

The Recycling of End-of-Life Vehicles(ELVs) in Taiwan

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Abstract

The overall area of Taiwan is 36,006 km² and population was about 22,535,000 persons in 2003. The population density became 625persons/km². The economic of Taiwan progress since 1970. Gross national production in 2004 increased by 2.3 trillion or 493% relative to 1981. The number of automobiles in 1981 was 821,862, and increase to 6,389,186 in 2004. The number of motorcycles in 1981 were 4,591,547 and increase to 12,793,950 in 2004. The vehicle growth rate of automobile and motorcycle was 677% and 178% respectively. The recycling end-of-life vehicles(ELVs) is specified in the Waste Disposal Act. Its main content is the system of asking the vehicle manufacturer and importing agents, who are responsible for recycling of the ELVs. The recycling task on ELVs was started initially in 1993. It is required that the manufacturers and importing agents deposit certain ratios of Waste Vehicle Disposal Fees proportional to the number of vehicle they manufacture and import into Taiwan under sales. This report will introduce the current status of ELVs recycling in Taiwan, and the future direction, as well as measures proceeding for the EPA- Fund Management Committee (RMFC) operating in the future.

Key words : End-of-Life Vehicles, Dismantling, Recycling, Taiwan

요 약

대만의 국토면적은 36,006 km² 이고 2003년 현재 인구는 대략 22,535,000명 으로써, 인구밀도는 625명/km² 에 달한다. 대만 경제는 1970년 이래로 꾸준히 발전하여 국민총생산이 2004년에는 1981년의 493%까지 증가하였다. 또한, 자동차 보유대수에 있어서도 1981년에 821,862대에서 2004년에 6,389,186대까지 증가하기에 이르렀고, 모터사이클은 1981년 4,591,547대에서 2004년 12,793,950대로 늘어났다. 이들로부터 발생하는 폐자동차 및 폐모터사이클의 리사이클링은 폐기물처리법에 의거 관리를 받고 있으며, 일차적으로 이의 생산자 혹은 수입업자가 최종 처리까지 책임을 지도록 하고 있다. 또한 이들은 일정한 비율의 부담금을 예치하도록 법으로 정하고 있다. 본 논문에서는 현재 대만에서의 폐자동차 및 폐모터사이클의 처리현황과 특히 향후 이를 관리하게 될 EPA-RMFC의 계획과 처리방향에 대하여 고찰하고자 한다.

주제어 : 폐자동차 리사이클링, 폐자동차 해체, 폐자동차 파쇄

1. INTRODUCTION

Taiwan, is an island about 160km of southeast coast of mainland China. It is separated with Fukien Province of mainland China by the Taiwan Straits. The island measures 377km long and 142 km wide at its widest point. The overall area of Taiwan is 36,006 km². The populations were about 22,535,000 persons in 2003. The population density became 625 persons/km².

The economic of Taiwan progress since 1970. In 2002, the economic growth rate of Taiwan went from -2.2% in 2001 to 3.6%, and became 3.2% in 2003, which showing the overall economy steadily stabilizing. Gross National Production(GNP) was US\$482 billion in 1981 and GNP in 2004 was increased by 2.3 trillion or 493% relative to 1981. For several decades, the strong emphasis on economic development has brought prosperity to Taiwan, at the same time, we have paid a high price in the form of environmental degradation. Our population density, vehicle density, and factory density all rank among the

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highest in the world. The number of automobiles in 1981 was 821,862, and increase to 6,389,186 in 2004. The number of motorcycles in 1981 was 4,591,547 and increase to 12,793,950 in 2004. The vehicle growth rates of automobiles and motorcycles were 677% and 178%, respectively.

The recycling of ELVs is specified in the Waste Disposal Act. Its main content is the system of asking the vehicle manufacturer and importing agents, who are responsible for recycling the waste vehicle. The recycling task on the ELVs was started initially in 1993. It is required that the manufacturers and importing agents deposit certain ratios of Waste Vehicle Disposal Fees proportional to the number of vehicles they manufacture and import into Taiwan under sales. The fees are under EPA-Recycling Fund Management Committee (RFMC), who use it to pay the recycling cost, the cost of assisting and rewarding the recycling system, the regeneration cost, the handling charges of the ELVs made by the official executing units, the audit certifying cost paid to third party associated by justified groups, and other policies relevant to the recycling purpose. This system has been implemented for more than ten years, and the legal system has been updated several times compliant with the recycling policy of other recyclable wastes. It has acquired the emphasis on public opinion and international and local environmental protection sense, making the legal system mature gradually. This report will introduce the current status of waste vehicle recycling in Taiwan and the future direction, as well as measures proceeding for the EPA- RMFC operating in the future.

