

Municipal Solid Waste Incineration for Electricity

Generation—A CDM Case Study

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Abstract: The article analyzes and evaluates the production and resource of municipal solid waste (MSW) in China, the application of technology of MSW incineration for electricity generation at home and abroad, the main factors which restricted the application of MSW incineration technology in our country and the application potential of waste incineration technologies in China. In the case of generation-by-waste-incineration technology, for example, based on the three baselines determined in this research and applying the incremental cost analysis approach, we calculate the unit carbon-mitigation cost of generation-by-waste-incineration technology as CDM project and conduct the sensitivity analysis. We suggest that generation-by-MSW-incineration technology should be a priority technology for cooperation in CDM project between our country and developed countries.

Keywords: CDM (Clean Development Mechanism) case analysis, city wastes, generation-by-waste-incineration, GHG, mitigation cost

1. Reasons for identifying MSW incineration technology as a CDM case study

1.1 Accord with the principle of meeting the double objectives

Being defined in Article 12 of the Kyoto Protocol, the Clean Development Mechanism (CDM) is a new international co-operation mechanism with the involvement from developing countries. Under the framework, the developed countries provide finance and technology, and participate in the implementation of the emission reduction project in developing countries which aim at climate change mitigation. The certified emission reductions generated from the project will offset part of their emission reduction targets and the commitment set in the Protocol.

China is a developing country with rapid progress of urbanization and rise of living standard. The increase of MSW is also huge, at a growth rate of 8% annually, which has made China one of the countries under the biggest burden of waste treatment in the world. The problem of the increase of MSW has become a potential obstacle restricting the sustainable development of China.

MSW has complicated components and a huge amount, and has become a main

pollutant to the environment with similar harm level as water pollution and air pollution. The traditional means of landfill technology caused big economic and social cost, therefore, the generation-by-waste-incineration technology will become a new industry with great potential, a priority technology to reduce the amount and harm of the waste changing the waste to resources, and the main supporting industry identified by the National Development and Reform Commission. In addition, the MSW incineration project is categorized as the renewable energy project that big amount of GHG emission reduction can be achieved.

1.2 Principle of additionality in technology, investment and financial source.

- **Additionality in technology:** the Annex 1 country involving in the CDM project should provide the hosting country with the advanced technology that have not been commercialized domestically and that will bring additional mitigation. Therefore, the technical additionality will determine the additional mitigation benefits. What's more, the technical additionality will also assist the Non-Annex 1 country in achieving sustainable development.
- **Additionality in investment:** the Annex 1 country involving in the CDM project should provide the Non-Annex 1 country with the mitigation investment additional to the project's original commercial investment, on the purpose of covering the incremental cost of the CDM project and obtaining a financial competence compared with the baseline scenario. The additionality in investment can also promote the sustainable development in the Non-Annex 1 country. Due to the high cost of equipment and the advanced technology provided by Annex 1 country, the additionality in technology as well as in investment is a must in securing the additional mitigation benefits. Projects with negative incremental cost of mitigation, which are "no-regret" projects, can be implemented by the hosting country itself, and its attractive commercial returning rate will draw investment. These projects have no additionality in investment, thus, can not be considered as CDM project.
- **Additionality in financial source:** due to the fact that developed countries have been undertaking the responsibility of providing financial aids, such as the GEF and the ODA to developing countries, the developed countries involving in CDM projects should offer finance additional to their existing financial obligations.
- **In terms of generation-by-waste-incineration:** the developed countries have a long history of the industry development, state-of-the-art technology, mature technics, adopting corporation operation that achieves high efficiency and good control of the waste treatment cost. In China, the living waste incineration technology is still a new industry on a starting stage. It has the bottlenecks such as lack of finance, laggard waste treatment technology, procedures, and equipments, big harm of the second-time pollution, and inefficient energy recycle. Consequently, using international finance and advanced technology to realize the complete localization of technical design and equipment manufacture will lower the investment cost of the technology significantly and accelerate the progress of establishing living waste treatment plants. It will also protect the ecological

environment and meanwhile develop the environmental protection industry, promote the technology improvement, and raise the overall technical level of the waste incineration in China to a position approaching or leading the international state-of-the-art. As a result, selecting the MSW incineration technology as the potential project for the CDM co-operation with the developed countries will be an effective approach to meet China's targets of reducing the amount of MSW, make it innocuous, and change it to resources, and has a broad technical application market.

