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Supplementary Materials for

CH_4 mitigation potentials from China landfills and related environmental co-benefits

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Section S1. Scenario descriptions

The three scenarios are based on the China's Intended Nationally Determined Contributions released at the United Nations Climate Change Conference (COP21), in which China committed to reach its peak carbon dioxide emissions in 2030. Three scenarios include the business-as-usual (BAU) scenario, the new policies scenario (NP) and the low carbon scenario (LC). The differences of three scenarios were summarized in table S1 from the technology, policy, CO_2 market price perspectives.

(1) The **BAU scenario** describes that all landfills follow the same policies and technologies applied in the baseline year of 2012. This means that no specific mitigation policies will be released and applied. This scenario is designed to offer a baseline picture of how CH_4 mitigation process would evolve without any new policy interventions.

(2) The **NP** Scenario takes into account all the existing policies that had been adopted before 2012, together with relevant new policy proposals for 2020, even though some specific measures have yet to be fully implemented, such as the outline of the National Program for long - and medium term scientific and technological development (2006-2020), and the thirteenth Five-Year construction Plan for urban and rural garbage disposal facilities. Both plans include detailed targets and programs to develop the waste disposal facilities and commitments to reduce carbon emissions. The potential mitigation technologies for each landfill were assessed by a case-by-case judgment. This evaluation was completed by addressing many institutional, political and economic obstacles. In some cases, the details for related new policies and implementation measures were lacking. For these cases, we refer to the reduction targets of these programs, especially the 2020 mitigation targets.

(3) The **LC** Scenario assumes that a relatively high carbon price will be released, high enough to help control the global temperature growth under two degrees celsius (2°C)

in the long-term. The CO_2 price was estimated to be around 89 USD_{2010}/t CO_2) (*12*). This scenario takes a different approach, adopting a specified outcome – the international goal to limit the rise in long-term average global temperature growth to two degrees Celsius (2 °C) – and demonstrating how that might be achieved. This scenario assumes a set of new mitigation policies will be implemented and the concentration of greenhouse gases in the atmosphere is assumed to peak around the middle of this century, at a level above 450 parts per million (ppm). Under this scenario, the concentration of greenhouse gases will stabilize at around 450 ppm until 2100.

Section S2. Calculation methods

2.1 The odor emissions simulation processes and the affected populations

The ground-level source Gaussian dispersion model is used to simulate the landfill odor diffusion. H_2S was chosen as the representative odor gas. The H_2S emissions from all landfills were calculated according to CH_4 concentration since the volume ratio of H_2S to CH_4 is proven to be almost stable, which CH_4 concentration is approximately 50%, and H_2S concentration is approximately 36 ppm of the total landfill gases (*22, 26*). The CH_4 emission from all landfills was calculated by the FOD model recommended by the IPCC, which is the commonly used method for calculating CH_4 emissions from landfills (*3*). The following equation shows how to calculate the H_2S emission

$$V_{\mathrm{H_2S}} = V_{\mathrm{CH_4}} \div 50\% \times 36 \times 10^{-6}$$

Where $V_{\mathrm{CH_4}}$ represents the CH_4 emission.

When the H_2S concentration is below the olfactory threshold (0.41 ppb or 0. 62 μg/m^3) along the diffusion process (*33, 34*), then the affected distance for the population can be obtained. u is set as the average annual wind speed at the landfill location. Six atmospheric stability scenarios are included in the ground-level source Gaussian dispersion model. All these 6 diffusion results were calculated under the corresponding wind speeds of different landfills. The maximum value was chosen as the impact radius for each landfill for odor emissions estimation.

The affected population was calculated according to the odor diffusion area of each landfill and the population distribution pattern in China (*17*). LandScan (developed by Oak Ridge National Laboratory), as a spatial population dataset (30" × 30" globally, and about 1 km^2 in China), was used for spatial analysis (*35, 36*). The spatial population pattern in 2030 was assumed to be the same of that in 2012, and the total population estimation for the year 2030 was obtained from the *World Population Prospects: The 2015 Revision* under the Medium Variant condition (*37*).

2.2 CH_4 emissions abatement options

FOD emission factors for CH_4 emissions in landfills are obtained from field surveys and lab analyses, and are summarized in tables S2-S4. Nine key CH_4 mitigation measures were selected according to the technical feasibility and economical levels for CH_4 mitigation from all landfills in China, namely, functional soil cover (FSC), collection and flaring (LCF), collection and power generation (LCP), refinement process for MSW landfilling (RPL), leachate treatment with biogas collection (LT), collection and purification for further utilization (LCPU), mechanical biological treatment (MBT), renewable landfill (RL), and mineral landfill (ML). Information concerning CH_4 abatement technologies for future use was identified and analyzed. These nine mitigation measures were grouped into four major categories.

