center

- Toyota Motor Corporation
  - Propose vehicle designs for easy recycling
  - Propose efficient dismantling technologies
  - Technical development for recycling rare metal and rare earth resources

- Dismantling and shredding industries, etc.
  - Disclose information on dismantling technologies, etc.

Automobile Recycle Technical Center

- Research into recyclable vehicle structures
- Research into efficient scrapping technologies
- Develop proper and efficient recycling technologies

- Component and material manufacturers
- Tool and instrument manufacturers
Compliance with the Automobile Recycling Law

The Automobile Recycling Law, which came into effect in January 2005, mandates an appropriate roles and responsibilities between automobile manufacturers and other involved parties, to promote the recycling and proper treatment of end-of-life vehicles. Under the Automobile Recycling Law, Toyota collects CFC/HFC, airbags and ASR from end-of-life vehicles, and actively promote recycling or proper treatment.


System for collection and recycling under the Automobile Recycling Law

Targets: 4-wheel passenger vehicles (including mini-vehicles) and 4-wheel commercial vehicles (standard, small, mini-trucks and buses)

Transition in Toyota’s recycling/recovery rate and ASR recycling/recovery rate

Legal standard for FY2015: 70%
Recycling in changing times and Toyota’s action

**Changing times**

<table>
<thead>
<tr>
<th>Year</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970~</td>
<td>From mass production and consumption to energy-saving and recycling</td>
</tr>
<tr>
<td>1990~</td>
<td>Recognize environmental problems and start addressing them on a global scale</td>
</tr>
<tr>
<td>2000~</td>
<td>Escalation of global environmental problems</td>
</tr>
</tbody>
</table>

**Towards establishment of a recycling-based society**

<table>
<thead>
<tr>
<th>Year</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1998~</td>
<td>Started ASR operations</td>
</tr>
<tr>
<td>2001</td>
<td>Established Recycle Technical Center</td>
</tr>
<tr>
<td>2007</td>
<td>Formulated scenarios for recycling technologies in 2020</td>
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<td>2008</td>
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**Recyclable design (Easy to dismantle design)**

Various recyclable design items were applied to new vehicles after Raum.

**Promotion of bio plastics 2003 -**

**Compliance with the Automobile Recycling Law**

**More advanced resource recycling (rare earths, rare metals, etc.)**

**Toyota’s action**

- **1970~**
  - Established Toyota Metal Co., Ltd.

- **1998~**
  - Started ASR operations

- **2001**
  - Established Recycle Technical Center

- **2007**
  - Formulated scenarios for recycling technologies in 2020

- **2008**
  - Established the Resource Recycling Committee

- Recyclable design efforts based on recycling technology scenarios

- Various recyclable design items were applied to new vehicles after Raum

- **Promotion of bio plastics 2003 -**

- **Compliance with the Automobile Recycling Law**

- **More advanced resource recycling (rare earths, rare metals, etc.)**

**Vehicle Recycling**
Getting complicated of balancing recycling-based society with low carbon society related problems

Towards establishment of a low-carbon society

- **2011**
  - Achieved 99% of ELV Recycling/recovery rate

- **2013**
  - Achieved 20% usage of ecological plastic and recycled resin material
  - Prime Minister’s Award for ongoing efforts to promote a sustainable society by reducing, reusing and recycling resources (3R) in FY2013
  - Received the 1st Rare Metal Recycle Award for Resource-Recycling Technologies and Systems in FY2013

- **2015**
  - Formulated Environmental Challenge 2050
  - Received the Global Environment Award

- **2009**
  - HV battery collection recycling system commences
  - World first

- **2010**
  - Carbide tool tungsten collection recycling system commences
  - World first

- **2012**
  - HV motor magnet recycling commences
  - World first

- **2013**
  - HV battery remanufacturing and reuse operations commences
  - World first

- **2016**
  - MIRAI FC tank and stack collection system operation commences