1.3 Local and global environmental benefits

The local and global environmental benefits are mainly represented by the double benefits of mitigation of local environmental pollution and reduction of global GHG emission through CDM project implementation. The waste is reduced by 90% in volume and by 70% in weight through incineration, and the resource of energy is renewed for application. It also reduce the land area serving as the dumping sites and the relative soil pollution, mitigate the serious pollution to water resources caused by high concentration permeating liquid in dumping sites, and the air pollution caused by nocuous gas emissions, and lower the negative impact to environmental sanity and the health of citizens because of the diseases spreading by flies and mosquitos live on the waste. Although the waste incineration technology belongs to renewable energy category, it makes difference from other renewable technologies, for example, the wind energy. It is similar to the technology of coal-bed methane recovery and utilization in a sense of double mitigation effects, which are CO₂ emission reductions through alternative means of power production and the CH₄ emission reductions as replacing the landfill technology.

2. Evaluation of the production and resource of MSW in China

2.1 Main factors to MSW production and its components

With the rapid progress of city expansion and urbanization in China, the production and the dumping volume of MSW is increasing annually. Till 1998, the number of the cities in China has reached 668, and the total waste removing amount is 113.02 million ton. From 1985 to 1995, the annual growth rate of MSW is about 8%-10%, and the daily waste production per capita is over 1.0 kg, which is close to the level in industrialized countries. The main factors to MSW production and its components are:

- Urban population increase caused by urbanization
- Economic growth and the rise of living standard of citizens
- Changes in life style and ways of consumption
- Changes in energy consumption mix
- Management system, laws and regulations and policies

Table 1 and 2 show different waste components of different cities in gas-fired region and coal-fired region in China.

Table 1. Waste components of the cities in gas-fired region in China(unit: %)

Region		Cities in Southern China				Cities in Northern China				
Cities		Nanning	Nanjing	Shanghai	Chongqing	Taiyuan	Jilin	Tianjin	Shenyang	Harbin
Organic		46.01	64.77	80.3	69.91	83.22	62.04	78.98	86.94	63.92
Mineral		45.76	18.33	7.54	19.91	4.12	27.26	5.88	9.34	20.22
Other waste	Paper	2.77	9.61	3.47	2.90	6.97	~	~	1.91	11.04
	Metal	1.06	1.93	2.00	1.19	1.13	~	~	0.41	0.66
	Plastic	1.22	1.49	1.86	2.12	1.60	~	~	0.27	1.73
	Glass	2.36	1.89	1.74	1.95	1.37	~	~	0.71	2.07
	Cloth	0.82	1.98	3.09	2.01	1.59	~	~	0.42	0.36
	Sub-total	8.23	16.9	12.16	10.18	12.66	10.70	15.14	3.72	15.86

Source: [5] Energy Research Institute of SDPC, the National Action Plan of Urban Waste Management and Landfill Gas Recovery Application, 1999

Table 2. Waste components of the cities in coal-fired region in China(unit: %)

Region		Cities in Southern China				Cities in Northern China				
Cities		Nanning	Nanjing	Shanghai	Chongqing	Taiyuan	Jilin	Tianjin	Shenyang	Harbin
Organic		17.02	26.28	31.96	16.80	10.86	4.80	22.26	37.97	30.86
Mineral		78.60	68.20	60.70	79.54	86.38	93.7	69.52	60.79	66.02
Other waste	Paper	1.61	3.18	2.00	0.75	1.57	~	~	0.35	1.70
	Metal	0.64	0.34	2.70	0.94	0.30	~	~	0.17	0.50
	Plastic	1.09	0.47	1.35	0.68	0.17	~	~	0.09	0.24
	Glass	0.43	0.72	1.06	0.84	0.21	~	~	0.24	0.49
	Cloth	0.61	0.81	0.23	0.42	0.51	~	~	0.21	0.72
	Sub-total	4.38	5.52	7.34	3.66	2.76	2.10	9.12	1.06	3.15

Source: the same as Table 1.

