

Recovery and Reuse of Waste Materials: Foreign Experience and Implications for China

Yaxi Zhang

School of Public Administration, Southwest Jiaotong University

P. R. China

E-mail: swjtuzhangyaxi@126.com

DOI: 10.6007/IJARBSS/v4-i1/573 URL: <http://dx.doi.org/10.6007/IJARBSS/v4-i1/573>

ABSTRACT: How to reuse waste materials has been one of the most important problems that China has to address. Compared with foreign countries, the overall recovery ratio of waste materials in China is still at a low level, and there is still a giant gap between China and foreign countries on laws and regulations, industrial chain, recycling operations and so forth. The paper summarizes firstly foreign effective measures in the treatment of waste materials such as waste batteries, waste glass, waste plastics and scrap metal. Then, combing with China's current situation, the paper proposes a mutual participation mode involving the government, the enterprises and the public to promote the development of waste material industries in China.

KEY WORDS: Waste materials; Recycling; Reuse; Government; Enterprise; Public

1. Introduction

How to reuse tremendous waste materials is one of the major tasks to build up a new economic growth point. Waste materials include productive and household waste materials with a wide range of types. Being a major part in recycling industry, the recycling of waste materials has become main economic growth point in Germany, the United States, Britain and other countries. Until the end of the 20th century, total output value of recycling industry in western countries had reached at \$250 billion, and up to \$600 billion at the start of this century (Hailun Zhu, 2006).

In the recycling use of waste materials, China is still at the starting stage and exists many problems compared to developed countries. The cause resulting in these problem have many, for example, the backward legal system, the lackage of supervision, the shortage of R&D inputs and so forth. To this end, some scholars put forward the methods to solve them. Hailun Zhu (2006) and Xiaoying Zhao (2006) proposed to strengthen China's legal management on the recycling use of waste materials through the "Resource Utilization Law" and "Renewable Resource Recycling Regulations" and others to create a reasonable legal environment and fundamentally to solve the problems. Baoshi Wang (2001) and others thought that China should increase the investment on research institutions and technology development projects, and at the same time should carry out the demonstration and promotion work in a large scale.

In order to solve these problems in the recycling and utilization of waste materials, the State Council has issued "Opinions about Speeding the Development of Energy Saving and Environmental Protection Industry" and proposed related goals and measures in this year. In

particular, it specifies that “average annual growth rate of the output value of energy saving and environmental protection industry will be more than 15% and until 2015 will reach at 4.5 trillion yuan, becoming a new mainstay industry of national economy” (The State Council, 2013). This provides good foundation and conditions for the solution of the recycling and utilization of China’s waste materials in the future.

In fact, on the recycling and utilization of waste materials, foreign countries have made a great progress. China may fully absorb and learn these successful experiences to accelerate the development of recycling industry. This paper firstly introduces the foreign experience on the recycling and utilization of waste materials, and then combining with China’s reality puts forward the related feasible countermeasures promoting the industry development of waste materials in China.

2. The reuse of waste materials

2.1 The reuse and disposal of waste batteries

The main pollutions in waste batteries are strong acid and alkali and heavy metal elements, which may easily cause irreversible damage on human body and the environment. The EU is the earliest area that concerned about battery recycling use and actually took measures with perfect laws and regulations. The decree taking effect from September 2008 stipulates the usage limit of battery mercury and cadmium and the recovery rate of portable waste batteries and requires to give a detailed description on battery label and consumer’s purchase and recycle (The EU, 2006).

Denmark and Sweden require all battery retailers to recycle waste batteries and levy special sale fees. Denmark charges fees based on the number of batteries, and the car batteries that the lead is below 100Ah levy 1.6109 euros, but higher than 100Ah levy 3.2217 euros. Sweden levies fees according to the weight. The change of prices based on hazardous substances is from 0.1836 euros/kg to 54.024 euros/kg. The government uses these charged fees to support the recovery, transportation and processing costs of waste batteries (Jinnan Wang et al, 2006).

In Germany, only the battery marked “recycled” and retirement date may be sold on the markets. Consumers can return various kinds of batteries to shops or waste recycling spots, and these places must unconditionally accept the waste batteries and send them to the manufacturer for recycling disposal. In addition, Germany implements recycling deposit system, which means the extra deposit is required during purchase. The price will deduct the deposit automatically, when consumers return scrap batteries. However, if not, the additional deposit will be charged forcibly on consumer’s next purchase (China’s battery net, 2013).

Of course, these measures can’t work smoothly without relevant laws and regulations. In recent years, China’s legislations on waste batteries are constantly increasing. The law of the “Waste Battery Pollution Control Technology Policy” released on October 9, 2013 has required to recycle and treat the waste batteries of nickel cadmium batteries, nickel metal hydride batteries, lithiumion batteries, lead-acid batteries and other waste rechargeable batteries and button-type disposable batteries (Ministry of Environmental Protection, 2013). However, due to technical and institutional inadequacies and others, there are still many difficulties and problems in actual implementation. Reform and improvement on system and mechanism is certainly inevitable in the future.