2. HISTORY OF WASTE DISPOSAL ACT

Due to Taiwan's high population density, waste management has been a serious problem. The first version of Waste Disposal Act was announced in 1974. The environmental hygiene is the very first concern of this Act. Then, as the time goes by, eight times of amendments have achieved till now. First amendment was done by intensifying the penalty of illegal disposal in 1980. In 1985, the Second amendment was revised all 36 articles. Third amendment was added the responsibility of enterprise to treat non-degradable and

hazardous waste in 1988. Fourth amendment was focused on recyclable item has to be recycled mandatory by Recycling Management Fund in 1997. Two years later, the Fifth Amendment was assured the responsibility of local implementing agency to conduct the recycling. The next year was amended due to the change of governing system. In 2001, the Seventh amendment was revised all 77 articles to increase the compulsory management of response agency for industrial at central government level to treat or recycle the general waste and industrial waste. The final amendment was done in 2004 for the revision of article 51. This article emphasizes for noncompliance penalty will increase the penalty and suspend the operation for violating the prohibition or restriction of manufacturing, importation, sale and use of articles or their packaging and containers that may cause serious pollution to the environment.

In coordination with last year's revision (2004) of the Waste Disposal Act, the EPA has drafted revisions to the various methods and facilities standards for the recycling, storage, clearance and disposal of a number of waste items that are required to be recycled, including motor vehicles, tires, lubricating oil and lead acid batteries. These revisions provide specific standards for recycling enterprises to follow so as to prevent the creation of secondary pollution through the recycling process. These draft revisions state that the primary disposal methods for end-of-life vehicles should be dismantling and separation through crushing and shredding, unless the EPA designates otherwise. Dismantling plants should possess Freon recovery equipments and Freon storage tanks. Storage methods for gasoline, motor oil, tires and batteries recovered from end-of-life vehicles should comply with the relevant method and facilities standards for the recycling, clearance and disposal of recyclable items. Auto body parts recovered through dismantling are required to be crushed and shredded and then separated before they are sent to electric arc furnace steel smelters. By removing non-metals, this process can reduce the amount of dioxin produced through the smelting process. The recycling/reuse rate achieved by this separation process would not be permitted to be lower than 60%.

3. RECYCLE FRAME AND SYSTEM

3.1. History of Recycling Fund Management

Assessed against the degree of government intervention, there are four stages of control of Taiwan's waste recycling system. The first stage covers the period prior to 1988 and is characterized by market-driven recycling initiatives. The second stage commenced with the Waste Disposal Act Amendments of 1988, which infused the existing recycling regime with government-imposed producer responsibilities, and ended with the Waste Disposal Act Amendments of 1997. During the second stage, manufacturers, importers, and sellers of government-designated products were responsible for recycling post-consumer products. At this time, the Taiwan EPA's role was to audit the success of manufacturer, importer, and seller recycling programs. The third stage followed the Waste Disposal Act Amendments of 1997, when EPA established eight third parties managed recycling funds, into which manufacturers and/or importers whose products were covered by the Act paid recycling fees to fund collection and recycling activities. Eight fund management committees (Table 1) were responsible for administering the funds and related collection and recycling activities. The fourth stage commenced in July 1998, when EPA transferred management responsibility for these funds to a centralized, government body under EPA, the Recycling Fund Management Committee.

The Waste Disposal Act, as it existed after the 1988 Amendments, represents Taiwan's first law imposing extended producer responsibility on manufacturers, importers, and sellers of an expanding array of consumer products. Article 10-1 of this version of the Waste Disposal Act provides that manufacturers, importers and sellers of articles, packaging, or containers, which after consumption may produce waste and seriously pollute the environment, shall be responsible for the collection and treatment thereof if such waste is not easily cleared away or treated; contains components that are not readily biodegradable; or contains hazardous substances.