(1) Collection and flaring. LFG collection and flaring is the most common applied abatement measure, including the direct heating applications, electricity generation applications, purification of quality landfill gas and feedstock in chemical manufacturing processes.

(2) Reduction of the exposure area and the application of soil cover. Soil cover is an effective way to reduce the fugitive landfill gas through the CH_4 oxidation, especially in the small and middle scale landfills. The reduction of the operation area could decrease the fugitive landfill gas emission.

(3) Source reduction measures. The reduction of waste disposal amounts to the landfills can be achieved by the enhanced waste diversion practices, e.g. mineral landfills from the incineration plants, the reuse of the existing municipal solid waste disposal sites through renewable landfills, sanitation and closure of illegal landfills.

(4) Leachate treatment process and CH_4 collection from anaerobic tanks. Leachate normally occupies 20-30% of the total landfilling volume. Around 0.18-0.35 m^3 CH_4/kg chemical oxygen demand (COD) could be generated from leachate under the anaerobic digestion process (*38*). The enclosure operation of the leachate storage pool and the anaerobic digestion system can contribute to the reduction of odor generation.

To estimate the abatement costs of different measures, the corresponding investment/operation costs, the potentials, and efficiency of GHG mitigation, were summarized in table S5. According to the assessment criteria for harmless MSW landfills (CJJ/T107-2005), the location, the landfill life, the construction level, and the operation level were all considered. The potentials of CH_4 mitigation under three scenarios were evaluated according to the three landfill assessment results conducted in 2006, 2009 and 2012. The full application potentials of these mitigation processes in all landfills under three scenarios were estimated according to the economic conditions and the environmental protection requirements of different landfills, as shown in table S6.

2.2.1 The details of nine mitigation measures

(1) Functional soil covers (FSC)

Soil cover is a basic practice for a modern landfill although some methane will be fugitively emitted from the soil cover. Thus, an enhanced oxidation system should be applied so that some naturally occurring bacteria can oxidize CH_4. To improve the mitigation efficiency, several bio-based systems, such as temporary or long-term bio-covers, passively or actively vented bio-filters, and bio-windows, have been developed. These systems can provide optimum conditions for microbial habitation and efficiently recover the landfill gases. For example, a novel simulated bio-cover was developed to facilitate the biological methane oxidation process using aged refuse and aged sludge from landfills (*27*).

(2) Landfill gas collection and flaring (LCF)

A landfill gas collection system is an indispensable part of one landfill. This system collects the landfill gas from the landfill body and reduces the LFG concentrations in the landfill. It can prevent the migration of CH_4 to on-site structures and adjacent properties and avoid the direct release of non-CH_4 organic compounds (NMOCs) to the atmosphere. A collection systems is configured either as a vertical well (which is the most common one), a horizontal trench (which is primarily used for a deeper landfill where the landfill cells are actively being filled), or a combination of the above two. A trench and a wellhead are connected through a pipeline that transports the LFG to a collection header. Such facilities should be constructed in advance before a landfill can accept any wastes. The LFG collection usually begins after a landfill is closed.

After the LFG is collected, it will be flare-ignited. Large landfills have historically collected CH_4 and flared it. Flare designs include open and enclosed flares. Enclosed flares are more expensive but provide better control of combustion conditions. They allow for stack testing and reduce light and noise nuisances, leading to higher combustion efficiency.

(3) Collection and power generation (LCP)

After a landfill gas is collected from landfill piles, the LFG could be flared or converted to electricity. Converting LFG to electricity offers a potentially cost-effective way to use the landfill gas.

LFG is extracted from landfills using a series of vertical or horizontal wells and a blower (or vacuum) system. This system delivers the collected gas to a central point, where it can be processed or treated depending on the ultimate use of the gas.

LFG treatment removes moisture and other contaminants (e.g., siloxanes) that may disrupt the energy generation equipment (*1*) . Treatment requirements depend on the end-use application.

Components of one electricity generation system include the equipment for generating energy (e.g., internal combustion engine, gas turbine, or micro-turbine) and the interconnections for transmitting produced electricity to the power grid.

