

Creating Environmentally Sound Products

Development Approach/Developing Eco-friendly Vehicles

Development Approach

Isuzu is working to develop technologies to minimize the environmental impacts of our engines and vehicles. We emphasize the seven key issues of creating environmentally sound products in the context of the life cycle assessment of vehicles. These include fuel efficiency, exhaust emissions and external noise (see figure at right). For example, total mileage of heavy-duty commercial vehicles often reaches 1.2 million kilometers during its lifetime; better fuel efficiency could result in significant differences in total energy consumption and CO₂ emissions over the vehicle lifetime. Efficiency is a critical issue for reducing the environmental impacts of commercial vehicles.

One major challenge with diesel, however, is reducing the emissions of nitrogen oxides (NOx), particulate matter (PM) and black smoke in vehicle exhaust. We have achieved reductions, including the launch of the ELF-KR light-duty truck series which comply with tough new exhaust emission regulations before they take effect; we will continue to develop and apply advanced technologies to make further achievements. We are taking various approaches to reduce the environmental impact of vehicles at every stage of the life, such as further reductions of external noise, a shift to more environmentally friendly materials, lower use of refrigerants in air-conditioners, and improvements in recyclability.

Key Issues of Developing Environmentally Sound Products

- 1 Improve fuel efficiency and reducing CO₂ emissions
- 2 Produce cleaner exhaust emissions
- 3 Develop vehicles that run on cleaner energy
- 4 Reduce external noise
- 5 Reduce usage of substances with environmental impact
- 6 Improve recyclability
- 7 Reduce volume of refrigerants in air-conditioners

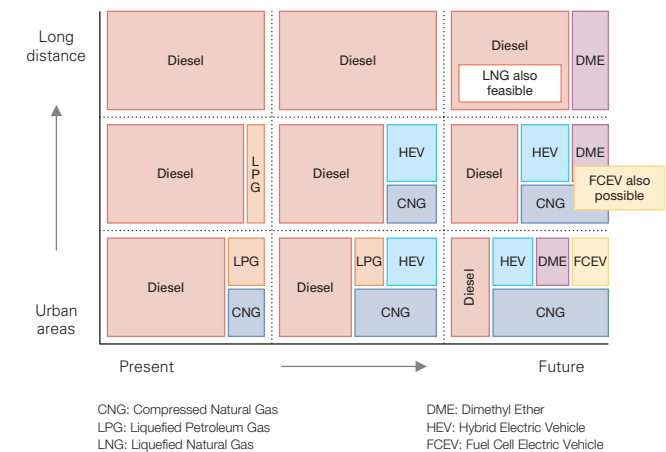
Developing Eco-friendly Vehicles

Diesel-powered vehicles play a central role in all road transportation today, from short to long distances. Eco-friendly diesel powered vehicles that are adapted to a range of uses are appearing. Isuzu is taking advantage of the high thermal efficiency and fuel efficiency of diesel engines, which also permit the use of various alternative fuels, and is making a major effort to clean the exhaust emissions that are one disadvantage of diesel engines. Isuzu's CNG-powered vehicles come in various models and are well-suited for driving in urban areas, where distances traveled are relatively short and air pollution should be reduced significantly. These vehicles have rapidly increased in recent years and are expected to increase in the future.

Regarding hybrid vehicles, not only passenger cars but also commercial vehicles will increase with the expected development in the near future. In addition, today the automobile and related industries are also researching and developing low-pollution vehicles and alternative fuels. Fuel cell-powered vehicles are drawing attention today for their potential in passenger cars; they are also considered promising for use in commercial vehicles. There are great expectations of dimethyl ether (DME), a fuel synthesized from natural gas etc. Commercial vehicles will be developed for a broad range of purposes, from short- to long-distance transportation.

Isuzu is working to develop next-generation eco-friendly vehicles, built on the foundations of our technical know-how, which we have accumulated over many years in the manufacture of diesel engines.