The categories of wastes and scope of industries covered by the above Section are designated by EPA; rules for collecting and treating of each type of general waste are promulgated by EPA in consultation with

Responsible Agency for the Enterprise Associated with the Industry at Issue at the central government level. Article 23-1 of the Act provides that for violations of Article 10-1, a penalty of between NT\$ 60,000 and NT\$ 150,000 shall be imposed and an order for compliance within a specified time period shall be issued and, if the violation continues after the end of the specified time period, then continuous daily fines shall be imposed. Under the Act, EPA listed 16 items subject to the Act's producer responsibility requirements. EPA also issued rules governing the recycling of covered items and target recycling rates for these items. As a result, the regulated industry jointly established organizations to develop recycling plans to submit to EPA for approval. The industry then implemented EPA-approved plans and reported to EPA with their achieved recycling rates. Because EPA did not have the capacity to check the achieved recycling rates reported by the industry, the recycling regime did not achieve many of the results desired by EPA. Under the regime, it also was difficult to penalize "free riders" without EPA's active involvement, further straining EPA resources. Hence, the 1997 Amendments changed the legal framework to require that manufacturers and/or importers pay the recycling fees into recycling funds. Under the 1997 Amendments, quantities of end-of-life products recycled must be certified by impartial third parties. In addition, EPA is authorized to check the quantities of items sold or imported by regulated industry members. Under such a regime, eight separate recycling funds were established. The members of the committees that manage the funds are selected by EPA. Generally speaking, 70 percent of the committee members comprise representatives from the regulated industry, and the other 30 percent are academics and other respected citizens. Under the 1997 Amendments, the regulated industry no longer manages recycling programs. In 1998, by the requests of the Legislative Yuan, EPA took the charge of managing the recycling funds. The funds became public funds and the budgets of which must be approved by the Legislative Yuan.

RFMC shall be responsible for reviewing important policies and measures on the recycling and reuse of renewable resources as drafted by the competent authority and industry competent authority and coordinating and assessing implementation and operational

Table 1. Eight Recycling Funds of 1997.

Name of the Funds	Items Covered
Containers & Dry Batteries	General Purpose Containers, Mercury-Containing Batteries
Containers of Agricultural Chemicals	Containers of Agricultural Chemicals
Vehicles	Autos, Scooters
Lead Acid Batteries	Lead Acid Batteries
Lubricants	Lubricants
Tires	Tires
Appliances	TV, Washing Machies, Air Conditioners, Refrigerators

matters as related to items stipulated in the various articles of the Source Management Chapter of this Act. The Committee shall have one chairman; which shall be the Administrator of the Environmental Protection Administration. Committee members shall be appointed for a period of two years, and shall consist of relevant government agency representatives, academics and specialists, and environmental protection group representatives. Academics and specialists and environmental protection group representatives may not constitute less than one-half of the total number of committee members. Committee members, their spouses, and their direct blood relatives shall avoid implementation and operational duties in the renewable resource recycling and reuse industries under review by the Committee during the appointment period of said member and for three years thereafter.

3.2. Waste Vehicle Recycling System

The resource recycling of ELVs has been implemented since 1993. Its main frame, through the economic market, is composed of the vehicle owner; manufacturer/importer; RFMC/Audit and Certification group; recycling operators (dismantling and crushing plant); environmental/police agency (Fig. 1). They perform the resource recycling and waste vehicle recovery. The operation and role-playing arrangement of these parties of waste vehicle recycling system are as follows:

1. Regarding vehicle owner: They have to pay the disposal fee for vehicle to manufacturer/importer when they purchase the vehicle. They will receive subsidy from EPA-RFMC when they make the declarations of unusable vehicles for recycling (NT\$3,000/vehicle for

auto, NT\$1,000/vehicle for motorcycle).

2. Regarding manufacturer/importer: They have to pay the disposal fee for vehicle to RFMC when they sale the vehicle (NT\$643~1000/vehicle for auto, NT\$250~98/vehicle for motorcycle).

3. Regarding dismantling plant: They have subsidies (administrative subsidy for auto is NT\$450~850/vehicle, for motorcycle is NT\$150~250/vehicle) when they dismantle waste vehicle from RFMC. They can bid the waste vehicle from environmental or police agency. They have to pay the vehicle owner for their declaration of unusable vehicle. Besides, they sale auto body to crushing plant and reusable parts to auto parts dealer.

4. Regarding crushing plant: They have subsidies when they crush waste auto body from RFMC. They have to pay the dismantling plant for their auto body. They sale recovered materials to ferrous metal and non-ferrous metal enterprise. Automobile Shredding Residue (ASR) will be reused or final disposal. ASR disposal subsidy is NT\$2,402~3,028/ton.

