

Assessing Municipal Solid Waste Management in China

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Under the economic and technological development, China has been facing environmental pollution which has been the product of municipal solid waste. The total amounts of municipal solid waste in China have been increasing by 8% to 10% per annum. In 2010 alone, it reached 180 million tons of municipal solid waste generated and collected. Currently, China is seeking to increase the incineration (waste-to-energy) and is trying to reduce the landfill. During the twelfth five-year plan (2011-2015), China forecasted that government funding for environmental protection would reach 3.1 trillion Yuan and that the total investment in municipal solid waste would reach 280 billion Yuan. In a concise manner, the significance of this study is to demonstrate different ways to manage perfectly municipal solid waste in China, and to improve environmental quality and people living standard by following environmental policies. This paper found that the amount of municipal solid waste produced but not generated is increasing per annum, because reduce, reuse and recycle became increasingly implemented in China. And as more items are reduced or reused and recycled, the amount of waste that needs to go to the landfill or incinerator is reduced, so the quantity of municipal solid waste generated decreased.

Field of Research: Management

1. Introduction

With rapid economic growth and massive urbanization, China has been facing the problem of municipal solid waste (MSW) which has been containing waste products arising from all aspects of human activity. Under environmental policies, Chinese government has identified a set of laws and regulations to find a suitable solution in order to reduce waste and to regulate the behavior of humans and economic organizations. Therefore, proper disposal of MSW is a necessity to minimize environmental health impacts and degradation of land resources. Systematic disposal methods are composting, landfill and incineration. This latter recovers energy from discarded MSW and produces electricity and steam for heating; it is recognized as a renewable source of energy, and it is playing an increasingly important role in MSW management in China.

This article provides an overview of managing municipal solid waste in China, by showing some data in different years about MSW, and the obvious means of managing and disposing it. As well as it discusses the major challenges in expanding incineration (Waste-To-Energy) in China. This research target is to shed light on the following questions: what is the real situation of MSW in China? How does the Chinese government deal with solid waste? What is the quantity of municipal solid waste in China? Is it increasing from year to year or decreasing? Are there some methods that Chinese state follows? What is the solution for reducing municipal solid waste? To find

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the compatible answers for these questions, we should provide enough information to analyze this situation. So firstly, we provide an overview of waste management in China. Secondly, we show the previous studies in this subject. Thirdly, we explain the research methodology used in this study. Fourthly, we analyze the situation in China of managing municipal solid waste. Then finally, we provide a conclusion for this research. The most of previous studies showed the amounts of municipal solid waste produced and collected (generated) until 2005, however, this study will provide these amounts until 2010. Moreover, the significance of this study is to demonstrate different ways to manage perfectly municipal solid waste in China, and to improve environmental quality and people living standard by following environmental policies.

2. An Overview of Waste Management in China

In East Asia and Latin America, openness to trade and knowledge have been important factors in economic growth (Thomas & Wang 1998). However, this rapid growth has been accompanied by negative impact on the environment. The importance of a good environment for a business may be greater than the availability of the wealth, because this latter will simply come if the conditions are appropriate (Thomas Sterner 2003). Environmental problems are always political ones because they can have a great impact on the health, wealth, and even the life and death of members of the general population.

In all the history, no country has ever seen as larger or as rapid an increase in solid waste generation as China is seeing at the present time. China has been unable to keep up with the increasing demand for waste management (Wen & Peter 2007). And the State Environmental Protection Agency (SEPA) calls environmental pollution “the bottleneck constraining economic growth in China” (World Bank 1999). With the economic development in China, the quantity of solid waste has been increasing, and the driving forces behind that were urbanization, urban population growth, and increasing affluence (Dong et al. 2010, and Guilberto & Shigefumi 2010). However, the control of solid waste pollution is an important aspect of environmental protection in China.

According to Chinese law, solid waste is classified into three types: industrial solid waste (ISW), municipal solid waste (MSW), and hazardous waste (HW) (Qi et al. 2006). Municipal solid waste (MSW) is one of the major problems that affect China’s environmental quality. In addition, the shortage of MSW disposal and treatment facilities and the backward technologies causes a large amount of MSW to be untreated and dumped in the open. Therefore, in many places in China, waste management is the “underdog” of Chinese environmental policies. Although the environmental question has definitely gained in importance, nevertheless, it remains subordinate to the economic imperatives. This obviously contributes to a certain failure in waste management. However, scientific research projects and demonstration projects have been undertaken; and research institutions in environmental sanitation have been established in major cities throughout the country to carry out research programs on MSW treatment technologies and equipment that suit local circumstances.