Trends in Development of Eco-friendly Vehicles



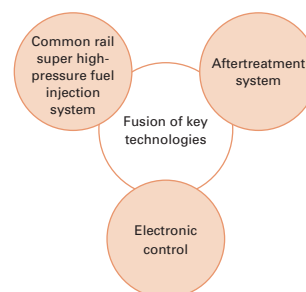
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Cleaner Diesel Exhaust Emissions

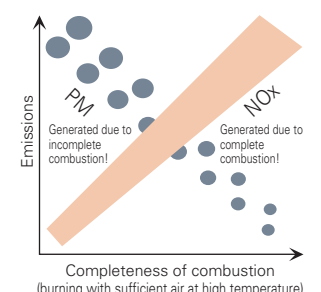
It is difficult to clean diesel exhaust emissions. This is because nitrogen oxides (NOx) are generated due to complete combustion of fuels at high temperatures, whereas particulate matter (PM) is generated due to incomplete combustion at low temperatures, and also because commercial vehicle engines are operated under severe conditions with the engine load changing depending on the amount of cargo they carry.

Isuzu has been able to elucidate the detailed mechanism of generation of NOx and PM in relation to fuel combustion and to establish clean technologies, thus achieving significant reductions in exhaust emissions. These state-of-the-art technologies include a precisely controlled common rail super high-pressure multi-stage fuel injection system per 1/1000 second, synchronized with four intake and exhaust valves for optimal

Isuzu Diesel Technologies and Expertise



Correlation of PM and NOx Emissions from Diesel Engines



Creating Environmental Technologies

combustion, a cooled exhaust gas recirculation (EGR) system, and an oxidation catalytic converter for aftertreatment. The ELF-KR series was equipped with the newly developed engines, meeting the tough new short-term emission regulations in advance.

We are working to achieve cleaner engines by controlling fuel injection at super-high pressures exceeding 200MPa.

Now we are working to develop a new-generation aftertreatment system that combines a urea agent type NOx catalyst and a continuously regenerating diesel particulate filter (DPF) system with a catalyst to significantly reduce particulate matter and black smoke emissions. This system should comply with the tougher exhaust emission regulations (new long-term regulations) to become effective in 2005.

For diesel-electric hybrid vehicles, which are in actual operation, we are working to reduce exhaust emissions and improve fuel efficiency by providing a driving power in the starting and low-speed ranges with a battery and by allowing the vehicle to run on the diesel engine alone in the middle- and high-speed ranges.

Technologies to Boost Fuel Efficiency and Reduce CO₂ Emissions

With their efficiency in converting fuel into driving power, diesel engines are environmentally friendly as they can obtain 20 to 40% lower CO₂ emissions than in gasoline engines. Isuzu is working to improve the fuel economy of the engine itself as well as that of the vehicle as a package. In fiscal 2002, we introduced the newly developed "Smoother" fully automated transmission in the G, F and E series, which combines the easy operation of automatic transmission and the economy of manual transmission.

● Smoother-G

"Smoother-G" is a 12-speed fully automated mechanical transmission installed in the GIGA series heavy-duty trucks. Shifting is fully automated for starting, changing and stopping. We have also introduced the "Eco Mode" in the "Smoother-G" a shifting mode that is programmed with data from fuel economy consultation we have compiled using the "Mimamori-kun" system. In this mode, shifting is automated to maintain an engine rotation rate that constantly maximizes fuel efficiency, thus enabling fuel-efficient driving, irrespective of the driver's skill. With this new transmission we achieved a remarkable 11% improvement in fuel efficiency compared to the 7-speed manual transmission model. This was accomplished by increasing the number of speeds and reducing the scatter in fuel consumption. With the addition of a speed limiter and other innovations, we achieved an average of 25% improvement in fuel efficiency.

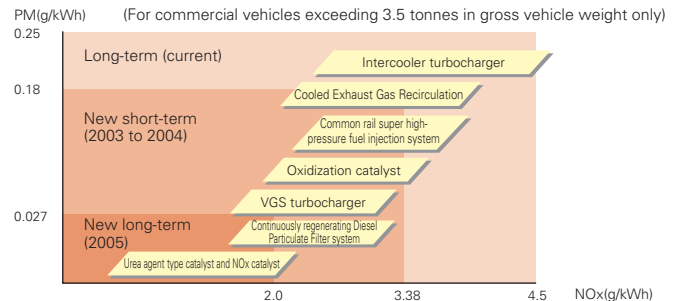
By combining an automatic cruising system and the Smoother-G, we were also able to prevent vehicle speed fluctuations that make fuel efficiency worse; this made a significant contribution to fuel efficiency.