5. Regarding RFMC/Audit and Certification group: RFMC supervise the recycling system. Audit and certification group help RFMC to certify the volume of treatment by subsidized organization.

6. Regarding environmental/police agency: They collect discarded vehicles and sale waste vehicle to dismantling plant for recycling.

3.3. Distribution of Dismantling and Crushing Plants

Dismantling and crushing plant for ELVs could be approved by ROCEPA as a subsidized organization. Some of them may only have the qualification to

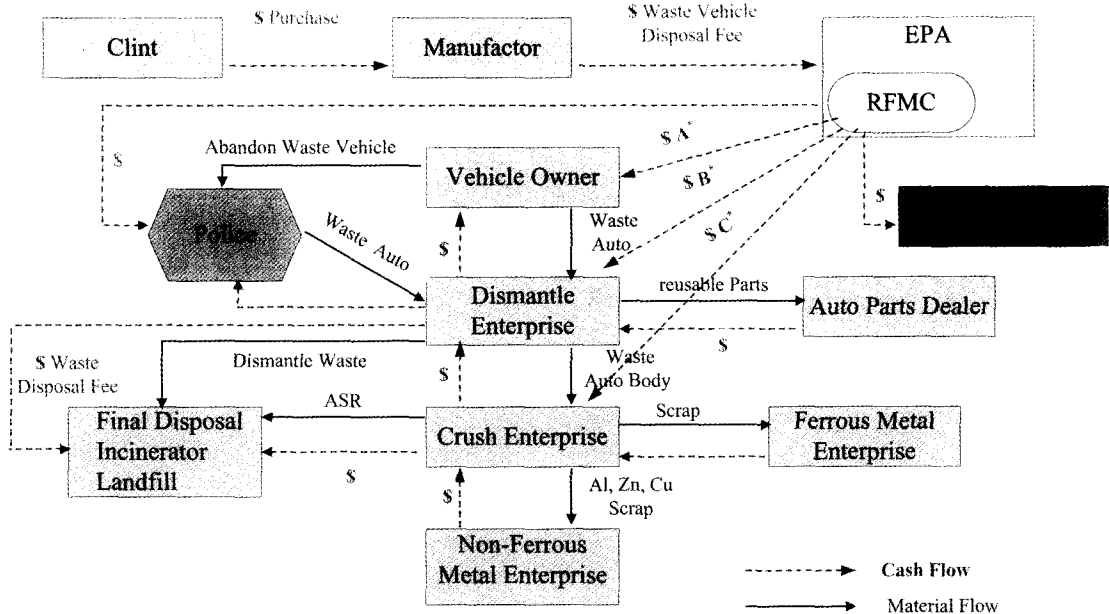


Fig. 1. ELVs Recycling System.

recycle the waste vehicle, but did not apply as a subsidized organization to get subsidy. The overall dismantling enterprises for ELVs are 192 plants in Taiwan. Among them, 147 plants become subsidized organization for waste vehicle recycling. There are three auto body crushing plants, which locate at north, central and south of Taiwan. They are all subsidized organization for waste vehicle recycling. Fig. 2 illustrates the distribution of dismantling plants and the location of three crushing plants.

3.4. Auditing and certification group

Auditing and certification group means a group selected by the EPA RFMC in accordance with procedures designated in the Government Procurement Act to implement auditing and certification of subsidized organizations. An auditing and certification group shall implement the following tasks when auditing a subsidized organization.

1. Auditing whether the operating procedures of a subsidized organization for recycling, storage, clearance and processing, etc. comply with recycling, storage, clearance and processing methods and facility standards for the waste vehicle recycling.

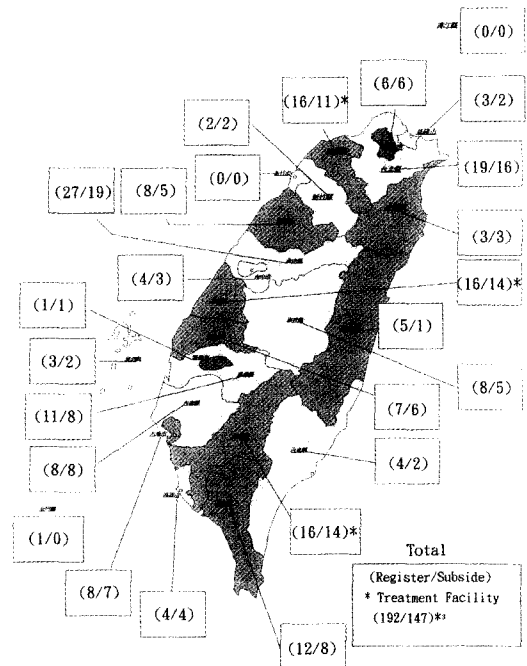


Fig. 2. Distribution of ELVs Dismantling and Crushing Plants.

