Chapter 12
Efforts to Reduce CO_2 Emissions in the Japanese Automobile Recycling Industry

Sosho Kitajima and Hiroshi Onoda

Abstract A CO_2 reduction program "Green Point Club", researched and developed by Waseda University and Japan Automobile Parts Recyclers Association (JAPRA), was announced in 2007 as a groundbreaking effort that has been developed to add a new "Environmental Contribution Index" to recycling parts. With the momentum of CO_2 reduction such as abnormal temperature increasing, we promoted the use of recycled parts of vehicles will help to reduce the CO_2 reduction effect. In this study, we summarize the CO_2 reduction figures from using recycled parts in the past 10 years in Japan and verified it. We would like to the spread the method such as cooperation with the administration, information exchange with foreign countries, point return etc. and aim at further usage expansion.

Keywords CO_2 · Automobile · Used auto parts

12.1 Introduction

It will be 15 years in 2020 since the enactment of the "Act on Recycling, etc. of End-of-Life Vehicles" (Automobile Recycling Law). This effort is evaluated as "generally going well" by report on the evaluation and examination of the enforcement status of the automobile recycling system of the Industrial Structure Council of the Ministry of Economy, Trade and Industry in Japan on September 2015. However, as a result of the China's movement of import restrictions on waste materials including waste plastics since Autumn 2018, industrial wastes that had been exported overseas other than automobiles have been concentrated in domestic shredding and sorting yards, causing delays in the collection of dismantled end-of-life vehicles for their final disposal. Apart from scrap business, which has a major impact on economic trends and social responses, the factor that contribute to the profit stabilization in car dismantling businesses is selling of recycled auto parts. In Japan, since Bigwave's predecessor was launched in 1979, the sales of recycled parts in the automobile aftermarket has been

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increased. In the 1980s, grouping was promoted to improve "distribution effects", which include an increase in the delivery rate of recycled parts and an increase in shipment volume. Amid this movement, the business has grown steadily. However, since enactment of the Automobile Recycling Law, it has become impossible for automobile dismantlers to emphasize "low price" that is the biggest benefactor to expand distribution of recycled parts, due to increased costs for facilities and other factors. In addition, while "recycled parts are good for the environment", exactly what is good was unclear, and it was impossible to clearly differentiate recycled parts from new parts or external parts.

Under such circumstances, in cooperation with Nagata Laboratory in the Faculty of Science and Engineering, Waseda University, LCA (Life Cycle Assessment) method, which quantitatively evaluates the level of "environmental friendliness" of recycled parts (especially reuse parts), was developed in 2001. This method presents a new evaluation axis that is not just the amount of money. Also, it has become possible to send easily understandable messages to society by developing and operating an "environmental load evaluation system" that is applied to the use of auto recycled parts, through industry-academia collaborations.

In nine years after the deployment of this "environmental load evaluation system", CO_2 has been reduced by about 1,273,000 t-CO_2 or more. In this report, the history from the development to the current trend of a CO_2 reduction program named as "Green Point System" is described. Its environmental load evaluation system has been used and worked on by many auto recycled parts sales networks in Japan, such as JARA and JAPRA, which are deemed to be representing these networks.

12.2 Automobile Recycling Law

The past situation of recycling of end-of-life vehicles (as of 2002).

Approximately 4 million end-of-life vehicles are generated in Japan every year (approximately 5 million when exported used cars are included), Since these cars were valuable as resources as they are made from useful metals and parts, recycling was carried out in the course of distribution (buying & selling) by dismantling, shredding and sorting operators. While the recycling rate of end-of-life vehicles was not low with about 80%, the landfill sites for treating ASR (Automobile Shredder Residue) that is left behind after metals and parts are recycled became tight. Also, due to the price drop of iron scrap and application of reverse charge (the situation where car users are required to bear the processing cost when handing over their end-of-life vehicles to the operator), concerns over illegal dumping and improper disposal of end-of-life vehicles arose. In addition, no real progress had been seen in the proper destruction of air conditioner refrigerants (fluorocarbons), which affect global warming, and appropriate disposal of airbags, which requires specialized techniques (Japan Automobile Recycling Promotion Center 2019a). Also, there were the following problems in the recycling of end-of-life vehicles

- Contamination of soil, groundwater, etc. due to outflow of harmful substances from illegally dumped end-of-life vehicles
- Destruction of the ozone layer and change of the ecosystem caused by fluorocarbons that have been released into the air due to improper treatment
- Specialized techniques are required for safe processing of airbags and seat belt pretensioners (collectively, referred to as "airbags") for the protection of passengers from the impact of a collision.
- Most of the shredder dust is landfilled as waste.