This analysis considers four alternative technologies under this abatement measure, including internal combustion engine, gas turbine, micro-turbine, and combined heat and power (CHP) technologies.

Generally, the sale of produced electric power can provide more revenues that offset the implementation costs. Such facilities include a LFG collection and flare system, as well as one electricity generation system.

(4) Refinement process for MSW landfilling (RPL)

The dumping, paving and compressing processes for MSWs are critical steps for mitigating odor emissions from a landfill pile. The reduction of an operation area could contribute to synergistic CH_4 and odor mitigation.

The refinement process for MSW landfilling includes minimization of the operation area; optimization of landfill cells and standard operations for MSW landfilling.

The ideal ratios of MSW landfilling amounts/operation area are usually 0.6-0.7 ton/m^2, but in the reality such ratios usually range above 0.8 ton/m^2 for most existing landfills, especially when some landfills are not covered all the time. Refining landfill operations can greatly reduce the operation area, which contributes to mitigating odors and CH_4 emissions from landfills.

(5) Leachate treatment with biogas collection (LT)

Leachate normally occupies 20-30% of one MSW landfill and generates around 0.18-0.35 m^3 CH_4/kg COD during the anaerobic digestion process, due to the high COD content (*38*). Enclosure operations for leachate storage pools and anaerobic digestion systems contribute to odor generation reduction. Leachate treatment (LT) is currently a legal requirement for removing pollutants from leachate, according to the regulatory standard for landfill site pollution control of municipal solid wastes (GB 16889-2008).

(6) Collection and purification for further utilization (LCPU)

Direct use of LFG provides an alternative with minimal treatment. In this situation collected LFG is pumped to a nearby (< 5 miles) end user. The LFG can serve as a fuel for boilers or drying operations, kiln operations, or cement and asphalt production.

Although minor condensate removal and filtration is needed, combustion equipment should be slightly modified so that it can be fueled with LFG.

Ideally, a LFG consumer has a steady annual gas demand compatible with the landfill's gas flow. The cost for a gas compression and treatment system includes compression and moisture removal facilities, as well as filtration equipment for transporting the gas.

(7) Mechanical biological treatment (MBT)

Mechanical biological treatment (MBT) is a waste processing measure that combines a sorting facility with biological treatment such as composting or anaerobic digestion. The primary objective is to reduce waste volume. A secondary objective is to lower environmental impact after its deposition (i.e., low emissions of landfill gas, small amounts of leachate, and a reduced settlement of the landfill body). MBT includes separation of useful waste components such as metals, plastics, and refuse-derived fuel (RDF) so that these items can be reused by local industries. A MBT plant is designed to process mixed household, commercial, and industrial wastes. It can enable materials recovery and facilitate biodegradable components stabilization. Sorting operations aim to recover the individual elements of the wastes or produce RDF for power generation. Typical reused waste items include ferrous and non-ferrous metals, plastic, and glass. There are three main types of biological treatment processes: ①an aerobic stabilization system in which the stabilized output is sent to a landfill or used for land remediation/recovery projects, ②an aerobic bio-drying system for producing RDF after undergoing an aerobic stabilization process, while the remaining streams are sent to a landfill, and ③ a system combining aerobic and anaerobic treatments in which the anaerobic process is used to produce biogas, followed by an aerobic process that produces a stabilized output that can be sent to a landfill.

To produce RDF, either window or box systems can be used. In box systems, the waste is treated aerobically for one week but with high aeration rates. The result is a dried material with slightly reduced organic content. Only the most easily degradable compounds are metabolized so that the loss of caloric value is low. The dry material can be fractionated very easily, because adhesive substances are eliminated in the bio-process. Iron and nonferrous metals, as well as glass and minerals, are separated for material recovery. Similar to the composting process, there is a small level of fugitive CH_4 emissions that accompany the aerobic degradation process, as well as some N_2O emissions from NO_x denitrification during the curing stages of the stabilization process.

(8) Renewable landfill (RL)

Renewable landfill (RL) is derived from a conventional landfill (CL) that shifts from a terminal disposal environment to a resource reservoir for temporary storage. RL provides an inexpensive and land-saved “waste landfilling” concept which integrates the options of landfill stabilization acceleration, landfill excavation/mining and comprehensive residual material resource routes. In contrast to a CL with a linear system (waste-landfill), RL is a circular system (waste–landfill - reuse of aged refuse and landfill volume - waste delivered to landfill again). Wastes are degraded under the optimum conditions and then the stabilized waste is excavated and removed so that this landfill can be reused.