2. Auditing the quantities of recovered materials and derivative waste derived from waste vehicle at the

subsidized organization, and depending on the characteristics of the waste vehicle, tracking of the source, flow direction, uses, transport distance, processing expenses, and other relevant data of the waste.

3. Auditing the receiving, production, sales, and inventory receipts, account books, and other relevant statements of the subsidized organization; other production, sales, shipping or input/output data; and inventory of waste vehicle, recovered materials, core elements and derivative waste in order to confirm audited and certified volumes.

4. Calculating the regulated waste vehicle audited and certified volume of a subsidized organization.

The auditing and certification group shall perform auditing and certification within ten working days after receiving an application from a subsidized organization concerning waste motor vehicle items.

4. WASTE VEHICLE DISMANTLING

4.1. Recycling Channel

ROCEPA implemented recycling process to cover waste vehicle. Waste vehicle can be sent through the recycling channels to recycling them. The channels include vehicle owner, environmental/police agency, and the vehicle maintenance plant(recycling operators) will come to collect waste vehicle, and then send to the

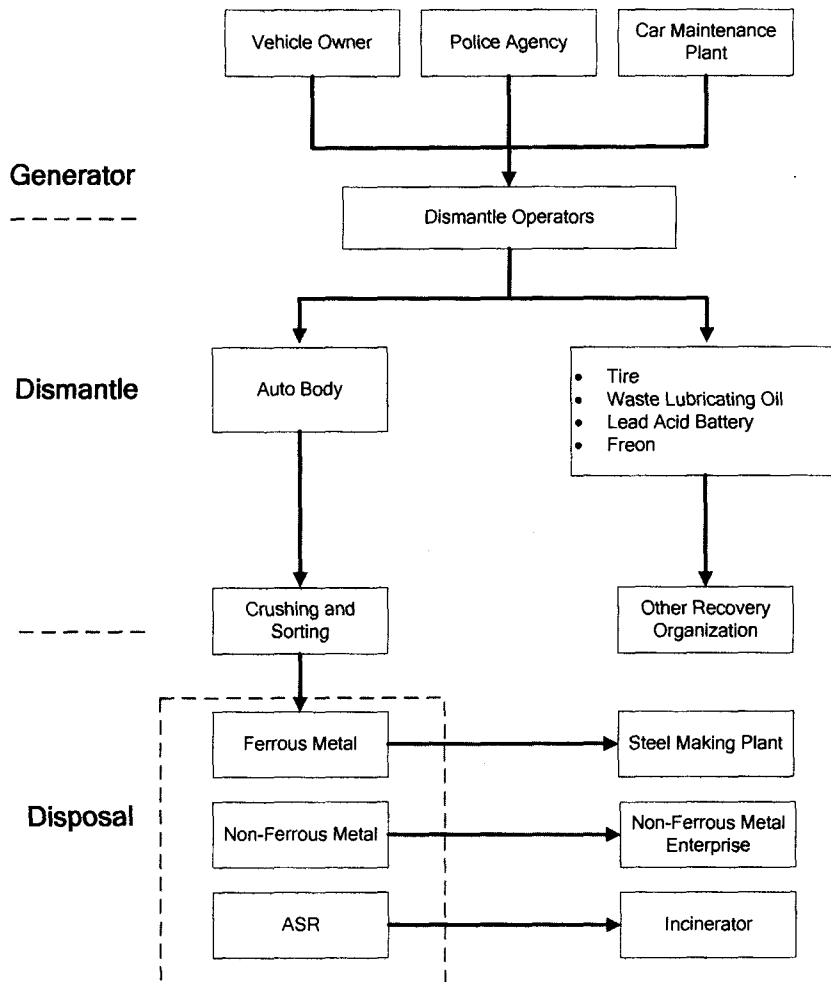
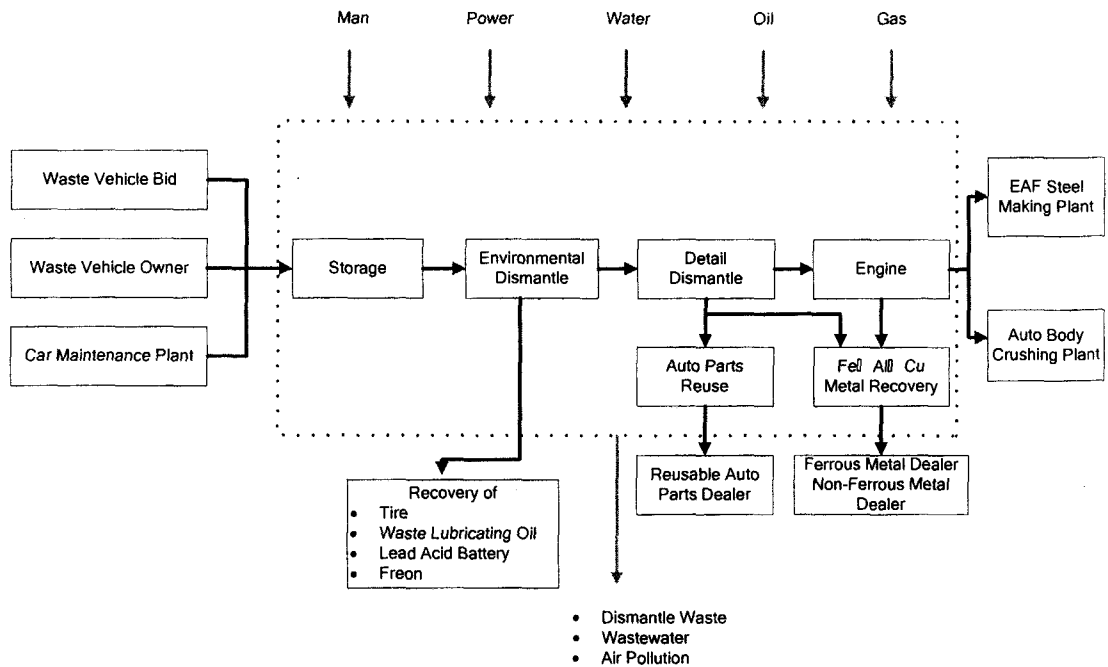