To address these problems, as the fifth individual law based on the "Basic Law for Establishing a Recycling-based Society", the Act on Recycling, etc. of End-of-Life Vehicles ("Automobile Recycling Law") was enacted on July 12, 2002 and enforced on January 1, 2005 (Japan Automobile Recycling Promotion Center 2019b).

12.3 Development of Auto Recycled Parts

In Japan, selling of auto recycled (used) parts started in the 1960s and this business has developed to be a very historic industry. At that time, local dealers and repairers found the same model of the vehicle they were repairing among the cars piled up at demolition shops, took the necessary parts off from those cars and bought them from the demolition shop at a low price. Started like this, this business has grown to be a market with annual sales of 200 billion yen. Such demolition shops were so-called "junkyard for stripping".

Later, in the 1980s, started from calling fellow shops to check the stock to fulfill the request of those customers who visited the yard to find the parts that were not stored there, a fax and computer system was constructed in order to collect more information and make more profit. As a result, this business saw a rapid growth, with each company increased the sales by double digit (Japan Automobile Recycling Promotion Center 2010a).

12.4 Launch of Japan Automotive Parts Recyclers Association (JAPRA)

In November 1995, Japan Automotive Parts Recyclers Association was launched after the preparation of the foundation started from 1992 by the persons related to the industry group, for the purpose of broadly contributing to society by responding to the national request for the effective use of resources, environmental protection and continuous supply of high-quality, inexpensive recycled parts to the users through the widespread use and sound transactions of recycled parts for auto repairs based on the "Law concerning the Promotion of Reclaimed Resources Utilization" and the "Environmental Basic Law".

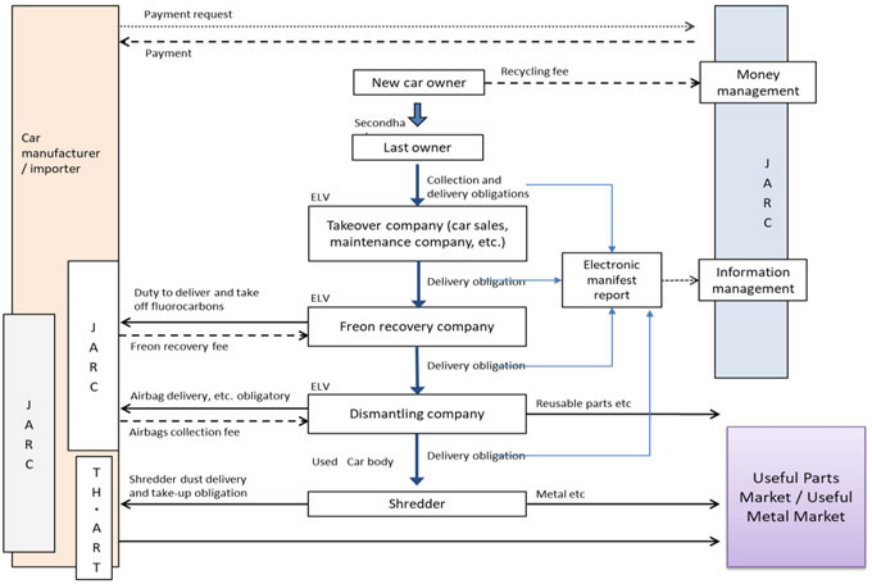

Fig. 12.1 Concept of the automobile recycling law (*Source* Ministry of the Environment HP)

Currently, 12 groups including JAPRA, SAP, NGP and JARA and more than 500 companies are the members of this association, collaborating in the industry (Fig. 12.1).

Since the announcement of the automobile recycling initiative by the Ministry of Economy (currently, the Ministry of Economy, Trade and Industry) in May 1997, these organizations have been advocating that the very promotion of use of "recycled parts" including "reuse parts" is a major factor to increase the automobile recycling rate and acting in line with it. In particular, the industry standardizes quality standards and warranty standards that were scattered throughout the group.

12.5 Background for the Development of Green Point System

It has been long since the dealing of "auto recycled parts" started. With the development of domestic motorization since the 1970s, the number of end-of-life vehicles has increased and social awareness on "environmental problem" and "pollution problem" has risen. In such a situation, the related "Waste Disposal & Public Cleaning Law" has been largely revised, and the "Automobile Recycling Law" was enacted in 2002, implemented in January 2005.