RL extends the concept of waste recycling from source separation (some valuable materials are collected and recycled by scavengers in some developing countries, which reduce the waste amount to the landfills). The compartment cell land and low value materials are recovered through landfill excavation and land remediation. As a derivate technology from CL, RL combines and integrates the valorization of waste by materials recycling (Waste-to-Material, WTM) and energy recovery (Waste-to-Energy, WTE), extending a landfill life through multi-utilization of the landfill volume. It is a new approach to reduce pollutants released from landfills in terms of leachate and landfill gas. It helps expand the MSW landfill capacity and avoid the high cost of acquiring additional land, leading to sustainable and economical landfilling operations. RL is regarded as a viable and abundant source for materials and energy recovery (*38*).

(9) Mineral landfill (ML).

Municipal solid wastes can be incinerated to reduce the total volume, save the landfill costs and recover energy from its combustion either for heating and/or electricity generation. Mineral landfills use bottom ash disposed from incineration plants. Thus, its main emissions include CO_2, CO, NO_x, and non-CH_4 volatile organic compounds (NMVOCs). The two most widely used incineration technologies are mass-burn incineration and modular incineration. Representative CH_4 emissions of 0.2 to 60 kg/Gg of waste (wet weight) and N_2O emissions of 41 to 56 g/ton of waste (wet weight) were obtained from IPCC (*26*).

2.2.2 Abatement cost for CH_4 reduction

It is necessary to get marginal abatement cost curves based on the achievable cumulative CH_4 emissions reduction processes (over the whole period). The whole process consists of the following steps: calculate total cost and abatement potential for all technologies; identify possible combinations and incompatibilities; manipulate and standardize data; derive the abatement cost curves. Information on existing GHG abatement technologies and future technologies were integrated for the three scenarios. The total abatement cost curve is a stepwise function, constructed from the costs of combinations of discrete abatement measures. The direct economic effects are given by the expert-based marginal abatement cost curves and can be captured by bottom- up models. Bottom-up models contain the options of reducing emissions through a number of discrete technologies but ignore the interactions between markets, discount rates, inflation rates, indirect costs, and social welfare. The total abatement cost curve is constructed from the expenses of discrete abatement measures and reduction potential (fig. S1).

Figure S1. The total abatement cost curve of different GHG mitigation processes for landfills.

Section S3. Data sources

The landfills constructed before or in 2012 are regarded as the old landfills. Data for all the old landfills (1955 landfills) were collected from provincial environmental protection bureaus and our field investigations (*17*). Data quality was checked by cross verification (logical analysis between different indicators), and some abnormal values were identified and revised after the field investigations.

China is divided into 7 regions according to regional climate, economic development and the people’s habits and customs, namely East China (EC), North China (NC), South China (SC), Northeast (NE), Northwest (NW), Southwest (SW), Middle China (MC) (fig. S2). The images of the selected large existing landfills are shown in fig. S3.

The landfills projected for 2030 were estimated according to the landfill situations in 2012, the expected populations and the economic conditions in 2030 in different regions. The closed time for the existing landfills was evaluated according to the remaining volumes and the daily landfilled waste amounts in 2012, where the remaining landfill capacities were different between the designed volumes and the actual volumes, and the closure time was calculated by dividing the remaining capacity and the annual MSW amounts filled in that particular landfill

$$V_{\text{remaing}} = V_{\text{designed}} - V_{\text{filled in 2012}}$$

$$T_{\text{closing}} = V_{\text{remaining}} / V_{\text{annual filled}}$$

Around 1316 landfills are supposed to be closed before 2030.

Usually, landfilling is the first choice for most west and inland areas in China due to the low investment and operation costs, and the available land. For the large and middle cities in the eastern regions, incineration is the predominant waste disposal method due to the land limitation. 680 Chinese cities have no waste disposal facilities. Around 495 new landfills with different scales will be constructed according to the related governmental environmental protection plans, the urban environmental sanitation industry reports, national construction plan of urban waste disposal facilities and the local conditions in 2012. Chai et al., (*2*) also claimed that although landfilling has been saturated in the east, it is still a promising method for waste management in the west.