Fig. 3. Recycling Channels and Flowchart of ELVs Recycling.



Recovery Process for Waste Vehicle

Fig. 4. Recovery Process for ELVs.

treatment facilities. Currently there are 192 plants to recycle and dismantle waste vehicle. However, there are merely three companies in Taiwan dealing with the crushing auto body. The main facilities to handle and to treat these vehicles are crusher or shredder. The recycling channels and flowchart of waste vehicle recycling are illustrated in Fig. 3.

4.2. Recovery Process for ELVs

The storage will be the first step to recycle waste vehicle. It follows by the environmental dismantling. In this process (Fig. 4), several recyclable goods of secondary pollution concern have to take care first, which are tires, lubricating oil, lead acid battery, and Freon. Detail dismantling will be the next step to reuse the usable parts and other metal recovery. The final step is to recover the engine parts. Then, the auto body parts will directly go to auto body crushing plant or electronic arc furnace (EAF) steel making plant. During the recovery process, it needs the input of man, power, water, oil and gas. It will generate the

dismantling waste, wastewater and air pollution. The dismantling plant will be benefited from reusable auto parts, ferrous metal and non-ferrous metal.

4.3. Present Status and Reform

The present recycling of waste vehicle is insignificant. The ROCEPA hence has worked out some measures in response to it, and makes the recycling ratio has increased. We have listed the recycling volume in the past years, the problems and difficult points we have accounted as well as our corresponding measures in respect to them.

The operation amount, recycling amount and recycling ratio of the past three years are tabulated in Table 2. It has been more than ten years since the implementing of the full range recycles of waste vehicle. From Table 2 we learn that the recycling volume has been increased but not significant.

To effectively control public reporting of unusable cars and avoid the ensuing problems with phantom cars and jalopies pieced together from various old

Table 2. Volume of ELVs recycling.