2.2 Evaluation of the resource of MSW in China

In 1999, the project of ‘the National Action Plan of Urban Waste Management and

Landfill Gas Recovery Application” undertaken by the Energy Research Institute has conducted a MSW resource investigation in 10 cities in China, such as Beijing, Shanghai, Tianjin, Guangzhou, Shenzhen, Dalian, Shenyang, Ma Anshan, Hangzhou, and Anshan. The investigation include: city population and economic status, fundamental data of city infrastructure, waste production, components and the value of each feature, waste transmission, disposal equipment and treatment status, and etc.

- Waste production rate: the daily living waste production per capita in the 10 cities ranges from 0.66kg to 2.62kg, and the average is 1.16kg/day/person. Among these cities, Shenzhen has reached 2.62kg/day/person which is higher than that in Berkeley, California. The figure for Guangzhou, Beijing, and Shanghai is 1.2kg/day/person, which is the same as that in Rio de Janeiro, Brazil. The figure for Tianjin, Shenyang and Dalian is 1.02kg/day/person, which is close to Nantes, France, Urban Aress, India, and Manila, the Philippines.
- Waste components: the ratio of kitchen waste, fruit skins, bamboo and wood chips is 34.86%-72.26%, which is the same as that in foreign countries: 28.8%-76%. Dregs and stones take up 2.79%-35.6%, while it's 1.5%-31.7% in overseas. The ratio of plastic, metal, and glass is similar to that in foreign countries. Organic components take up 60%-95%, which is about the same level as that in other 3rd-World countries.
- Heat value, volume, weight, and water containing rate: heat value of waste has a big scope, ranging from 1850kJ/kg to 6413kJ/kg, with an average of 4000kJ/kg which can be directly combusted without any accessory fuel in the 10 cities. The waste volume and weight scope ranges from 220-450kg/m³. The water containing rate ranges from 44% to 70%.
- Waste disposal status: about 90% has been disposed through sanitary landfill, 9% has been composted, and only less than 1% for incineration.

2.3 Estimation and evaluation of MSW resource

- Estimation of MSW production

The main factors on waste production are GDP and population, among which GDP will reflect directly the social and economic development level, and presents indirectly the living standard of the citizens. Consequently, multi-factor method is applied when setting up the maths model for displaying the relations among the waste production and the two factors. Then estimation of future waste production is undertaken by using the maths model. In 2020, China's MSW production will reach 372.71 million ton from 135.89 million in 2000, with annual growth rate at 5.17%. The daily waste production per capita will increase to 1.77kg from 1.33kg in 2000, with the annul growth rate of 1.45%. Table 3 and Table 4 show the MSW production and the components (percentage before drying) in 2000 and 2020.

Table 3. Estimation of future production of MSW in China

Year	Annual production (10,000ton)	Annual growth rate (%)	Average annual production per capita (ton/year person)
1995	10748	-	0.468
2000	13589	7.18(1995-2000)	0.485
2005	17660	5.38(2001-2005)	0.485
2010	22798	5.24(2006-2010)	0.507
2020	37271	5.04(2011-2020)	0.646

Source: [5] Energy Research Institute of SDPC, the National Action Plan of Urban Waste Management and Landfill Gas Recovery Application, 1999

Table 4. China MSW components in 2000 (percentage before drying)

Component	Kitchen waste	Paper	Plastic	Cloth	Bamboo, wood, fruit skins	Metal	Glass	Dregs	Others
Proportion (%)	55.8	5.5	7.72	2.47	7.89	0.71	2.43	16.3	3.08

Source: the same as Table 3.