Those landfills constructed between 2012 and 2030 are regarded as the new landfills. Generally, the detailed calculation process was assumed based on “the construction standards of the solid waste disposal facilities in the small towns” . The minimal landfill disposal facility is 50 t/d for one county/town, and the collection distance is set as 40 km, since a longer transportation distance will cost too much for wastes. Therefore, waste disposal facilities should be constructed if the local population density reaches 40-80 people/ km^2. However, in the eastern China, incineration is the first choice if the population is above 1000 people/km^2.

The new landfills capacities are estimated according to the local population and the per capita MSW generation. According to the national standards, 13, 160 and 322 new landfills belong to level I, II, and III landfill sites, respectively. Time frame of commissioning new regional landfills will be scheduled in 2017, 2020, 2021 and 2022 in the East China/South China/North China, North East/Middle China, Southwest and Northwest China, respectively. The corresponding MSW volumes, CH_4 and odor emissions are then estimated for the year 2030.

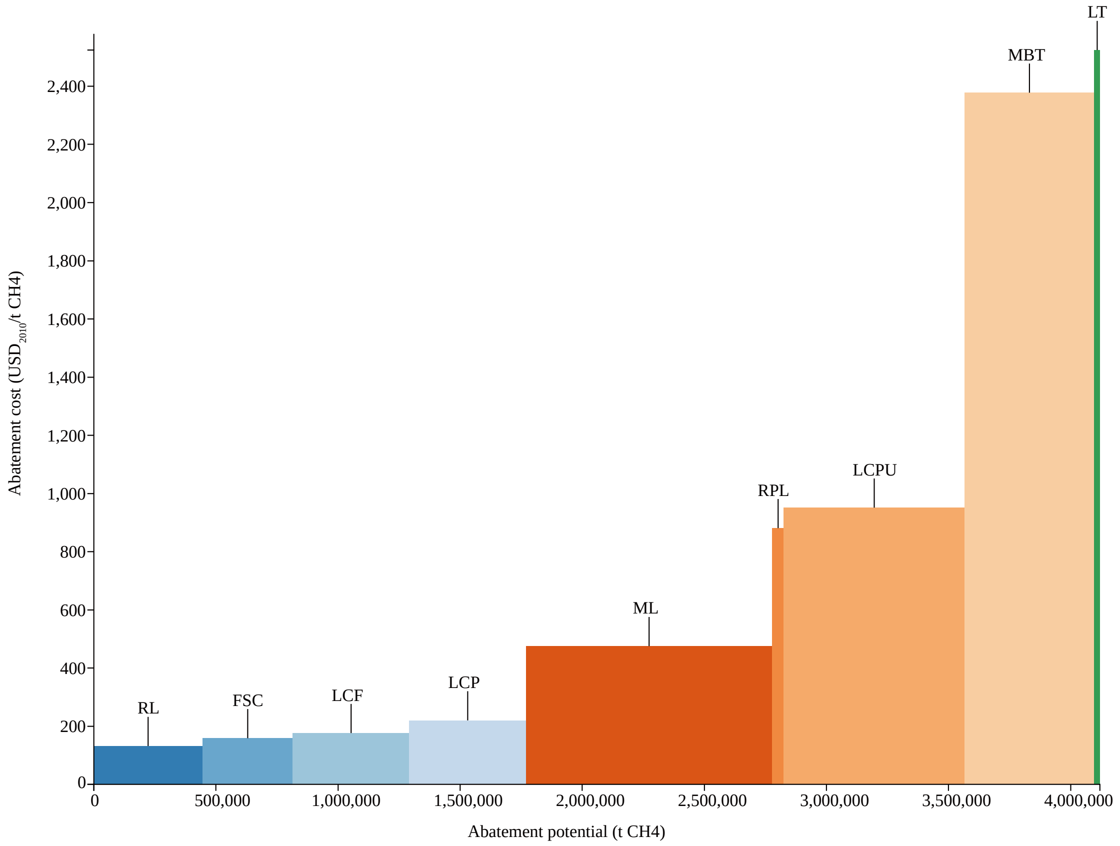

Fig. S1. The total abatement cost curve of different GHG mitigation processes for landfills.

Note: This means that the true marginal cost curve consists of a series of spikes, each spike representing the point at which the next, more expensive technology must be applied in order to achieve further abatement, followed by a range of zero marginal cost representing the total abatement achieved by the technology in question.

Fig. S2. The seven regions of China.

Note: The white lines in the map represent the provincial boundaries.