● Smoother-F and -E

With the new "Smoother-F and -E" transmissions, we have eliminated the clutch pedal from the manual transmission, by employing a combination of a fluid coupling and a wet multi-disc clutch. The vehicles equipped with this transmission enables the driver to accurately control the speed by the fluid coupling, while shifting and accelerating in the same manner as with conventional manual transmission vehicles. These vehicles may also be operated by drivers with a license limited to driving with automatic transmissions, so are open to a broad range of vehicle drivers. Because these transmissions allow engine braking and exhaust braking, as with conventional models, speed control on descending slopes is of no concern.

Introduced in the FORWARD medium-duty trucks, the "Smoother-F" has earned a good reputation in the market, and in May 2003, it received the "Technical Innovation Award" in the 53rd annual awards from the Society of Automotive Engineers of Japan. The ELF light-duty trucks are equipped with the "Smoother-E" type, equivalent to the "Smoother-F" in durability and reliability.

Major Technologies for Complying with Exhaust Emissions Regulations



New short-term: Exhaust emissions regulations that became effective in 2003
New long-term: Stricter regulations on Environmental Preservation that take effect in 2005

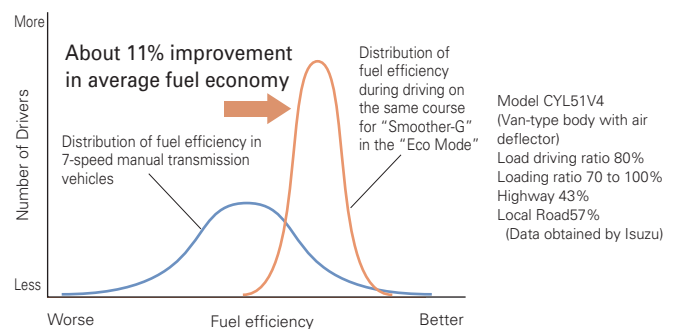
Topics

JSAE Technical Innovation Award

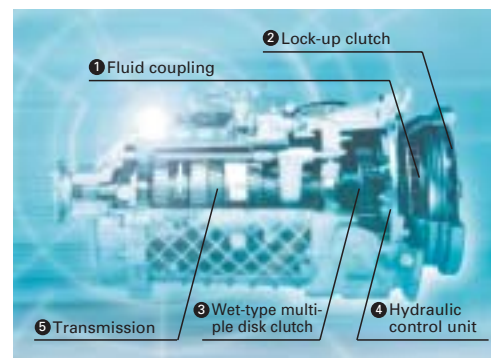


Isuzu's "Smoother-F" received the Technical Innovation Award from the Society of Automotive Engineers of Japan for the 53rd annual awards.

"Smoother-G" Model Driving Patterns



"Smoother-E" Transmission Mechanism



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Development and spread of Clean Energy Vehicles

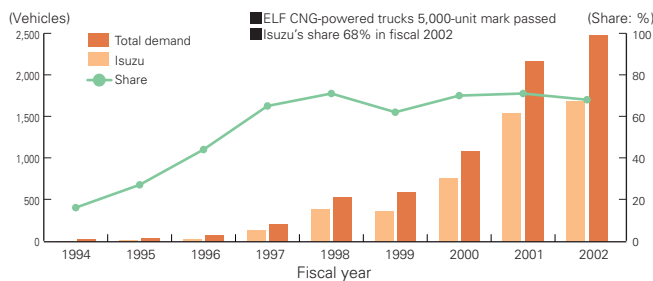
Isuzu is actively carrying out research and development of alternative-energy vehicles to find solutions for the problems of world's dwindling petroleum resources and air pollution in large cities.

We have already developed, and are now manufacturing and selling CNG-powered trucks and buses and LPG-powered trucks.