2.1 Municipal Solid Waste (MSW)

In general, Municipal solid waste is the waste collected by municipalities which is generated mainly by households, commercial activities and street-sweeping, as well as

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construction and demolition debris (Martin Medina 2010, Linda, Debora & Noel 2003, Olar & M.S. Candidate 2003, and Guilberto & Shigefumi 2010). Most MSW is produced in the daily life of local citizens, including dust, tiles, paper, plastic, textiles, glass, metal, wood, and residual food (Qi et al. 2006). China's waste stream is growing fastest in paper, plastic, and multi-laminates such as tetra-pack or plastic coated paper. According to the World Bank (1999) MSW should be carefully categorized within seven categories, and the following table shows more details about sources and types of MSW.

Table 1: Sources and Types of Municipal Solid Waste

Source	Typical Waste Generators	Types of Solid Waste
Residential	Single and multifamily dwellings	Food waste, paper, cardboard, plastic, textiles, leather, yard waste, wood, glass, metal, ash, special waste (e.g., bulky items, consumer electronics, white goods, batteries, oil, tires) and household hazardous waste
Industrial	Light and heavy manufacturing, fabrication, construction sites, power and chemical plants	Housekeeping waste, packaging, food waste, construction and demolition materials, hazardous waste, ash, special waste
Commercial	Stores, hotels, restaurants, markets, office buildings	Paper, cardboard, plastic, wood, food waste, glass, metal, special waste, hazardous waste
Institutional	Schools, hospitals, prisons, government centers	Same as commercial
Construction and Demolition	New construction sites, road repair, renovation sites, demolition of buildings	Wood, steel, concrete, dirt, etc.
Municipal Services	Street cleaning, landscaping, parks, beaches, other recreational areas, water and wastewater treatment plants	Street sweepings; landscape and tree trimmings; general waste from parks, beaches and other recreational areas; sludge from water and wastewater treatment plants
Process	Heavy and light manufacturing, refineries, chemical plants, power plants, mineral extraction and processing	Industrial process waste, scrap materials, off-specification products, slag, tailings