2.2 The reuse of waste glass

Britain, Denmark, Sweden, Switzerland and other industrialized countries began to recycle and reuse the glass since the 1970s, and the glass recycling program is fruitful. The majority of the European countries have established glass recycling associations that are responsible for organizing the recovery and reuse of waste glass. The annual report of glass bottles from the European Union shows that the recovery rate of European countries is at a higher level than 60% (The European Container Glass Federation, <http://www.feve.org/>, 2011).

The main application for foreign countries is to make full use of waste glass for construction materials. After establishing industry chain, recycle technology has continually been improved to achieve high recovery efficiency. For example, Belgium launched smart glass recycling bins containing optical sorting technology devices inside, which can automatically identify glass. The research in France showed that the recycling efficiency according to pin color was much higher and thereby applied it to whole country. Germany has always been focusing on resource recycling. Earlier in October 1996, Germany has implemented the regulations of the prevention, reuse and stacking management of waste glass, and at present has established recovery processing network on bottles and flat glass (Meijun Xu, 2007).

Waste glass recycling in China started late, and the recovery rate of waste glass is only 25-30%. The reason of China's slow development is the limited application of waste glass, and waste glass is mostly used as the supplement of industrial soda ash. As for foreign countries, waste glass has become a major component of building materials. They have researched and developed many new materials from waste glass to apply them in production and life.

2.3 The reuse of waste plastics

The recycling use of waste plastics in foreign countries started earlier. Japan in 1977 had released container packaging regulations requiring consumers to separate waste at first and then recycled by the recycling companies to obtain working capital from the government. In the early 1960s, the United States had made extensive research on the recycling use of waste plastics, and made breakthroughs on the use of heat in the combustion of waste plastics. The European Plastics Association has held the annual selection of best recycled plastic products competition since 2009 to appeal consumers to vote, and the winners can enjoy free publicity on official website and periodicals reports (European Plastics Association, 2013).

China has become the world's largest country of waste plastics, and at the same time the largest importer of waste plastics, too. On the recycling and use of waste plastics, China is still at the starting stage and the recovery rate of waste plastics and package is incredibly less than 10%. At present, China's waste plastic industry is in an important transition period of development, moving from spontaneous and disorder state gradually to specialized, large-scale recycling and processing system. Recently, The China Association of Waste Plastics Recycling has officially become a member of the Bureau of International Recycling, looking forward to promote industrial development by mutual cooperation.

2.4 The reuse of scrap metal

Romania always regards scrap metal as a major source of national materials and has set up metal scrap collection centers and processing centers. Its recycling network even covers each region to ensure that every place has at least one recycling facility and spot. The recycling and use of scrap metal has been taken into national plan, and all industrial departments, centers,

actories and mines must cover recycle plan when they drew up materials plan in accordance with national legislation.

In the early 1990s, Russia exported a large number of scrap metal to foreign countries, resulting in scrap metal supply shortage from 2011. In order to promote the return of scrap metal resources, Russia attempted to improve the recovery efficiency through the acquisition of scrap metal yards or investment in equipment, and at the same time reduced import tariff to zero and levied high export tariff and carried out export bans to ensure domestic scrap metal at a relatively low price (Baoshi Wang, 2001) .

How to avoid the mistakes like Russia is the problem that China has to deeply considerate on the recovery and use of scrap metal. As an indispensable raw material of steel industry, light industry, agriculture and commodity production, scrap metal is the main parts of waste material recovery, and has an undeniable function in industrial and agricultural production as well as in people’s life. Since 1978, China has canceled the mandatory plan of scrap steel and opened the market. However, this has led serious problem in the circulation of scrap steel. Therefore, it is necessary to solve it timely (Guanru Feng et al, 1994).

3. The current situation of the recovery and use of waste materials in China

Table 1 describes the disposal situation of China’s solid waste in recent years and shows that the growth speed of comprehensive utilization amount is far less than generation amount, indicating a serious drain on resources. It indicates there are many problems in China’s solid waste management.

Table 1 The disposal and utilization of industrial solid waste

Year	Generation amount	Disposal amount	Comprehensive utilization amount
2008	177721.0 mt	45776.0 mt	114932.0 mt
2009	190673.5 mt	44940.2 mt	128607.6 mt
2010	225093.6 mt	53652.5 mt	150899.4 mt
2011	322772.3 mt	70465.3 mt	195214.6 mt

Source: 2009-2012 China Statistical Yearbook.