In recent years, we find that interest is especially growing in CNG-powered vehicles for city transport. Isuzu has started line production of the CNG-powered ELF and FORWARD series in response to growing demand, and has been working to stabilize their quality and reduce prices for further expansion. These trucks have been designated as super low-pollution vehicles by eight Tokyo-area local governments (including the Tokyo Metropolitan Government), demonstrating their outstanding environmental performance.

We are also developing diesel-electric hybrid ELF light-duty trucks to make the most of the excellent fuel efficiency of diesel engines. In addition, in an initiative commissioned by Japan's Ministry of Economy, Trade and Industry we are now developing engines powered by dimethyl ether, a next-generation clean alternative fuel, and testing them in medium-sized buses and light-duty trucks.

The CNG-powered ELF — New Vehicle Registrations



CNG-Filling Station "Shonandai Isuzu Eco-Station" Opens

In April 2003, Isuzu began operating "Shonandai Isuzu Eco-Station" the first compressed natural gas filling station to be established in the northern area of Fujisawa City, at a site adjoining the Fujisawa Plant in Kanagawa Prefecture. In response to the growing demands for low-pollution vehicles, the number of owners of CNG-powered vehicles, including local governments, has recently been increasing. The "Shonandai Isuzu Eco-Station" offers plenty of space to ensure easy filling of compressed natural gas, contributing to the convenience of this fuel for nearby local governmental and private customers.



Shonandai Isuzu Eco-Station
Facility area: 996m²
Filling capacity: 250m³/hour



CNG-filling stand

Other Initiatives: Reducing Noise, Using Less Refrigerant in Air-conditioners

External Noise Reduction

In Japan, under the world's most stringent noise regulations, Isuzu pays much attention to vehicle noise, even at the vehicle design stage. Our efforts to create quieter vehicles include developing a pilot fuel injection system in diesel engines to reduce both noise and exhaust emissions, and analyzing the pathways followed by engine combustion sounds to have a soundproof structure.

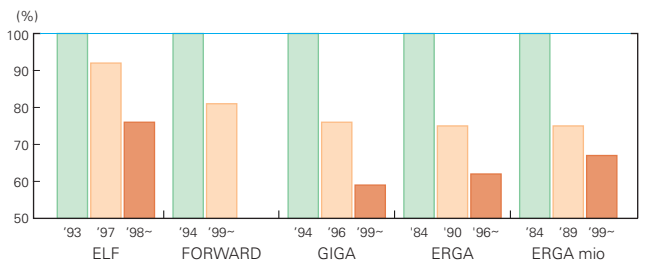
The common rail fuel injection system and sound insulation cover made for a much quieter ELF; engine combustion noise itself was reduced, and idling noise was found to be two decibels lower than previous models.

Reducing the Use of Refrigerants in Air-conditioners

In 1993, Isuzu completely phased out the use of CFC12 refrigerants, which destroy the ozone layer and switched to HFC134a, a CFC alternative. As HFC134a is also a greenhouse gas, however, it too must eventually be phased out. Thus, Isuzu has been working to reduce its consumption by 10% compared to 1995 levels, and has been able to achieve a reduction of more than 20% for all of its vehicle models, well beyond the target.

Currently, we are working to develop air conditioners using other refrigerants such as CO₂.