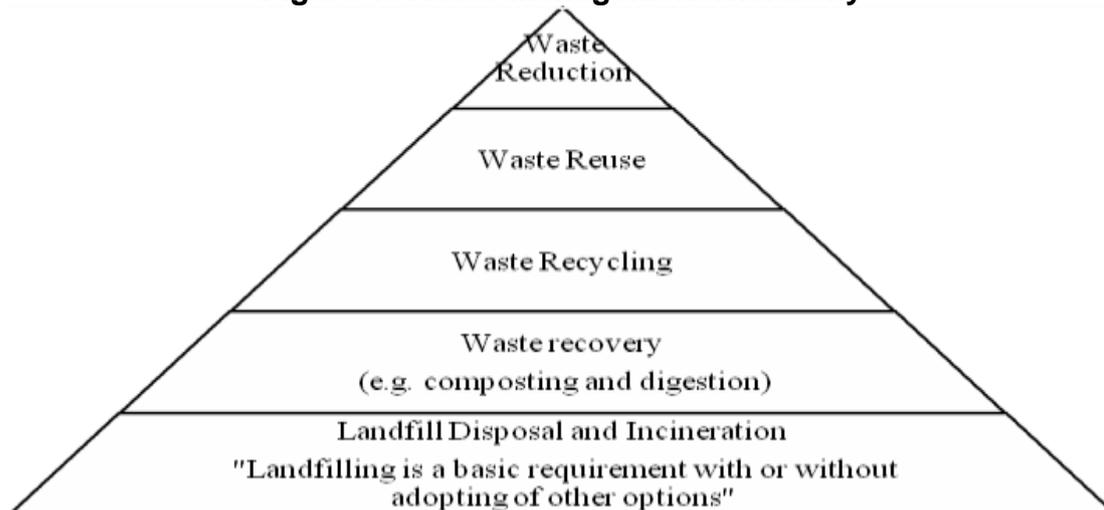
Source: World Bank, 1999

2.2 Municipal Solid Waste Management

Waste management is the epitome of environmental management. The dumping of solid wastes and the flow of untreated effluents can disrupt sensitive ecosystems, leading to deterioration of water quality and thus poor human health (Thomas Sterner 2003). Waste management is first to reduce waste generation and separate potential recyclables at source to improve the quality of materials for reuse, including organics for composting or anaerobic digestion. That cannot be reduced should be reused if possible. That cannot be reused or reduced should be recycled, particularly secondary materials such as metal and paper. Waste that cannot be recycled should be recovered, usually through bacteriological decomposition. Landfill is always cheaper than composting and incineration (World Bank 2005). Reduce-Recycle-Reuse became more active in China in natural resource development and uses. By the end of 2005, there were 23,512 enterprises engaged in the 3R industry in China (Liu et al. 2006).

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Figure 1: Waste Management Hierarchy



Source: World Bank 2005

Recycling

Although the state did sponsor some kind of recycling industry, the private and informal activities constitute the most important mode of recycling. That is because the casual waste picker relies on this recycling to resell the materials. Based on the Ministry of Environmental Protection of China, informal recycling goes in four steps, (1) individuals separate the wastes to their smallest unit, (2) it is brought to community-based waste collection centers, (3) it is then brought to centralized garbage centers, and (4) it is sent to a plant. In 2008, China's recycling rate was lower than other countries, because the secondary materials' market in China was affected by several factors such as; the value to the recycles. China's target is to realize 50% recycling of waste paper by 2030, over 38 million tons of waste paper could be diverted from disposal. Recycling has a lot of positive aspects, it creates job opportunities and it provides products in less prices. In 2005, the recycling industry in Britain, already worth over \$20 billion a year, and employed 140,000 people (Adedipe, Sridhar & Joe 2005). In fact, recycled paper might be up to 25% cheaper than normal white paper and each ton of recycled paper saves 17 trees and the energy equivalent of 165 gallons of gasoline compared with paper made from trees, in addition to requiring only half the water. The U.S. Environmental Protection Agency estimated that recycling 8 million tons of metals in the United States has eliminated more than 26 million tons of greenhouse gases which are equivalent of removing more than 5 million cars from the road for a year.

Composting

Composting is an integral part of the waste processing and disposal systems. It is a viable option in China because over 50% of the waste stream consists of bio degradable organics. However, composting efforts have been hindered by improper separation of glass, plastic and other chemicals from the compost feed. In small operations that have been experimented with so far, the compost product has been of limited value, discouraging further composting activities. Even so, the majority of rural food wastes are recycled as pig feed or fertilizer. Therefore, Composting can be sustainable cost in developing countries (Bogner et al. 2007).

Landfill

Landfill in China occurs at three categories: Open dump or open landfill, Semi-controlled or operated landfills and Sanitary landfills. According to the Ministry of Environmental Protection of P.R.C, at the end of 2005, there were 372 active landfills,

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in 661 cities in China. And then in 2006, it decreased to 324 active landfills in 656 cities. In 2007, landfill gas-to-electricity (LFG) projects were underway in Hangzhou, Guangzhou, Nanjing, Xian, Beijing, Changsha, Wuxi and Jinan. By the end of 2007, 18 LFG utilization projects had been completed and commissioned throughout mainland China. As of 16 January 2008, 21 MSW treatment projects had been approved by the National Development and Reform Commission while most of the larger landfills have signed agreements in place with foreign companies for LFG utilization. In 2008, the Laogang landfills in Shanghai was one of the biggest landfill in Asia, which is located next to the coast and occupies 360 hectares with an anticipated total capacity of more than 34 million tons of waste over the 20-years concession contract. The municipal government reportedly said that in 2011, 80% of waste from Beijing is sent to landfill.

Currently municipal landfills are the least environmental solution for the treatment of wastes. They are a hazard to the landscape; they take up a lot of arable land; they provide high risk of contamination to surrounding land and water, and also, the methane produced by the fermentation of the wastes threatens the quality of air. So in recent years, Chinese cities are reducing landfills and making more interest to incineration by building waste incinerators, aiming to burn the trash while producing electricity.