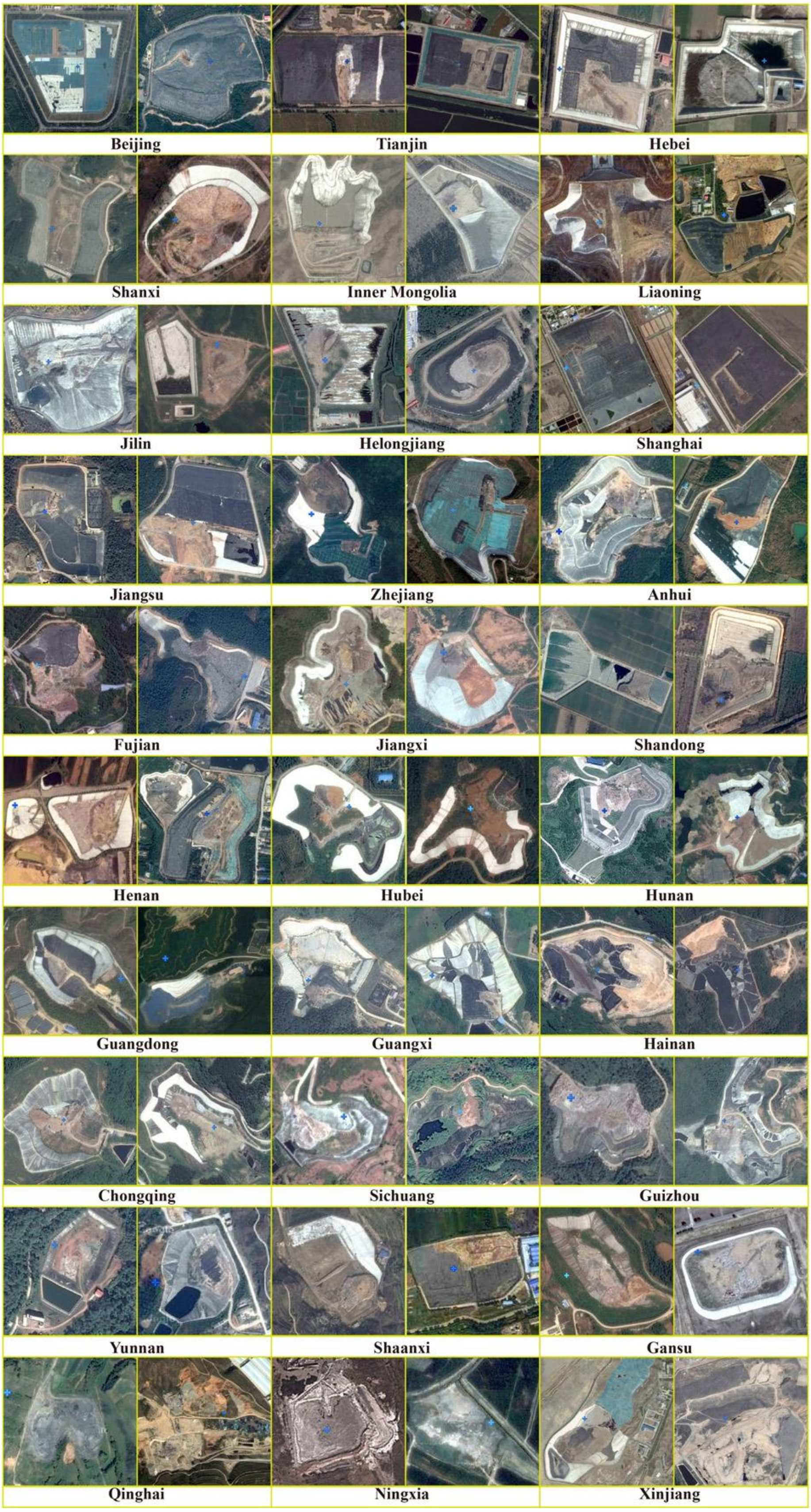

Fig. S3. The graphic list of the typical landfills in 30 provinces.

Table S1. The summary of the policy, mitigation, and market prices in three scenarios.