As a result, "dismantling business" has become subject to a permit system, and the "dismantling activities" in the places other than the factory facilities approved

by law have been prohibited. Gradually, the name of "environmental industry" has come to be crowned to the business.

However, basically the work process has not been changed, where end-of-life vehicles go through the "liquid removal process" for waste oil & liquids, "flon and air bag disposal process", and finally proceed to the "part removal process". The useful parts removed are "commercialized" after inspection and cleaning, and reused as "recycled parts". This process is "reuse and recycling of products" in terms of "resource saving" and "energy saving", and unmistakably it "eliminates wasteful consumption of resources and energy". That is, "recycled parts are the products friendly to the global environment". Based on this concept, the General Insurance Association of Japan is promoting widespread use of recycled parts.

The concept is understandable somehow as an image, however, there was no ground to answer the question of what truly proves "earth-friendly".

In March 2001, clear expressions of "environmental friendliness" with "numerical figures" was enabled by the LCA method researched by Professor Katsuya NAGATA and Hiroshi ONODA (the author of this report) in Nagata laboratory in the Faculty of Science and Engineering, Waseda University.

In 2003, the implementation plan for the research on "the system to expand the use of reuse & rebuilt parts" was presented by Waseda University. The first-year plan was "to practice environmental load evaluation of reuse parts". After the basic research, (1) investigation and evaluation on highly-demanded parts, (2) sophistication of the evaluation method based on the more detailed data, (3) expansion of target auto models to be evaluated, and (4) effective method of using the results of environmental load evaluation were considered to create a prototype of the current Green Point System.

Under these circumstances, the research based on "disassembly and measurement" was started by the Waseda University Environmental Research Institute in 2005 at U-PARTS for small-car parts, and at Kyoei Jikou (Edogawa, Tokyo) and at Kanazawa Shokai (Saitama Plant) for large-car parts. Indexing of the effect of the using of reuse parts in CO_2 emission reduction completed in 2007. In May 2007, a joint press conference was held by Waseda University and Automotive Parts Recyclers Association (one company) after the demonstration of 90% or more of CO_2 emission reduction effect of reuse parts compared to new parts. "This result could be a guide for promoting the use of reuse parts", they stated in the press conference (Japan Automobile Recycling Promotion Center 2010b).

12.6 Usage Status of Green Point System

12.6.1 Operational Deployment

Since December 2007, named as "Green Point System", and the user group using this system as "Green Point Club", this system has been supervised and operated by Japan Automotive Parts Recyclers Association.

As of 2009, Green Point Club was consisted of 12 groups and 530 companies. The number of the parts sold each month by these members to repair shops is converted to the equivalent of CO_2 reduction amount and published. In fiscal 2008, 3,324,000 parts were sold with CO_2 reduction effect of as much as 160,000 tons.

Also, the number of target items has been increased to 475 from the initial number of 40 at the time of development of the system. The columns to enter CO_2 reduction figure is provided for each product on the invoices for sold parts issued by the members. The figures are automatically recorded to provide the customer with the information of environmental contribution effect (Japan Automobile Recycling Promotion Center 2010c).

12.6.2 System Overview

Green Point System overview is provided in Fig. 12.2. The items in the master data for names and components of those parts used by each auto recycled parts network were unified and standardized. These data are linked to the CO_2 data server on the part of Waseda University for analysis. Also, CO_2 reduction figures can be calculated based on the sales data for each customer. The calculation results can be output into a PDF or CSV file in a fixed format for Green Point Club. The member companies input their respective figures on the invoice for sold parts issued for each customer so that the repair shop (customer) can check CO_2 reduction figures with the invoiced prices of recycled parts purchased from the member.

In addition, each recycled parts network has customized the system in accordance with their respective purpose to increase the convenience (Fig. 12.3).

12.6.3 Evaluation Method for CO_2 Reduction Figure

In Green Point System, the following numerical evaluation method is applied

(1) Evaluation scenario

The difference between environmental load of the new part and environmental load of the reuse part is quantified as the CO_2 reduction effect of the part.