Reducing the Use of Air-conditioner Refrigerant in Each Isuzu Vehicle



Reducing the Use of Substances with Environmental Impact

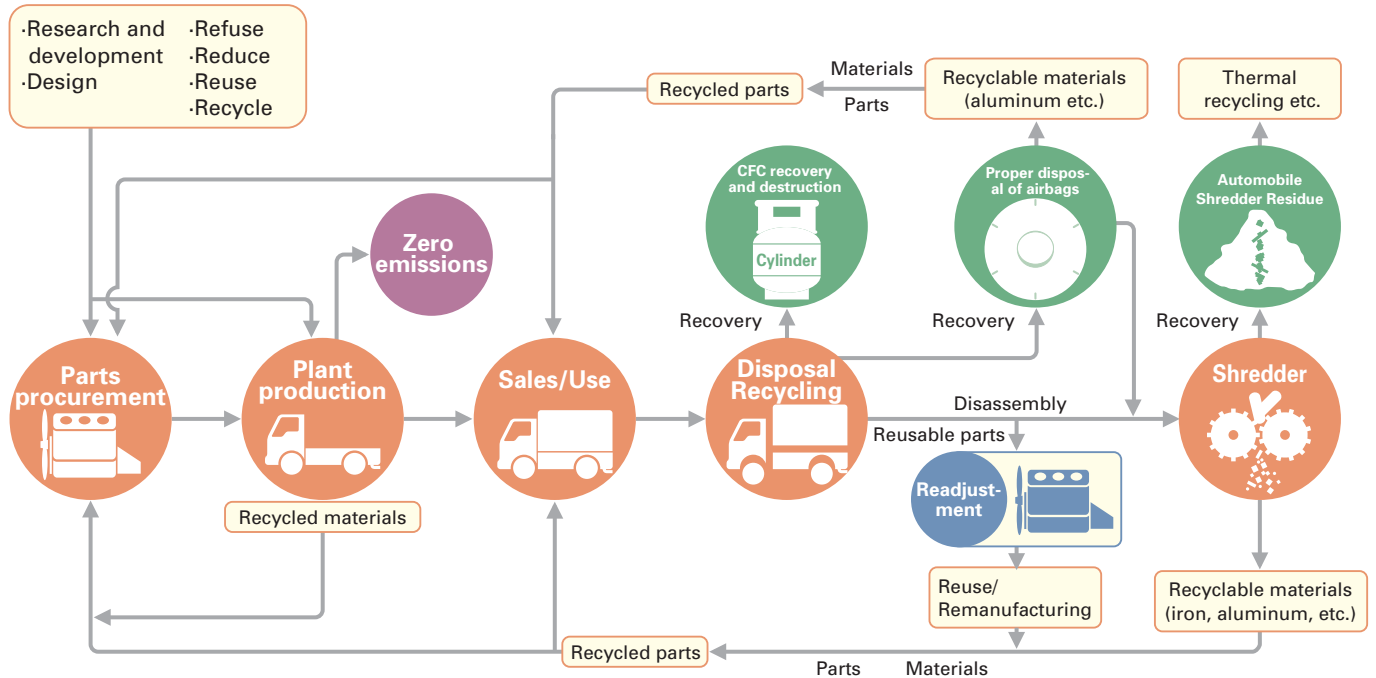
Isuzu is actively working to reduce our use of four major substances: lead, hexavalent chromium, cadmium and mercury. To accomplish the specific goals we established in fiscal 2001 for each model and type of equipment we produce, we are working at a gradual phase-out with the cooperation of our suppliers.

For examples of actual reductions we achieved, please refer to pages 16 and 17; for details of the cooperation our suppliers, please see page 23.

Lead	Reduce amount used to one-tenth or less (one quarter or less for large vehicles) of 1996 levels by 2006.
Hexavalent chromium	Gradual phase-out of use in new vehicles between 2003 and 2008.
Cadmium	Gradual phase-out of use in new vehicles between 2003 and 2007.
Mercury	Complete phase-out in new models after January 2005, when the Automobile Recycling Law will go into effect, excluding some lighting equipment and indicator devices.

Recycling Initiatives

Vehicle Life Cycle



Concept of Vehicle Recycling

● Preparing for Complying with the Automobile Recycling Law

In Japan, the basic law concerning the promotion of establishing the recycling-based society went into force in June 2000, the recycled resource use promotion law as amended went into force in April 2001, the CFC recovery and destruction law was formulated in June 2001 (went into force in October 2002 for air conditioners for vehicles), and the automobile recycling law was formulated in July 2002 and will become effective in January 2005. As legislation pays increasing attention to issues relating to recycling, the expectations for manufacturers to respond grow steadily. Isuzu and its group companies are working in preparation for complying with the Automobile Recycling Law. As the handling of vehicles at the end of their useful life becomes a growing concern in society, not only in Japan but in Europe as well, automobile manufacturers face a growing role in addressing this issue. Through technology and information exchanges with the GM Group manufacturers on recycling, Isuzu is actively working from a global perspective to improve recycling technology. We will continue our extensive cooperation with environment-related industries and other industrial sectors. We feel a civic and moral duty to be a company that seriously observes all present and future regulations on vehicle recycling and truly fosters a recycling-based society.