● Evaluation of MSW resource

The heat value of MSW has a range from 1850kJ/kg to 6413kJ/kg, which is a notable energy resource. The disposal and recovery methods of MSW in the world so far are: waste gasification or incineration waste heat recovery; landfill gas (LFG) recovery and application; and biogas produced from compost and RDF, etc. At present, the main method China has been adopting is sanitary landfill, taking about 90%, and the application rate of re-utilizing living waste as an energy resource is very low.

Based on the estimation in Table 3, China's MSW production will be 227.98 million ton in 2010. According to the components in Table 4, its organic part is 79.4%, mineral part is 21%, water containing rate is 56.8%, and volume and weight rate is 340kg/m³. If all of them will be disposed by landfill, the landfill gas (LFG) produced equals to 3.37-23.14 billion m³ of natural gas.

If waste incineration technology is applied to the 227.98 million ton of MSW to be produced in 2010, based on the generation rate of 20%, power of 300kWh can be generated from each ton of waste. Then the total power generated from waste will be 68500 GWh, taking up 3% of the country's total power production. Through incineration, the volume and weight of waste can be reduced, leading to a reduction of landfill disposal to 1/10, which remarkably reduce the land for landfill, expand the lifetime of landfill plant and protect the environment effectively.

3. The application of MSW incineration technology

3.1 The characteristics of MSW incineration technology

- Advantages: It has good effect on reducing the volume of MSW. It can reduce at least 80~90% of the MSW volume; sufficient disinfect; high temperature combustion can decompose the harmful components completely, kill virus; remove or reduce the effect to the environment from the continues procedure; significantly reduce the density of the pollutants from landfill liquid, and the smell from the released gas; it can especially benefits the resource utilization of MSW. The high temperature smoke from burning the MSW can be used for heat supply, power generation, cooling system etc.; the efficiency of disposal process is high. Since this technology requires less space, it can be build close to the urban, shorten the transportation distance, this is especially important for developed areas.
- Disadvantages: The investment for combustion facilities are huge, capital return circle is comparably long; it has certain requirement on the heat value to be utilized, not lower than 3.34MJ/kg, which has limited the application range; the price for disposing the outlet gas is high, technologies is not available for solve the pollution issue completely.

3.2 Applications of MSW incineration technology abroad

Currently, MSW incineration method has been used to dispose 51~80% of the urban waste in countries like Japan, Netherlands, Sweden, Denmark, Swaziland etc. There are nearly 2000 MSW incineration plant in Japan, dispose about 40 million tons of waste, which has the largest scale MSW incineration in the world. Figure 5 gives the share of the MSW disposal methods in major county/city's in 1998.

Table 5. The share of the MSW disposal methods in major counties/cities in 1998

Country	Landfill (%)	Piled fertilizer (%)	Incineration (%)	Numbers of incineration plants	MSW burned (Million ton/year)
U.S.	75	5	10	157	3
Japan	23	4	73	1899	3.086
Germany	65	3	32	53	1.000
U.K.	88	1	11	38	0.18
France	40	22	38	284	0.2
Netherlands	45	4	51	11	0.17
Belgium	62	9	29	29	0.132
Switzerland	20	-	80	34	0.17
Denmark	18	12	70	46	0.145
Sweden	35	10	55	23	0.14
Australian	62	11	24	3	0.035

Source: [5] Energy Research Institute of SDPC, the National Action Plan of Urban Waste

3.3 The present status of MSW incineration technology application and the major barriers in China

- Present application

The application of MSW technology research was started late in China, only few cities such as Shenzhen, Macau, Shanghai has implemented the incineration technologies based on importing new/advanced technology and facilities from other countries. There're two kinds of development and application currently in China: one is the local manufactured incineration facility. Its first generation is developed on the research on how to combust the remain from the piled fertilizer; the second generation of the products were able to burn original MSW directly. The capacity of these facility is 50ton per day. The second kind of facility is comprehensive incineration equipment. It is a system combined by international technology and domestic experience, a few cities has planned or already start to use this system, but currently only Shenzheng has build the system and operating continuously.