Incineration

As land surrounding large cities becomes increasingly scarce, the combustion of MSW in waste-to-energy (incineration) facilities became the preferred disposal option in many Chinese cities. Incineration has several benefits such as great volume reduction and destruction of pathogens, but it is constrained by high capital cost and potential toxic air emissions if poorly designed (World Bank 2005). Incineration reduces the volume of waste by 90%, and 80% of its weight. Furthermore, it reduces the toxicity of the wastes that will then be put in landfills, and offer the opportunity to use the energy contained in the waste.

According to the Ministry of Environmental Protection of P.R.C, MSW incineration began in China in the late 1980s and developed rapidly in the 1990s. Many Chinese Waste-To-Energy (WTE) plants were set up with technology provided by foreign help. China has several household incineration factories, including the one in Shanghai "Minhang," which is supposedly the largest one in China. The facility is designed to have a daily garbage handling capacity of 3,000 tons and generate around 270 million kilowatt-hours of power per annum. One of the largest waste-to-energy power plants is in Jiangqiao, Shanghai; it burns 1,000 metric tons of waste each year. In 2007, there were 66 WTE plants in China, and the Chinese WTE capacity has reached 14 million tons. Recently, incineration has been widely applied in many developed countries, especially those with limited space for landfill such as Japan and many European countries. In 2003, about 17% of municipal solid waste was incinerated with recovery in the EU-25. And in 2006, the EU-15 indicates that 20-25% of the total municipal solid waste is incinerated at over 400 plants with an average capacity of about 500t/d (Bogner et al. 2007).

The first goal of municipal solid waste management (MSWM) is to protect the health of the urban population, particularly that of low-income groups who suffer most from poor waste management. Secondly, MSWM aims to promote environmental conditions by controlling pollution (including water, air, soil and cross media pollution) and ensuring the sustainability of ecosystems in the urban region. Thirdly, MSWM supports urban

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economic development by providing demanded waste management services and ensuring the efficient use and conservation of valuable materials and resources. Finally, MSWM aims to generate employment and incomes in the sector itself (Peter et al. 1996).

2.3 Five-Year Plans Of Chinese Municipal Solid Waste Management

During the *Seventh Five-Year Plan* period (1986-1990), a number of facilities were established in Beijing, Shanghai, Guangzhou, Hangzhou and other cities for MSW treatment, recovery and use. During the *Eighth Five-Year Plan* period (1991-1995), the central government has allocated nearly USD 1.5 million for science and technology programs on MSW composting, landfill, incineration recovery and reuse and development of relevant special equipment. During the *Tenth Five-Year Plan* period (2001-2005), the government made a commitment to raise spending on environmental protection to 1.5% of GDP about USD 16.5 billion by the year 2005 (World Bank 2005). During the *Eleventh Five-Year Plan* period (2006-2010), China took major steps to increase waste to energy (WTE) by producing energy according to the MSW, and it has increased its WTE capacity from 2 to 14 million tons of MSW. This made China the 4th largest user of WTE after EU, Japan, and USA. During this period the total efforts to resolve outstanding environmental issues, made important progress in the understanding of policy, institutional and capacity of environmental protection. With some foreign help, Shanghai municipality has been able to build landfills sited with modern technologies and also has modern MSW incineration facilities. The World Expo hosted by the city in 2010 was also a major incentive to concentrate on environmental issues, following in the lines of the expo's theme "Better City, Better Life" thus conforming to the idea of an "Ecological World Expo".

According to the Ministry of Environmental Protection of P.R.C, international exchanges and cooperation are expanding, and China has introduced MSW treatment technologies and equipment from Japan, Denmark, German, USA, and the UK, and used loans from the World Bank to construct MSW treatment facilities in some cities. Based on the statistics of the National Development and Reform Commission, during the *Twelfth Five-Year Plan* (2011-2015), *China forecasted that government funding for environmental protection would reach 3.1 trillion Yuan and that the total investment in municipal solid waste would reach 280 billion Yuan.* Hence, the Chinese government is gearing up funding for environmental protection; its goals are to promote the scientific development, speed up the resource-saving and environment-friendly society.