	Policy implementation	Mitigation technologies	Market price
Baseline 2012	China is a member of the Global Methane Initiative	1. Standard of Assessment on Non-hazardous Disposal of Municipal Solid Waste (CJJ/T107-2008); 2. The real situation of the mitigation technologies 3. the Renewable Energy Law of 2006	
2030-BAU	1. Standard for Pollution Control on the Landfill Site of Municipal Solid Waste (GB 16889-2008) 2. Technical code for municipal solid waste sanitary landfill(GB 50869 – 2013) 3. 2010- Construction of small cities and towns life garbage disposal standards	1. The settlement of the mitigation technologies were according to the experts judgments 2. Follow the mitigation situation of 2012	
2030-NP	1. Hu Jintao. Unswervingly advance along the path of socialism with Chinese characteristics,strive to build a well-off society——At the 18th CPC National Congress report 胡锦涛. 坚定不移沿着中国特色社会主义道路前进为全面建成小康社会而奋斗——在中国共产党第十八次全国代表大会上的报告［EB/OL］. 人民网, http://cpc.people.com.cn/18/n/2012/1109/c350821-19529916.html. 2012-11-8 2. Outline of “Healthy China 2030 " program 健康中国 2030”规划纲要 3. U.S.-China Joint Announcement on Climate Change, 2014, Nov. 12, 中美	1. The settlement of the mitigation technologies were according to the experts judgments 2. The expert judgments for the potential application of mitigation processes. We organized a group for this assessment, and the detailed information of the referees are as follows: We selected 7 Prof. in the waste area from different regions, Tongji Univ. in Shanghai (Prof. Zhao Youcai), Huazhong Univ. of Science and Technology in Wuhan (Prof. Ii Guangke), Chongqing Univ. in Chongqing (Prof. Peng Xuya), Tsinghua	

	气候变化联合声明 4. China’s Intended Nationally Determined Contributions at the United Nations Climate Change Conference (COP21) 巴黎协议 5. " Thirteen-Five " national construction planning of urban living garbage treatment facilities 发展改革委、住房城乡建设部.“十三五”全国城镇生活垃圾无害化处理设施建设规划. 2016 年 12 月 6. Outline of the National Program for Long - and medium - term scientific and technological development (2006-2020). 国家中长期科学和技术发展规划纲要（2006-2020 年） 7. People's Republic of China stock of housing and urban - rural construction waste management project management approach	Univ., in Beijing (Prof. Liu Jianguo), Guilin University of Science and Technology in Guangxi province (Prof. Sun Xiaojie), Shenyang Aerospace Univ. in Shenyang (Prof. Li Rundong), Zhejiang Gongshang Univ. in Zhejiang Providence (Prof. Shen Dongsheng). The treatment patterns of the waste disposal in different stages, especially on the occupied percentage of the relative disposal processes, the waste compositions, and the disposal level of the landfill. 3. We combined the results of these 7 Prof. and our previous data accumulation, and set the roughly activity data on this estimation.	
2030-LC	All of these policies, plus the economic incentives	1. the settlement of the mitigation technologies were according to the experts judgments 2. most of the mitigation technologies could be applied, with the higher CO_2 price	The top price , 60 $/t CO_2 (*12*)

Table S2. Waste compositions in seven regions of China.

Region	Provinces	Number of cities investigated	Composition of waste type with degradable contents (%)			
			Kitchen waste	Paper	Textile	Wood
Northwest	Xinjiang, Gansu, Qinghai, Ningxia, Shaanxi	7	39.26	5.00	2.38	3.92
North China	Shanxi, Inner Mongolia, Hebei, Beijing, Tianjin	7	53.25	7.67	3.26	3.21
Northeast	Heilongjiang, Jilin, Liaoning	9	59.90	7.30	1.54	2.30
Central China	Henan, Hubei, Hunan	6	35.57	4.58	1.07	1.73
East China	Shandong, Jiangsu, Anhui, Shanghai, Zhejiang, Fujian, Jiangxi	16	54.07	7.27	4.45	1.55
Southwest	Chongqing, Sichuan, Guizhou, Yunnan, Tibet	6	45.54	7.14	3.14	3.64
South China	Guangdong, Guangxi, Hainan	4	44.05	5.80	2.00	3.17

Note: The time span of data covers 2000–2010 for these 55 cities.

Table S3. The wet-based ratios of degradable organic carbon in different components of MSWs.

Source	Kitchen waste	Paper	Textile	Wood
Results in this paper	0.11	0.24	0.27	0.33
IPCC default value	0.15	0.40	0.24	0.43

Table S4. Key parameters in the FOD model.

Type of landfill	CH_4 oxidation factor			CH_4 correction factor	CH_4 recovery rate (%)
	Northwest	North China, Northeast, Central China, East China	Southwest, South China		
I	0	0	0	1	40
II	0.08	0.10	0.15	0.92	24
III	0.15	0.20	0.30	0.61	5

Table S5. The mitigation costs, potentials, and efficiency for the different treatment processes.