Year	Recycling Certification of Automobile		Recycling Certification of Motorcycle	
	Estimation of Waste Automobile	Certification on Waste Automobile	Estimation of Waste Motorcycle	Certification on Waste Motorcycle
1998	332,081	52,031	920,842	134,607
1999	376,017	102,257	947,786	431,504
2000	419,169	137,668	973,995	366,034
2001	455,770	221,718	1,003,476	308,633
2002	504,491	198,024	1,397,773	344,570
2003	512,241	142,549	1,422,035	182,994
2004	511,594	155,026	1,414,876	260,741

parts, the ROCEPA has developed a project to review and reform the existing recycle, clearance and disposal system for motor vehicles declared unusable. The ROCEPA is currently engaged in preparation and in-depth discussion with the Ministry of Transportation and Communications (MOTC) regarding related measures. Any cars declared unusable should be sent to EPA/MOTC allied service counters at monitoring stations for recycling. All related procedures can be processed at the same counter. People who have legitimate reason to reclaim the vehicle under their own custody must undergo cutoff examination and receive approval before they can have their vehicle back. Such cases will be recorded and followed up on

to determine the custody status of the vehicle in order to safeguard public property rights. People who dismantle vehicles for used parts should apply with on-site certifiers for a second-hand usage permit.

5. WASTE VEHICLE CRUSHING

5.1. Recycling Process

The main recycling facilities in crushing plant include the equipment of pre-crushing, crushing, air sorting, magnetic sorting, hand sorting, and air pollution control system (Fig. 5). The crushing step divides into pre-crushing and crushing step to further shredding auto body to small pieces. Air sorting is the

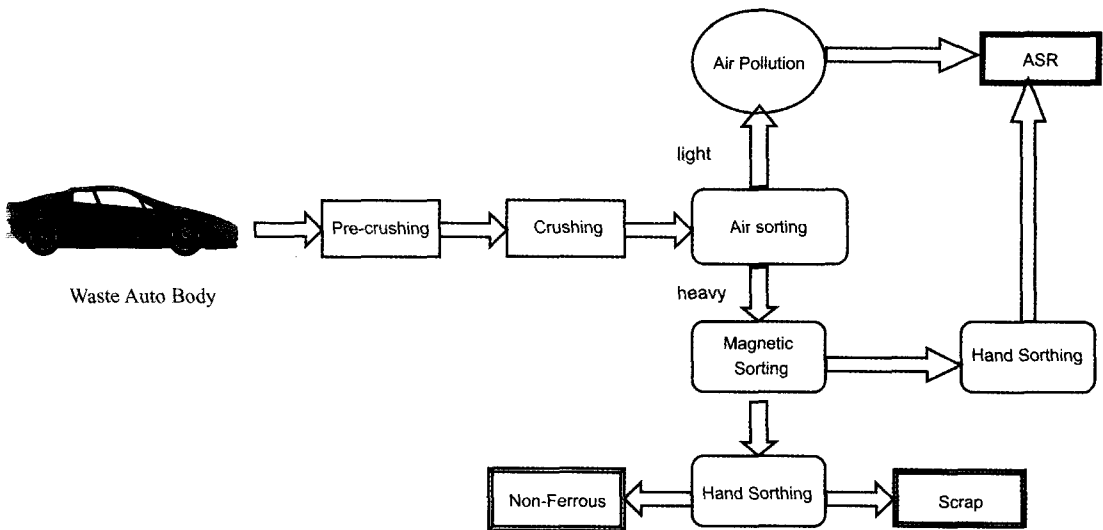


Fig. 5. ELVs crushing and sorting process.

Table 3. Volume of ELVs body crushed in crushing plant.

Unit: ton

Year	North	Central	South	Total
2001	--	--	72,792	72,792
2002	50,103	4,250	49,986	104,339
2003	47,080	32,909	42,535	122,524
Sum	97,183	37,159	165,313	299,655

Table 4. Typical amounts of input and output in crushing plant

Unit: ton

Item		INPUT(T)	OUTPUT(T)		
		Auto Body	Ferrous Metal	Non-Ferrous Metal	ASR
N	Amount	23819.11	14804.69	268.29	8343.81
	Percentage (%)	100	63.22	1.15	35.63
S	Amount	97,528,980	64,196,250	2,094,140	30,861,430
	Percentage (%)	100	66.08	2.16	31.77

Table 5. Comparison among three crushing plants.