3. Literature Review

The list of top 10 municipal solid waste generating countries includes four developing nations (Brazil, China, India, and Mexico) in part because of the size of their urban populations and in part because their city dwellers are prospering and adopting high-consumption lifestyles. The good examples of municipal solid waste management are in developed countries such as Germany, France, Japan, and United States. Ulrich and Cees (2002) viewed municipal waste management in some European countries including the current situation of municipal solid waste and the general overview of municipal solid waste. Matt et al (2002) discussed the biodegradable municipal waste management in Europe. They covered the successful composting of municipal waste, incineration, and landfill. Christian, Stefanie & Samuel (2003) talked in their book about strategies and technologies of municipal solid waste management to reach some

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sustainable solutions. And they included waste disposal, recycling, landfill, incineration, and sustainable waste management. Furthermore, Mette et al (2008) pointed in their working paper the municipal waste management and the greenhouse gases. They discussed the municipal waste management in the EU 27, the composition of municipal solid waste, and the amounts of municipal waste incinerated and landfilled in the EU 27 from 1995 to 2009. Moreover, Itaru and Vivian (2007) were among the reviews about municipal solid waste management in Japan. Prem et al (2012) pointed in their article the geospatial strategy for sustainable management of municipal solid waste to grow urban environment.

There have been a series of published papers and books which reviewed the trend of municipal solid waste management in China. World Bank (2005) talked about waste management in China by providing some issues and recommendations. Qi et al (2006) analyzed the situation of solid waste management in China. In addition, Guilberto and Shigefumi (2010) discussed the municipal waste management and issues in south east and East Asian countries. They included municipal solid waste composition, laws, regulations, and standards for municipal solid waste in China. Dong et al (2010) discussed the status, problems, and challenges of municipal solid waste management in China, and they talked about waste collection and disposal methods. Furthermore, Xu et al (2010) made an overview of municipal solid waste management in China.

There are some literatures about municipal solid waste management in Beijing city such as Xiao et al (2007), Li et al (2009), and Qu et al (2009). Among the studies in Shanghai there are Hong et al (2006), and Zhu et al (2009), who described a waste generation and composition analysis, and provided a comprehensive review of municipal solid waste management in Pudong new area, Shanghai. Shan and Carlos (2004) discussed the waste management literacy and waste reduction preferences of domestic waste generators in Guangdong cities. In addition, Chung and Poon (2001) compared municipal solid waste management in Guangzhou and Hong Kong. Moreover, other authors have addressed municipal solid waste management in different cities in China such as: Chongqing “Yuan et al (2006),” Hangzhou “Zhao, Wang and Lu (2009),” Tianjin “Zhao et al (2009), Geng et al (2007),” and Tibet “Jiang et al (2009).” Ming Lang Tseng (2011) analyzed the importance performance of municipal solid waste management in Taiwan.

Most researchers focused only on the old data of the amounts of municipal solid waste in China until 2005; however, this study updates the data of the amounts as possible. This paper analyses how the Chinese environmental legislations help to manage and reduce municipal solid waste in China. And it shows the importance of government’s intervention to manage MSW according to five-year plan. Moreover, this paper analyzes the challenge which is not answered previously of the quantity of municipal solid waste that is produced but not generated. And it shows the best ways for reducing municipal solid waste.

4. Data and Methodology

In order to understand the facts, observe patterns, formulate explanations and try out hypotheses we choose an effective analysis methods. Therefore, this research uses data analysis explained methods, so that useful information can be highlighted to understand all what is presented in order to analyze the situation of municipal solid waste in China. And arrive at a more complete understanding and historical of solid

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waste management in China. This research depends on useful way to summarize the findings by means of graphs and figures. This study focuses not only on a city in China but on the whole country of China, because China is among the top 10 municipal solid waste generating countries in the world. This paper is prepared since 2012, and it depends on data between 2001- 2010 of the amounts of municipal solid waste; because it was the possible data provided by mailing the ministry of environmental protection and the ministry of construction of China. For that, this study depends on qualitative method in order to interpreting and analyzing data collected from these ministries for clarifying the characteristics of managing municipal solid waste in China. Moreover, this study targets to reach to more understanding about the difference between the quantities of municipal solid waste produced and the quantities generated; which is not answered previously.