● Recycling Initiatives throughout the Vehicle Life Cycle

We divide a vehicle's life cycle into four stages — research and development, manufacturing, use, and end-of-use phases, — and are carrying out research to promote recycling. We will keep a global viewpoint as we study easily-recyclable materials, designs that allow easy dismantling, and the proper processing of the substances released during dismantling and recycling.

Our Voluntary Action Plan

Isuzu has established a voluntary action plan with specific targets and guidelines in compliance with the "Voluntary Action Plan for Vehicle Recycling Initiatives" and the "Reducing the Use of Substances with Environmental Impact — JAMA Voluntary Initiatives," both formulated by the Japan Automobile Manufacturers Association, the EU-ELV Directive, and other regulations. We are working to reduce the use of substances with environmental impact and improve recyclability in new vehicle models, and to promote the proper processing and recycling of vehicles at the end of their lives.

In April 2003, we organized the "Recycle Promotion Group" in the Sales Promotion Dept., in preparation for complying with the Automobile Recycling Law. Its responsibilities include contacting with regulatory authorities, arranging in-house organizations, working with recycling companies, and holding explanatory seminars.

● Improving Recyclability Rates

In fiscal 2001, Isuzu accomplished the goal of boosting the recyclability of new vehicles to over 90% for all vehicles it produced (calculated by Isuzu's independent criteria, on a weight basis) on and after 2002. We will work to achieve further improvements, including improved dismantlability of vehicles and optimization of materials. Our next goal is to boost the recyclability to over 95% for new vehicles by fiscal 2015.

● Reducing the Use of Substances with Environmental Impact

We have formulated a voluntary plan for reducing and phasing-out the use of lead, hexavalent chromium, mercury and cadmium, as well as air conditioner refrigerants, based on the respective targets. We were able to develop an alternative material to replace lead; it is already used in new vehicles and new equipment. In the new 10-tonne model we launched in June 2003, we achieved the 2005 goal of reducing the use of lead in new vehicles to one-third or less of the fiscal 1996 level or less. We will work to achieve further cuts in the use of lead, and to completely phase-out hexavalent chromium, mercury and cadmium.

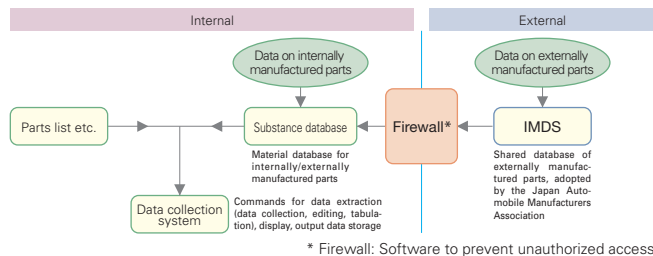
Recycling Initiatives

Initiatives at the Research and Development Phase

Chemical Substance Control System

Isuzu started in 1998 to research the ease of dismantling its vehicles and recycling the materials. We evaluated the recyclability rate of each vehicle from the standpoint of the workers dismantling, including such aspects as the ease of removing fuel and oil, ease of removing the parts that should be removed first, and the readability of markings to help identify the materials. Our findings were used to make suggestions to improve new vehicle design. We also started operating the International Material Data System (IMDS), a globally introduced and operated system developed in Europe, in order to build a database for materials and chemical substances used in vehicle components. This database keeps track of which materials and substances are used in which amounts in each vehicle.

Chemical Substance Management System (Future Environmental Management System)



Initiatives at the Engineering and Manufacturing Phases

Training Engineers

To facilitate vehicle engineering that ensured easy recycling, Isuzu is providing actual practice training programs for engine and vehicle on vehicle dismantlability and optimization of materials. Isuzu has introduced ISO 14001 to its Engineering departments, and is providing on-the-job training for their members, with an emphasis on vehicle design that enables easy recycling of vehicles, as part of our ISO 14001 environmental management system.