Item	Comparison Between Crushing Plants			
	North Plant	Central Plant	South Plant	Remarks
Operation	Agency Owned Private Operation	Private	Private (Rent Land)	Different Investment Type, and same subsidy
	Fair	Good	Good	
Equipment	USA, Crusher 1,500HP 40 tons/hr	USA, Crusher 1,500HP 40 tons/hr	German, Crusher 1,250HP 40 tons/hr	
	Good	Good	Fair	
Pre-crusher	Yes Avoid gas explosion	Yes Avoid gas explosion	No Possible accident of gas explosion	Carefully check for the waste oil
	Good	Good	Poor	
Control	Computer Control	Computer Control and Manual	Mechanical Manual	Computer control could protect the equipment
	Good	Good	Fair	
Environment Certification	Annual	No	No	
	Good	Fair	Fair	
ASR Check	Period	No	No	
	Good	Fair	Fair	

main separation step for sorting light and heavy materials. Heavy portion will follow by magnetic separation to sorting out ASR; and further engage with hand sorting to separate ferrous metal and non-ferrous metal.

5.2. Present Status

The volume of three crushing plant crushed in Taiwan is listed in Table 3. The overall crushing

volume is about 100,000 tons each year. The typical amounts of input and output of one of these crushing plants are shown in Table 4. The ferrous metal produced 63~66% of input auto body, non-ferrous metal was about 1~2% of input auto body. Besides, 31~36% of ASR was generated during crushing. The comparison among these three crushing plants are listed in Table 5. Their operation and equipments are different.

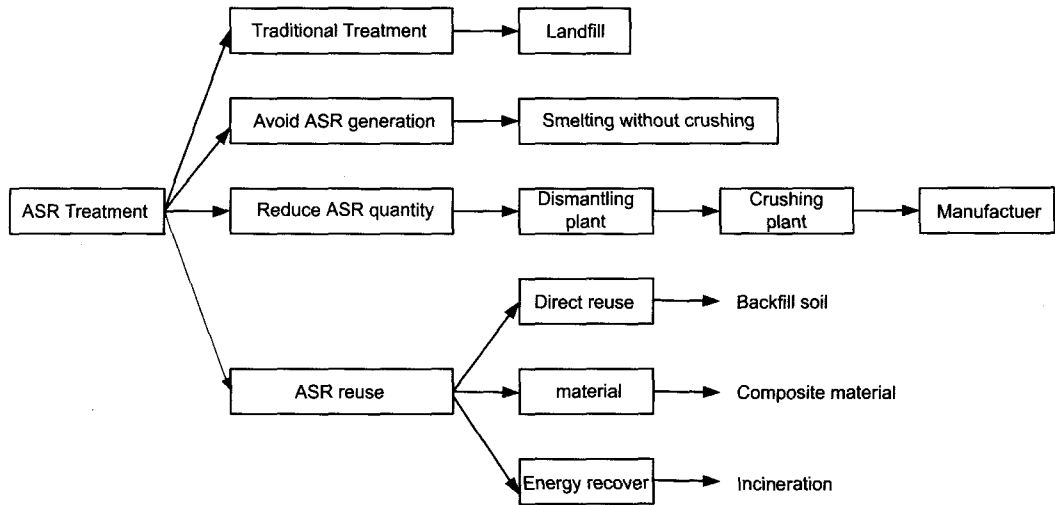


Fig. 6. ASR Treatment Technology.

5.3. ASR Treatment Technology

The treatment technology for ASR is listed in Fig. 6. It contains mainly plastic and fiber material, minor components are rubber, wood and others. The heavy metals contained in ASR are lead, zinc, and copper. Lead, zinc and copper content are about 0.4~2.1, 5~9 and 0.2~12 ppm, respectively. Traditional treatment is sending them to landfill site. There are two other ways to avoid and reduce the amount of ASR, which are directly smelting the waste auto body without further crushing and shredding and to reduce the quantities generated in dismantling plant, crushing plant and manufacturer. ASR reuse will be the future trend, it can be direct reuse as backfill material, or composite material, or incineration for energy recovery.

6. CONCLUSION

There are still rooms for improvement to step toward the sustainable circulating society by implementing the resource recycling and reutilization. The directions to be enhanced regarding the treatment of waste vehicle in the future include:

1. Review the subsidy and recycling project for the recycling projects of waste vehicle in the local government in Taiwan.
2. Provide assistance to the parties and groups

performing the waste vehicle recycling.

3. Evaluate the EPA subvention measures regarding the recycling of waste vehicle.
4. Access the subsidy distribution and propagation of the resource recycling of waste vehicle at the local government's levels.
5. Promote the resource recycles policy of waste vehicle by the central government.

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