5. Results Discussion

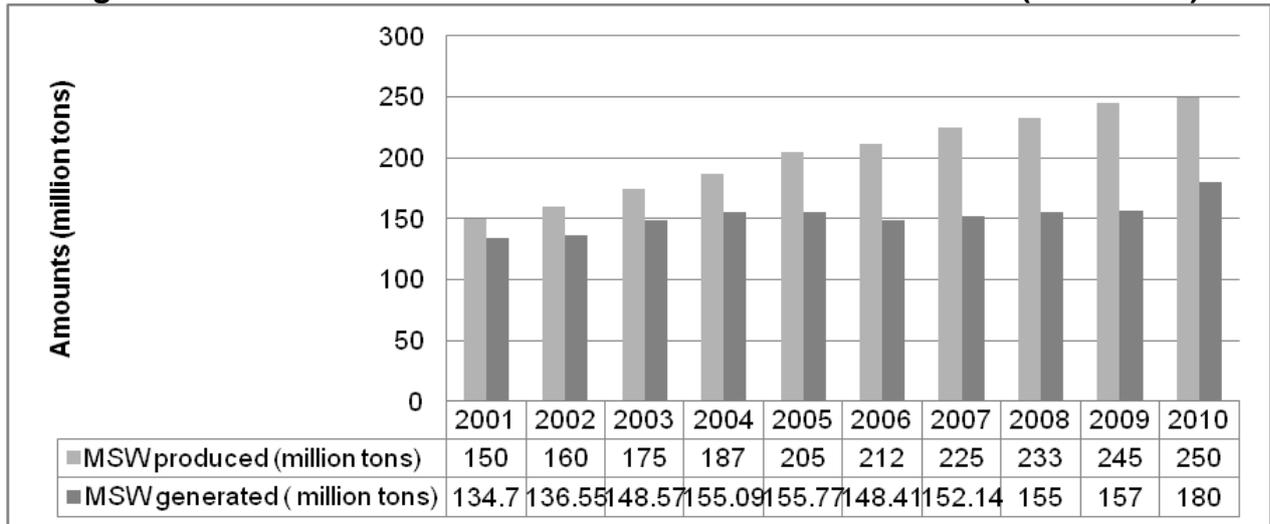
5.1 Municipal Solid Waste Amounts in China during 2001-2010

Municipal solid waste (MSW) is one of the major problems that affected China's environmental quality and the sustainable development of China's cities and rural areas. Meanwhile, the total quantity of MSW has been increasing by 8% to 10% per annum. According to the information collected from Ministry of construction and the Ministry of Environmental Protection of the People's Republic of China for the period 2001- 2010, it is shown that in 2001, China produced 150 million tons of MSW; however, it generated 134.70 million tons for disposal, and 15.3 million tons were recycled. In 2002, there were 136.55 million tons of MSW generated and 80% of it was landfilled, 3.72% was incinerated and 6.98% was composted. During the period 2001-2004, there were small amounts of MSW recycled, and then it increased from 2005, because of the increasing interest on recycling. Moreover, during the period 2001-2005, Chinese government made a commitment according to the Tenth Five-Year Plan to rise spending on environmental protection to 1.5% of GDP about USD 16.5 billion by the year 2005.

The amount of municipal solid waste increased every year. And it reached in 2006 about 212 million tons of MSW, where 148.41 million tons were generated. In the same year 91.4% of MSW was landfilled, while 6.4% of the waste was incinerated and 2.2% was composted (Dong et al. 2010). After 2005, the incineration increased every year because of the adoption of the 11th Five-Year Plan; where China took major steps to increase waste to energy (WTE) by producing energy according to the MSW. And during the period 2006- 2010, China was the 4th largest user of Waste-To-Energy after EU, Japan, and USA.

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Figure 2: The Amounts of MSW Produced And MSW Collected (Generated)



Sources: Ministry of construction of P. R. C and Ministry of Environmental Protection of P. R. C

The figure “2” shows detailed data about the amounts of MSW produced and MSW generated and collected from 2001 to 2010, where it shows that there is difference between municipal solid waste produced and municipal solid waste generated. And these amounts that is produced but not generated have been increasing per annum, because reduce, reuse and recycle became increasingly implemented in China. And as more items are reduced or reused and recycled, the amount of waste that needs to go to the landfill or incinerator is reduced, so the quantity of municipal solid waste generated decreased. And this is the results obtained in this study which differ than previous studies.

In 2010, the country’s total waste output has reached 180 million tons. However, China is creating more laws and regulations to reduce and control the quantity of municipal solid waste. According to China Association of Environmental Protection Industry, the municipal solid waste (MSW) output in China will reach 179 million tons and 210 million tons in 2015 and 2020 respectively.