The technologies developed in China are also separated into two kinds: one is fixed bed incinerator and chain incinerator, the other one is fluidized bed technology. The first one is cost effective, but because the burned air will not mix completely with the waste, and the combust temperature is comparatively low, and not equal, which cannot decompose the harmful organic components in the waste, neither can control the emission of SOX, NOX, HCI, CO etc. therefore this kind of technology will not become the main stream of the waste combustion stove. The latter one has the advantages of cost effective, completely combustion process, and high efficiency, which is already became the focus of the future research and development. The thermal physical engineering institute of Academy of China (it has build a pilot project), Zhejiang University and Jinjiang Group Co. Ltd., Thermal Engineering Department of Tsinghua University, Anshan Coking Fire-Resistant Material Design Institute has already focus on development of this kind of waste incinerator. Since all of them has approached the method of burning the mixed waste or piled fertilizer waste and coal needs to be added in the process, the reliability and the life circle will be considered during the practical works.

- Barriers

Currently most of the MSW has a low heat value (<3344kJ/kg which is not reaching the baseline for self burning; MSW has higher ash component which become a barrier for volume reduction effort of the waste incineration; the MSW incineration technology is not available in the country yet, the construction and operating projects are lack of reliable technology; the modern MSW incineration technology needs high investment, construction capital has difficulties to collect.

4. Case study of MSW incineration for power generation as CDM project

4.1 CDM project description

- Objectives

Introduce advanced MSW incineration technologies, develop a MSW incineration power generation plant in one of the South city in China, to apply the waste volume reduction, harm decompose and comprehensive utilization. And in the end to be a polite CDM implementation project in Chinese Renewable Energy sector.

- Introduction

One waste incineration stove on 550 ton per day' capacity, will have a power generator at the capacity on 12MW, the technology and equipment are all imported, the general investment is 30 Billion RMB, it will still remain capacity on 2 production lines on 600 ton/day.

- Technology

Waste incineration technology including waste collecting system, incineration system, remained heat utilization system, ash utilization system, smoke process system, sausage system, auto-control system. The key technology will be the waste separation solid fuel technology, waste incineration stove and stove inter-combustion control technology, and smoke purify technology.

4.2 Baseline description

According to the conclusion of COP7 Documentation, appendix II, MSW power generation projects' baseline is the third kind (Renewable Energy Project). But Waste power generation project is different from wind and solar or other renewable energy projects. Besides it could replace other power generation methods, reduce CO₂ emission, it also helps to reduce or remove the CH₄ emission problems in landfill project. Therefore it is similar to Coal-bed Methane project, which has a double emission reduction effort. The baseline for this project is as following:

To replace the GHG emission considered under the existing power structure

Two parts of the power source in the existing power structure should be considered: power generated in local, and the power bought from other places. The purchased power should consider its source, and for the local generated power should consider the local power structure. If the future power structure development in the local and the generation efficiency have equal change curve, therefore CER acquisition time frame's mid point will be taken, the baseline emission will be calculated according to the future power planning and the generation efficiency.

Replacement for the GHG emission volume considered the local power structure, plus the CH₄ emission volume from the waste used for landfill, and this part will be add into the baseline. Since the waste is to be berried each year, the CH₄ emission will change after the years, to be easy to calculate, we suppose the CH₄ emission will be equal since the waste was berried, the calculation frame is 7 years.

the GHG emission which would be generated under the local power structure, and the CH₄ emission according to the landfill process would be calculated, and the time frame is 10 years.

4.3 Calculation of mitigation and its cost of the CDM project

4.3.1 Major parameters of the calculation

Table 6 shows the major parameters of the mitigation and its cost of the CDM project and the baseline.