Note: mt indicates million tons

The first is diversified channels. From the circulation channels to view, the cooperative of supply and sales has been running renewable resources since the establishment of new China. In the medium-and-late 1970s, scrap metal has formed two circulation channels of the cooperative and the materials system. After the reform and opening up, many individuals join in the industry, forming the third channel (see Table 2). Among them, individual channel is most active. However, due to large number of participates and widespread allocation, resource can

not be largely concentrated, resulting in a low recycling efficiency. At the same time, this is also the reason why waste materials is easily prone to appear price gouging, vicious competition and market price confusion.

Table 2 Three recycling channels

Category	State-run channels	Private channels	Individual channels
Property	State-owned or collective	Private	Personal
Supervisor department	the cooperative of supply and sales or materials sectors	No	No
Pattern	Top-down	Spontaneously	Spontaneously
Staff	State-owned enterprise workers, merchants, self-employed individuals	Merchants	Self-employed individuals
Main types	Recycling operation, recycling and processing	Recycling operation, recycling and processing	Pick up, acquisition, resale
Operating projects	Scrap metal in production and household, waste paper and other traditional business projects	Various household waste materials	Various waste materials
Operating mode	To establish and operate the waste materials distribution market, or directly to engage in the recycling business, or to build recycling network system in community.	To establish and operate the waste materials distribution market, or directly to engage in the recycling business, or to bid large-scale recovery projects, or to sublet management contract.	Flowing acquisition

Source: Peng Huijuan , Zhang Jicheng , Lu Mingzhong. Organizations operate waste recycling market Analysis. Renewable Resources Research, 2006 , 6: 1-4.

The second is differently hierarchical enterprise. Due to low entry requirement of market, multi-level enterprises exist on the same market. Because the technological level of partly minor enterprises is very low, it easily causes the second time waste as well as new environmental problems.

The final is the vacancy of laws and regulations. Compared with developed countries, China’s law provisions on the recycling and use of resources are few and lack of enough specific

requirements. This leads serious local protection in government’s management and market development. Especially, local governments don’t give priority to environmental resources but their politic performance, resulting in the unfair management of government and department.

4. The associated countermeasures to promote the recovery and use of waste materials

From the perspective of the experience of developed countries, The joint participation and burden-sharing of the government, the enterprises and the consumers is an efficient measure to promote the recycling and use performance of waste materials.

4.1 The government

4.1.1 The rectification of circulation market

For the confused market of waste materials, the principle of policies based on “to shut down small ones and to support large ones” should be practiced. To create a sound recovery system and market, Chinese government has introduced a variety of policies and regulations such as the "Solid Waste Management" in 2011, the "Processing and Utilization of Waste Plastics Pollution Prevention Regulations" in 2012, the "Imports of Waste Plastics Regulations" in 2013 and so forth (Ministry of Environmental Protection of China, <http://www.zhb.gov.cn>, 2013). These regulations not only enhance the import requirements of waste materials, but also reflect national remediation force.

4.1.2 The construction of the industrial chain of waste materials

For the recovery and use of waste materials, the governments need firstly to resolve the problem of industrial chain, while one of the most effective measures to build the industrial chain is to restrict the export of waste materials. To take the China’s export of broken and waste glass and glass block as an example, since 2011 China's export of waste glass obviously has decreased, reflecting the increasing demand of domestic market for waste glass. However, China's initial processing level of waste glass is actually far backward from the foreign companies (see table 3).

Table 3 The export of waste glass

Year	Export Volume (kg)	Export Value (\$)	Import Volume (kg)	Import Value (\$)
2010	65 012 880	30 067 764	1 698 795	29 137 166
2011	43 748 207	32 824 350	1 648 465	51 075 710
2012	41 739 405	42 096 484	1 471 503	44 266 954

Source: Customs Information Network, <http://www.haiguan.info/>, 2013.

The premise to ensure the full use of domestic waste materials is to guarantee the stable supply of the industry chain of waste materials, requiring the government to restrict exports. Otherwise, it may easily follow the same old road like Russia, causing a great shortage of domestic resources after the large-amount exports of domestic waste materials.

4.1.3 Preferential policies

The government's preferential policies including the financial grant from the state, the financing and the taxes may promote more enterprises to enter the recycling industry of waste materials. The first is to give financial support. For the new firms of waste materials, because they need a lot of money in the panning of site, the purchase of equipment and others, the government may set up a special fund of processing waste materials to loan new firms with low-interest or interest-free. The next is to give tax privileges to reduce the burden on firm's cash flow.

4.2 The enterprises

The enterprises have an important role in recycling system. For the enterprises, it is necessary firstly to build their own recycling channels such as the German's DSD companies. China may establish the processing company of waste materials in different regions. The company again entrusts a firm to recycle the waste materials from every family with fee-free to classify, dispose and reuse.