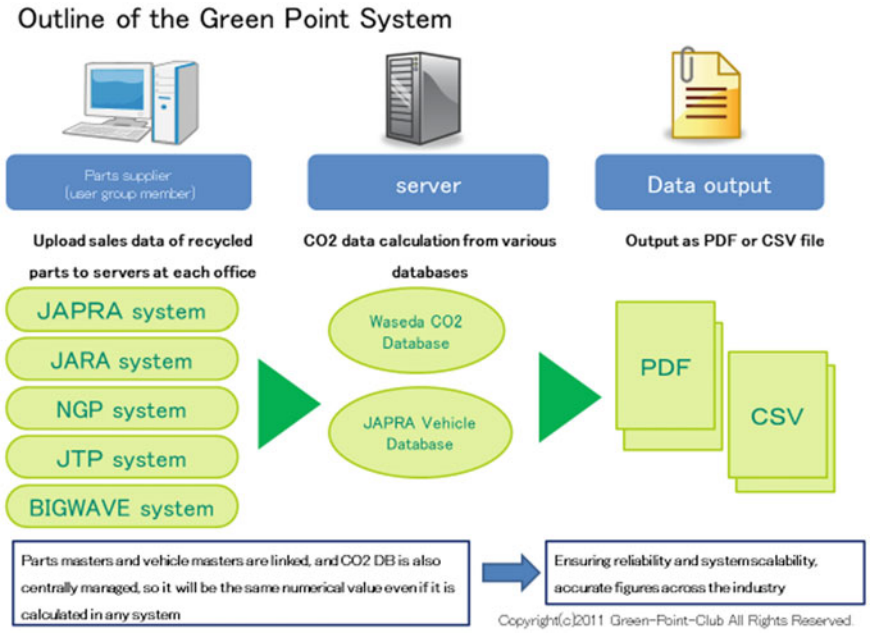

Fig. 12.2 Outline of the green point system (*Source* Greenpoint Club-JAPRA)

(2) Basis of environmental contribution points

CO_2 emissions of the new part − CO_2 emissions of the reuse part = CO_2 emissions that may be reduced by using the reuse part.

12.6.3.1 Evaluation Scenario of Reuse-Parts

Figure 12.4 shows the process of new parts and reuse-parts manufacturing. The ELVs are trucked to Automobile dismantlers to be dismantled. They retrieve trouble-free parts and market after quality checking. In this reuse parts manufacturing process, transportation fuel and energies in dismantling are consumed. Meanwhile, in original system, a new part manufacturing, new resources in new materials and energies in parts manufacturing are consumed.

Therefore, the CO_2 reduction effect of the reuse parts is given by the following equation;

$$R_{X\,reuse} = (Ev + E_M) - (E_T + E_D) \tag{12.1}$$

where CO_2 reduction effect of a reuse parts X is expressed as R_{Xreuse}; CO_2 emissions from producing virgin materials is expressed as E_V, CO_2 emissions from parts

TO: ABC Body shop

Date: 2018-10-31

Automotive Recycled Parts CO2 Reduction Contribution Report

Ver.0908

Date	Parts	Category	Car Name	Model	Qty	CO2 Reduction amount(KgCO2)
10/1	Front bumper	Used	Life	JA4	1	324.0
10/5	L-Head lump	Used	Estima	ACR55W	1	123.0
10/5	L-Front Brake caliper	Used	Acty	HA4	1	137.0
10/6	L-Front Fender	Used	Lancer	CK2A	1	199.0
10/6	L-front Door Assy	Used	Lancer	CK2A	1	139.0
10/8	L-front Door Assy	Used	IS	GSE20	1	139.0
10/10	Bonnet food	Used	Lancer Evo	CT9A	1	159.0
10/10	Rear Gate	Used	Fit	GE6	1	87.0
10/12	AC Compressor	Used	Jeep	HYMX	1	69.0
10/12	R-Head lump	Used	Wagon-R	MC12S	1	122.0
10/15	Radiator	Used	Demio	DE3FS	1	319.0
10/16	Rear Bumper Assy	Used	Move	L900S	1	319.0
10/23	AT transmission	Used	Oddessy	RA5	1	472.0
10/26	R-Head lump	Used	Serena	C25	1	128.0
10/27	R-Front Lowerarm	Used	Serena	C25	1	122.0
	Total				15	2858.0

Member No.12345

Member Name: ABC Body shop

Street address: 0-0-0 Minato-Ku, Tokyo, Japan.

TEL: 03-0000-0000

自動車リサイクル部品の供給で地球温暖化防止に貢献

Green Point Club

Fig. 12.3 CO_2 reduction introduction sample written on the invoice of a recycling parts sales company that has been output data (*Source* Greenpoint Club-JAPRA)

manufacturing is expressed as E_M; CO_2 emissions from transport is expressed as E_T; CO_2 emissions from dismantling an ELV is expressed as E_D.