Table 6. Major parameters of the CDM case study and the baseline

Major parameters of the CDM project	Major parameters of the baseline
Total project investment RMB300 million yuan Project lifetime: 20 years Social discount rate : 12% Daily waste treatment capacity: 550 ton/day Annual waste treatment capacity: 198,000 ton/year Minimum heat value produced: ~4000kJ/kg Generator capacity: 12MW Daily operating cost: 80 yuan/day Annual application hours: 7200 hours	Local power sources mix: Coal-fired plant : 94.5% , 47.1 GWh Oil-fired plant: : 5.5% , 2.8 GWh Coal consumption : Coal-fired plant : 332gce/kWh Oil-fired plant : 328gce/kWh Power generation cost: Coal-fired plant : 0.21yuan/kWh Oil-fired plant: 0.25yuan/kWh Average cost: 0.2123yuan/kWh Oil-fired plant: Minimum heat value: 40.91MJ/kg Carbon containing rate: 85% Carbon oxidation rate: 98% Emission factor of oil-fired plant: 0.163 kg-C/kWh ; Coal-fired plant: Minimum heat value: 24.49MJ/kg Carbon containing rate: 65% Carbon oxidation rate: 94% Emission factor of coal-fired plant: 0.303kg-C/kWh

4.3.2 Calculation of GHG emission reduction cost of the CDM project

$$C_i = (C_m - C_b) / (E_{mm} - E_{mb})$$

In which :

C_i ——incremental cost of the CDM project mitigation (yuan/t-C) ;

C_m ——total cost for generating 1kWh in the CDM project (yuan/kWh) ;

Cb——total cost for generating 1kWh in the baseline (yuan/kWh) ;

Emm——GHG emission of generating 1kWh in the CDM project
(t-C/kWh) ;

Emb——GHG emission of generating 1 kWh in the baseline (t-C/kWh) ;

4.3.3 Unit carbon mitigation cost of the CDM project

Unit carbon mitigation cost of the CDM project based on Baseline 1

Generation cost of the CDM project:

annual investment cost for generation: 40.2 million yuan/year

annual operating cost for generation: 13.2 million yuan/year

annual total cost for generation: 53.4 million yuan/year

unit cost for generation: 0.618yuan/kWh

Unit generation cost of the baseline: 0.2123yuan/kWh

Unit incremental cost of the CDM project: 0.4057yuan/kWh

Average carbon emission of unit generation of the baseline: 0.295kg-C/kWh

Annual CO₂ emission reduction: 25488 t-C/year

[6] Unit carbon mitigation cost of the CDM project: RMB1375/t-C ; equals to :
USD158/t-C

Unit carbon mitigation cost of the CDM project based on Baseline 2

Power generation+Landfill (life cycle is 7 years, and start calculating mitigation
from the 4th year.)

Average annual landfill production: 282,800 ton

CH₄ emission from the waste in unit emitting time(based on 40 years):

0.001925 ton/year*ton of waste

CH₄ emission of annual landfill production: 554 t-CH₄ , equals to 3232
t-CO₂

CH₄ emission of unit generation in the baseline: 0.037 kg-C/kWh

CO₂ emission of unit generation in the baseline: 0.295 kg-C/kWh

[6] Annual CO₂ emission reduction: 28720 t-C/year

[7] Unit carbon mitigation cost of the CDM project: 1222yuan/t-C ; equals to: USD140.5/t-C

Unit carbon mitigation cost of the CDM project based on Baseline 3

Power generation+Landfill (life cycle is 10 years, and start calculating mitigation from the 4th year.)

Average annual landfill production: 554,000 ton

CH4 emission from the waste in unit emitting time(based on 40 years):

0.001925 ton/year*ton of waste

CH4 emission of annual landfill production: 1066 tCH4 , equals to 6221 t-CO2

CH4 emission of unit generation in the baseline: 0.07 kg-C/kWh

CO2 emission of unit generation in the baseline: 0.295 kg-C/kWh

[6] Annual CO2 emission reduction: 31709 t-C/year

[7] Unit carbon mitigation cost of the CDM project: 1112yuan/t-C ; equals to: USD127.8/t-C

The above calculation demonstrates that the unit carbon mitigation cost for the CDM project using MSW incineration technology ranges from USD127.8 to USD158//t-C. A research team of the Nuclear Energy Research Institute of Tsinghua University has conducted an estimation of the incremental costs of the major GHG emission reduction technologies. The results are: wind energy project: USD81~98//t-C; solar water heater: USD287~402//t-C; coal-bed methane recovery: USD95~207//t-C. The figures show that living waste incineration technology as the CDM project has certain competency compared with other renewable energy technologies.