The second is to practice product liability system. In China, the enterprises have not direct responsibility for the environmental pollutions of products leaving factory and all responsibility eventually will be transferred to local government. However, the government may make the responsibility for the enterprises through implementing the legal provisions about producers' or processors' liability to meet circular economy demand. The government may offer subsidies for increased costs and give some supports on the tax, capital and land for the enterprises.

4.3 The consumers and residents

For the consumers and ordinary residents, the focus of work is how to stimulate their enthusiasm. According to experience abroad, one of the most critical policies and measures is to build the deposit-refund scheme. To take the battery as an example, the consumers need to pay a deposit when the consumers buy the battery, and this deposit will be returned when they take the old battery to the firm. Of course, Coupons or cash could be applied considering different operating conditions.

Another important aspect is the construction of recycling network system. In the early, regional recycling and processing center may be built, and ultimately the entire network can be made. Recycling network system consists of two subsystems, one recycling system with the residents, the dealers and the department of environmental protection, and another with the suppliers, the firms and the processing center in the recovery system of waste materials. The former mainly recycles household waste materials, while the latter focuses on productive waste materials.

Of course, the co-operation of all parties is indispensable in the promotion of the scheme. Among them, the most important thing is to establish specialized disposal company. To deal with waste batteries, for example, Japan and Switzerland adopted a similar approach, namely the establishment of a special battery disposal company, while the Japan's Nomura Kosan Co., Ltd., and the Switzerland Bartlek companies is the industry leader of handling waste battery, respectively. In China, this kind of specialized processing companies can be joint formed by the government and the firms to reduce the costs of the firms.

5. Conclusions

From the perspective of international experience, strong legal supports are the premises of rapid and stable development of the recycling industry of waste materials. Because China lacks a sound legal regulation, waste materials market as a whole presents chaos for the lack of effective management. Considering abroad experience, the main bodies of waste materials industry are the government, the enterprises and the public, and only they may change the state of waste materials industry in China. the primary responsibility of government is to create a good environment for the development of enterprises, while the companies need to increase research and development and improve market operation performance. As for the public, they should enhance the awareness of environmental protection and classify household garbage voluntarily to improve recovery rate in the producing of wastes.

Due to various problems reflected on different sub-markets, it is essential to adopt associated tactics. Because main problem in waste batteries is the enthusiasm shortage of the public and the firms for their recycling use, deposit-refund scheme and product responsibility scheme are efficient measures to solve this problem. Waste glass with a limited use could be introduced into the industry chain of construction materials to expand its application. Waste plastics market may be improved by supporting large ones and shutting down small ones. The scrap metal market may be improved by the concentration of resources and the development of dominant firms.

Corresponding Author

Yaxi Zhang, School of Public Administration, Southwest Jiaotong University, P. R. China. E-mail: swjtuzhangyaxi@126.com. Address: School of Public Administration, Southwest Jiaotong University, Jinniu, Chengdu 610031, Sichuan, P. R. China.

References

1. A State Council (2013), <http://www.gov.cn/>
2. EU website (2011), <http://www.europa.eu/>
3. Moura Bernardes A, Espinosa DCR and Tenório J. A. S. (2003), 'Collection and recycling of portable batteries: a worldwide overview compared to the Brazilian situation', *Journal of power sources*, 124, 586-592.
4. China Battery Net (2013), <Http://www.battery.com.cn/>
5. Ministry of Environmental Protection (2013), <http://kjs.mep.gov.cn/>
6. Meijun Xu (2007), 'International and domestic waste glass recovery, utilization and development', *Guide to Building Materials*, 1, 52-55. (in Chinese)
7. The Plastics Porta (2013), <http://www.plasticseurope.org/>
8. Pingguan Ru, Ying Li and Qijun Wang (1994), 'Acquisition market for scrap metal analysis', *Renewable Resources Research*, 6.
9. Wang Baoshi (2010), 'Chaos of the Russian scrap metal market', *Resource Recycling*, 11, 32-33. (in Chinese)
10. Zhu Hailun (2006), 'Circular economy oriented waste recycling system innovation-based on

socio-economic development of our country into the accelerated transition of basic judgment', *Renewable Resources Research*, 2, 1. (in Chinese)

11. Hongying Su (2012), 'Russian scrap metal recycling industry status quo', *World Non-Ferrous Metals*, 7, 60-61. (in Chinese)
12. Huijuan Peng, Jicheng Zhang and Mingzhong Lu (2006), 'Organizations operate waste recycling market analysis', *Renewable Resources Research*, 6, 1-4. (in Chinese)
13. Difan Song, Wenzhang Zhou (1990), 'Waste metal recycle and reuse', *Metallurgy Management*, 9, 4. (in Chinese)