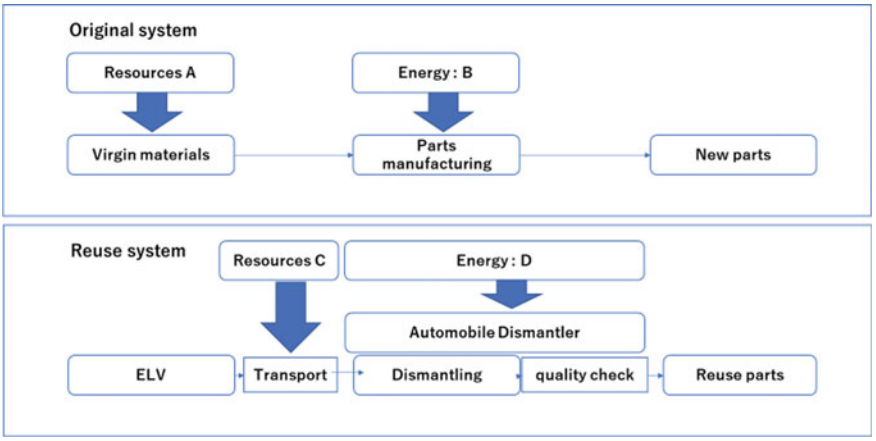

Fig. 12.4 Process of new/reuse-parts manufacturing (*Source* Waseda Environmental Institute Co., Ltd. 2011a)

12.6.3.2 Evaluation Scenario of Rebuilt-Parts

Figure 12.5 shows the process of new parts and rebuilt-parts manufacturing. The ELVs are trucked to Automobile dismantlers and trouble-free are retrieved. The parts needed locally-repaired are torn down, cleaned, replaced to new parts, and assembled once again. The original system is the same as mentioned.

Therefore, the CO_2 reduction effect of the rebuilt-part is given by the following equation;

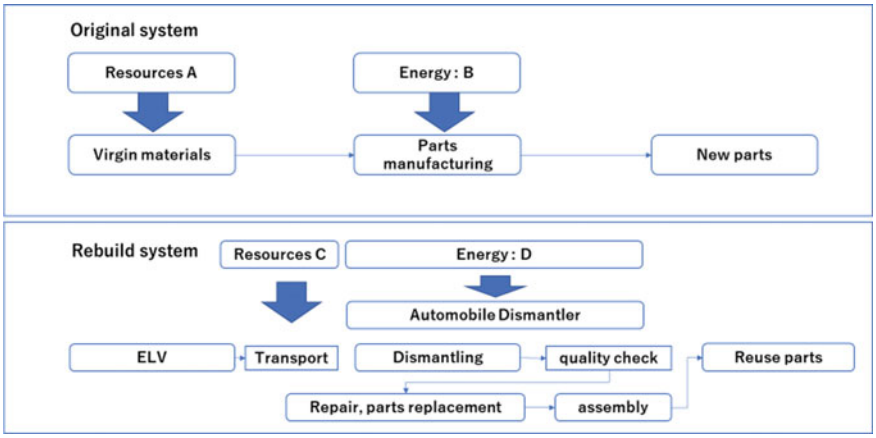

Fig. 12.5 Process of new/rebuilt parts manufacturing (*Source* Waseda Environmental Institute Co., Ltd. 2011b)