5. Sensibility analysis

5.1 The supposed conditions for analysis

- Suppose the cost for power generation is not changed, the nature gas share in baseline project power structure increase to 10% and 10%, then analyze the effect to the power generation cost in baseline projects, Coal reduction in CDM project and the cost of coal reduction according to the change of power structure.
- Suppose the power generation cost for baseline project keep still, the investment for

CDM project reduce 10% and 20%, the social discount rate of the project reduced from 12% to 10.8% and 9.6%, to analyze how would these changes effect to the cost of coal reduction in CDM project.

5.2 The result and conclusion of sensibility analysis

Table 7 and 8 have given the result of the sensibility analysis, according to that the conclusions are as following:

- The power structure changes does not effect much to the cost of baseline project, as the sensibility of emission reduction cost was not sensible due to the power generation structure.
- The investment to CDM project and the changes of social discount rate, has similar effect to coal reduction cost as power structure does.
- To reduce the cost of coal reduction in CDM project, an individual aspect will not make a significant different, we need to consider many aspects and the comprehensive effects.

Table 7. Suppose the generation cost remains unchanged: 0.618yuan/ kWh

The changes of nature gas share in power structure for baseline project (%)	0	10	20
The changes of the power generation cost in baseline project: (yuan/ kWh) Changes: (%)	0.2123 -	0.227 6.9	0.243 14.6
The changes of the coal reduction in CDM project: (g-C/kWh) Changes: (%)	295 -	275 7	255 14
The cost changes of emission reduction in CDM project : (Yuan/ t-C) To US\$: (\$/ t-C) Changes: (%)	1375 158 -	1433 165 4.2	1493 172 8.6

Table 8. Suppose the power generation cost for baseline project is keeping still: 0.2123yuan/ kWh

Investment changes for CDM project: (%)	0	Reduce 10%	Reduce 20%
Cost changes for the emission reduction in CDM project: (Y/t-C) Changes: (%)	1375 0	1221 11.2	1072 22
Changes of discount rate in CMD project: (%)	12 0	10.8 10	9.6 20

Changes: (%)			
Coal emission reduction cost in CDM project: (Y/ t-C)	1375	1261	1144
	158	145	131
To US\$: (\$/ t-C)	0	8.3	16.8
Changes: (%)			

6. Conclusions and suggestions

- 6.1 The emission reduction potential for MSW focuses on the replacement of other power generation methods, the CH₄ emission reduction volume from the landfill process is not regarded as the major share for reduction volume. (baseline 2 is 11%, baseline 3 is 19%).
- 6.2 The cost for MSW incineration for power generation is slightly less than other renewable energy project, and it has significant social benefits and environmental benefits, which can be the priority field for implementing CDM project in China.
- 6.3 MSW incineration for power generation has more potential as CMD project compared with CH₄ utilization project from landfill plants.
- 6.4 It's recommended to reduce the unit carbon-mitigation cost for MSW power generation project, develop relevant CDM policies for building the capacity as a CDM project, so that the responsibilities and obligations of the government and the MSW disposal industry can be fixed. (For instance, increase the processing fee of MSW, make policies to promote the commercialization of the project.)
- 6.5 Annex 1 countries should provide key technology/equipment in CMD projects, especially the manufacturing technology, the Non-Annex 1 countries should lower the unit carbon-mitigation cost of the MSW incineration project through absorbing, localizing, coping and applying those mature technologies, and by so-doing improve the competition capacity as a CDM project.
- 6.6 Developed countries have advanced technology and rich experience of application on MSW incineration for power generation. The technology in this sector in China is still under development, but the potential for technology application is huge, and has very good social and environmental benefits. China should actively develop this technology with joint efforts from developed countries, establishing substantial cooperation under the regime of the CDM.

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