Reducing the Use of Substances with Environmental Impact

We made our internally manufactured components and major externally manufactured components lead-free paint by August 2003. After many cycles of trial-and-error investigations, we were able to develop alternative rust- and weather resistant pigments and top-coat color pigments, with all the appropriate properties. We also repeated a variety of trials to determine the best painting and drying conditions for the painting process. We will complete the shift to lead-free paint, for a totally lead-free product line by the end of 2004. Other initiatives include phasing out the use of lead in battery cable terminals and fuel tanks for the GIGA series heavy-duty trucks and other vehicles, and a shift to cadmium-free wax for brazing of SUS stainless steel pipes in some parts that had required this heavy metal. For vehicles to be released to EU countries, we began using lead-free vinyl chloride or rubber parts and hexavalent chromium-free surface-treated steel plates.

Developing Applications of Recyclable Materials

Isuzu has expanded the applications of recyclable resins and alternatives for South Sea lumber to vehicle parts. Specific efforts include the collection of used plastic bumpers and waste plastics from the molding process for



Training on Actual Practice

use in wheel well liners, and a shift to steel cargo deck joists. We will go towards shifting to Scandinavian birch lumber and Japanese cypress lumber from thinning as alternatives for South Sea lumber. We believe these initiatives are important in reducing our environmental impacts because the cargo decks of commercial vehicles have traditionally been made of a large volume of South Sea lumber.

Recycling Initiatives at the Disposal Phase

Legal Compliance

Following the entry into force of the CFC Recovery and Destruction Law in Japan, starting on October 1 of 2002, vehicle manufacturers are required to completely recover and destroy CFCs in used automobile air-conditioners. As a member of the Japan Automobile Manufacturers Association, Isuzu has worked to establish an automotive CFC recovery and destruction system as part of a project sponsored by the Japan Automobile Recycling Promotion Center. Prior to starting the system, we entered a subcontracting agreement with the Japan Automobile Recycling Promotion Center. We are working to secure the recovery and destruction of automotive CFCs from our vehicles.

The Automobile Recycling Law, which will go into effect in January 2005, covers airbags and shredder dust, as well as CFCs. We hold explanatory seminars for the concerned companies and in our company. We are making proactive efforts to secure complying with the Automobile Recycling Law and to improve the recycling rate, with relevant issues discussed by experts from individual departments.

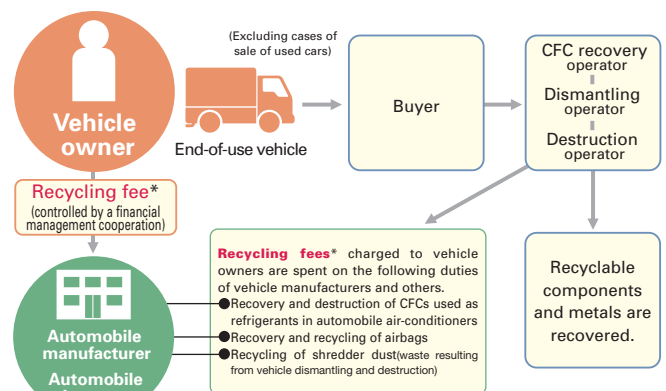
Initiatives for Reuse and Remanufacturing

To promote the reuse of parts from vehicles at the end of their useful life, our domestic sales division is linked with the domestic dealers through an intranet network called "Remani Net" (Remanufacturing Network). Through this network, we exchange information concerning unnecessary and reusable parts in dealer stock and, in order to use them more efficiently. Items posted to the system range from remanufactured diesel engines to powertrain components and other parts. In fiscal 2002, we sold 433 units of remanufactured diesel engines. We will work to promote its utilization, moving toward being a recycling-based society.



Powertrain components collected for reuse

Vehicle Recycling System Complying with the Automobile Recycling Law



Takes responsibility

Sources: Japan's Ministry of Economy, Trade and Industry, and Ministry of the Environment

* Recycling fees collected are securely managed, with high transparency and public accessibility, at a third party finance management cooperation designated by Japan's national government, until they are spent. As a general rule, the Automobile Recycling Law covers all models of four-wheeled vehicles, including heavy-duty and commercial vehicles such as trucks and buses.