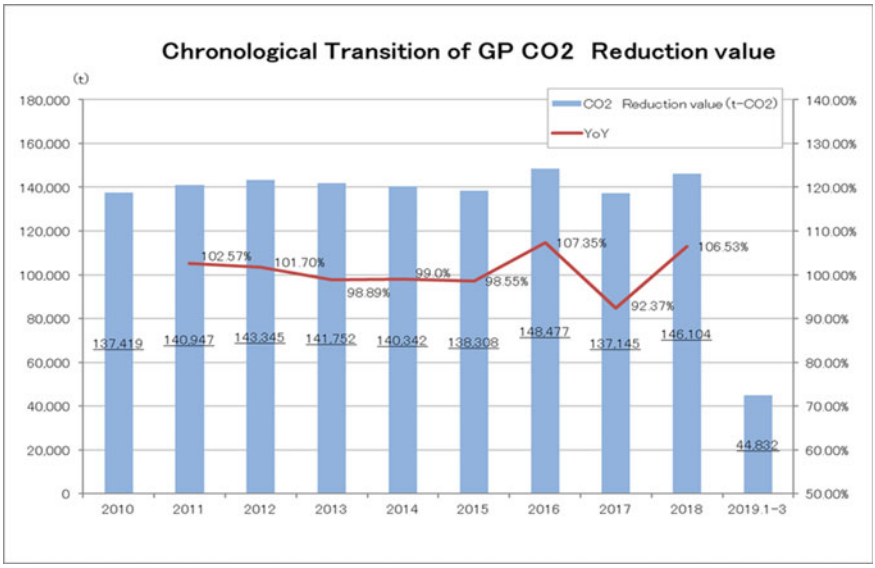

Fig. 12.6 Annual changes of CO_2 reduction figure for recycled parts (*Source* Japan Automotive Parts Recyclers Association & JARA Co.)

$$Rx_{rebuilt} = (E_V + E_M) - (E_T + E_D + E_L) \tag{12.2}$$

where CO_2 reduction effect of a part X is expressed as $R_{Xrebuilt}$; CO_2 emissions from producing a locally-repaired part is expressed as E_L (Nakajima et al. 2012).

12.6.4 Annual Changes of CO_2 Reduction Figure for Recycled Parts

The effect of Green Point System for nine years from 2010 is summarized in Fig. 12.6.

Although there is some ups and downs, the annual changes in CO_2 reduction figure has been stable, with total reduction amount of 1,273,000 t-CO_2 for nine years.

It can be said that the system has made a significant contribution to environment, which is equivalent to 90,928,500 cedar trees. The details are shown in Table 12.1.

12.7 Domestic Response

Domestically, the system has been appreciated by many administrative agencies and companies. Especially, it is highly evaluated by administrative agencies and new collaborations with the organizations using this system have been emerged, which

Table 12.1 CO_2 reduction figures of recycled parts (2010–2018)

	Unit # of sold parts	CO_2 reduction (t)	Year-on-year
2010	3,430,719	137,419	
2011	3,438,252	140,947	102%
2012	3,554,781	143,345	101%
2013	3,573,453	141,752	99%
2014	3,578,607	140,342	99%
2015	3,512,423	138,308	99%
2016	3,444,228	148,477	107%
2017	3,105,215	137,145	92%
2018	2,784,495	146,104	107%
	30,422,173	1,273,839	

Source Japan Automotive Parts Recyclers Association & JARA Co.

include the partnership in the application of reuse parts for the repairing of city official vehicles (Kumagaya City, Saitama Prefecture).

Also, some companies convert the reduction figures into points for collaboration and donation.

Many member companies selling auto recycled parts have created plates and distributed them to their customers (i.e. repair shops) to enable those customers to represent themselves as "a company contributing to CO_2 reduction" by placing it on the reception counter or desk to draw attention to their activities and improve their image as an environmentally friendly company. In addition, as an enlightenment measure for automobile users, we would like to focus on sharing the environmental contribution of automobile recycling parts with non-life insurance companies.

12.8 Response from Overseas

Since its launch, "Green Point System" has been presented as "a new movement in Japan" at international conferences.

When presented at the International Roundtable on Auto Recycling (IRT) held in Liverpool, England in June 2012, the system attracted considerable interests from automobile recycling bodies and companies in Sweden, United States, Canada, Australia, etc., and joint use of the system has been suggested from Australia. Recently, the interest in the system is growing among Chinese companies. They have expressed the desire to use the Japanese system itself.

In the situation where greenhouse gas reduction activities are attracting global attention, the use of this very effective system to grasp the figures related to automobile recycling is expected to be considered with the introduction of automobile recycling scheme in those countries where such scheme has not been introduced, and the needs for the system will increase further.

12.9 Conclusions and Future Outlook

Since the start of Green Point System initiative, inquiries from interested companies have been increased. Previously it was only image-oriented educational activities. Now, the specific figures issued by this system are cited in CSR or other reports of companies and administrative agencies. These organizations have established a new status by the use of auto recycled parts.

The recycled parts on which the Green Point is attached increase its appeal as a product. There is many more potentials in Green Point System, which include;

- Visualization of reduction of the CO_2 emissions caused by the disposal of each end-of-life car
- Visualization of reduction of the CO_2 emissions caused by the processes such as dismantling and removal of parts in the whole factory
- Creating various donation systems using Green Point numbers
- Survey and report on CO_2 figures of used parts exported.

Another potential in this Green Point System is the coordination with other various point systems, which is expected to be an important mean for enlightening activities targeting general users in the future.

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