5.2 Laws and Regulations for Municipal Solid Waste in China

According to The Ministry of Construction of P.R.C, and the Ministry of Environmental Protection, China has comprehensive set of policies governing solid waste management (SWM). The current policy system can be divided into three different levels, namely: regulations, laws and documents issued by the State Administrative, regulations and documents issued by related ministries of central government, and local laws and regulations issued by local governments State level.

The law of the P.R.C. on Prevention and Control of Solid Waste Pollution issued in 1995 is the basic and most important law with regards to solid waste management, which formulates basic requirements for dumping, cleaning up, collection, transportation, recycling, treatment and disposal. This law was revised in December 2004, and the new version becomes effective on April 1st, 2005.

In addition, some related regulations and standards have already been formulated by the State Council, the Ministry of Construction, State Environmental Protection Administration, State Development Planning Commission, Ministry of Finance, and the

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Ministry of Environmental Protection ...etc. some examples are: city appearance and environmental sanitary management ordinance 1992, regulations regarding municipal residential solid waste 1993, law on prevention and control of environmental pollution caused by solid waste of PRC 1996, comments on the promoting of industrialization of municipal waste-water treatment and municipal solid waste treatment 2002, national catalogue of hazardous wastes 2008, catalogue of solid waste forbidden to import in China, catalogue of restricted import solid wastes that can be used as raw materials in China, catalogue of automatic-licensing import solid wastes that can be used as raw materials in China 2008, and imports of solid waste management practices 2011...etc.

6. Conclusion and Implications

China is among the top 10 municipal solid waste generating countries because of the size of urban populations and the high-consumption lifestyles. Currently, China is facing the dilemma of combining fast economic growth with sustainable development and environmental conservation. The process of economic growth has been exerting increasing pressure on the ecological carrying capacity of the country. China has preliminarily set up its environmental protection system, although not very completed. The basic laws and regulations of the People's Republic of China on Environmental Protection are very important for guiding to prevent and control solid waste pollution. However, all country members should follow these laws and regulations for helping to reach these goals.

Although this research had some limited information, but it reached a supported result for the previous studies, which is the increasing of municipal solid waste annually in China. And as an expanded result, the quantity of municipal solid waste produced but not generated has been also increasing every year, because of the increasing implementation of reuse and recycle. Moreover, the government is seeking to reduce the amounts of municipal solid waste by encouraging reduce, reuse and waste recycle to reduce the quantity of municipal solid waste generated for landfill, incineration and composting.

Incineration industry is expected to experience significant growth in the coming decade and make greater contribution to supplying renewable energy in China. Even so, China took major steps to increase waste to energy (WTE) by producing energy according to the MSW, which made China the 4th largest user of WTE after EU, Japan, and USA. The increase of WTE projects in China will help the country to reduce the negative effects of solid waste in the country, and at the same time produce useful energy for the country. In order to improve the future situation of municipal solid waste in China it is better to make more WTE projects, because of its positive effects and reduce the landfill. In addition, successful completion of the planning goals will help China's construction of MSW treatment facilities and speed up the goal's realization. This will improve environmental quality and arise from people living standard and to ensure sustainable development of society both in urban and rural areas. Some addition suggestions are to learn the good practices on MSW treatment from foreign help.

Consequently, this study targeted to increase peoples' awareness about the significance of reducing waste by implementing reduce, reuse and recycle as most as possible to provide natural resources for future generation as well as to reduce the amounts of municipal solid waste to prevent our environment and society. Moreover, it encourages to more expanding for incineration to produce energy and reduce landfill to

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gain more space for operational projects. In addition, the most important factor that can help protecting the environment is to encourage reducing, reuse and recycle of municipal solid waste by society' members. And develop policies at the national or local level addressing municipal solid waste management through 3R principles. As well as encourage the recycling industry. Finally, the best way to improve the future situation of MSW in China, all country members should reduce the waste as possible, and help the country in managing municipal solid waste.

This research has some limitations, such as the limited information about the year 2011 and 2012, for that the data provided in this study was until 2010. The 3R principle (reduce, reuse and recycle) is still in growing stage in China; hence, there is still lack in information about the use and development of this principle. However, reduce; reuse and recycle are very important to improve the management of municipal solid waste in China.

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