	Suitable area			Mitigation cost		mitigation potential	mitigation efficiency
	L	M	S	Yuan RMB/t CH_4	Yuan USD/t CH_4	t CH_4	%
RPL	√	√		5460.01	880.65	47754.7	4.5
FSC	√	√	√	982.801	158.52	370301	25
LCF	√	√		1092	176.13	477547	45
LCP	√	√		1365	220.16	477547	45
LCPU	√	√		5896.81	951.10	740602	50
MBT				14742	2377.74	530607	50
RL	√	√	√	819.001	132.10	444361	30
ML	√	√	√	2948	475.48	1008154	95
LT	√	√	√	15649.7	2524.15	23254.9	1.57

Table S6. The application potentials of different mitigation processes.

		The Current Policies Scenario BAU			**New Policies Scenario**			**Low Carbon Scenario**		
		I	II	III	I	II	III	I	II	III
EC	RPL	40%	20%	10%	40%	30%	30%	60%	80%	70%
	FSC	90%	80%	50%	5%	10%	20%	10%	20%	45%
	LCF	40%	20%	0%	20%	20%	20%	20%	40%	70%
	LCP	10%	5%	0%	10%	15%	0%	30%	35%	0%
	LCPU	0%	0%	0%	0%	0%	0%	10%	0%	0%
	MBT	0%	0%	0%	0%	0%	0%	10%	0%	0%
	RL	20%	5%	30%	20%	15%	0%	20%	15%	10%
	ML	0%	0%	0%	20%	20%	20%	40%	40%	40%
	LT	80%	70%	20%	10%	10%	20%	20%	30%	50%
NC	RPL	20%	10%	0%	20%	10%	20%	60%	30%	40%
	FSC	80%	60%	40%	10%	20%	20%	20%	40%	55%
	LCF	30%	20%	0%	20%	20%	20%	30%	40%	70%
	LCP	10%	0%	0%	10%	20%	0%	30%	40%	0%
	LCPU	0%	0%	0%	0%	0%	0%	10%	0%	0%
	MBT	0%	0%	0%	0%	0%	0%	10%	0%	0%
	RL	0%	0%	0%	20%	10%	0%	40%	20%	40%
	ML	0%	0%	0%	20%	10%	0%	40%	40%	0%
	LT	80%	60%	11%	10%	20%	29%	20%	40%	59%
SE	RPL	40%	20%	10%	60%	70%	60%	60%	80%	70%
	FSC	90%	80%	60%	10%	20%	30%	10%	20%	35%
	LCF	60%	20%	10%	0%	20%	20%	-20%	40%	60%

	LCP	10%	5%	0%	30%	15%	0%	50%	35%	0%
	LCPU	0%	0%	0%	0%	0%	0%	10%	0%	0%
	MBT	0%	0%	0%	0%	0%	0%	10%	0%	0%
	RL	20%	5%	10%	20%	15%	10%	20%	15%	30%
	ML	0%	0%	0%	20%	20%	0%	40%	40%	0%
	LT	80%	70%	14%	20%	10%	46%	20%	30%	66%
NE	RPL	10%	5%	0%	40%	35%	30%	90%	95%	80%
	FSC	80%	60%	40%	20%	20%	30%	20%	40%	40%
	LCF	40%	20%	10%	20%	40%	40%	10%	40%	60%
	LCP	5%	0%	0%	35%	20%	0%	45%	40%	0%
	LCPU	0%	0%	0%	0%	0%	0%	0%	0%	0%
	MBT	0%	0%	0%	0%	0%	0%	5%	0%	0%
	RL	0%	0%	0%	20%	10%	0%	30%	20%	10%
	ML	0%	0%	0%	10%	10%	0%	20%	20%	0%
	LT	60%	50%	12%	30%	30%	48%	40%	50%	58%
NW	RPL	10%	5%	0%	30%	35%	20%	80%	75%	70%
	FSC	60%	40%	20%	40%	20%	30%	40%	60%	60%
	LCF	30%	10%	0%	20%	20%	20%	30%	50%	50%
	LCP	0%	0%	0%	20%	10%	0%	30%	40%	0%
	LCPU	0%	0%	0%	0%	0%	0%	0%	0%	0%
	MBT	0%	0%	0%	0%	0%	0%	10%	0%	0%
	RL	0%	0%	0%	0%	0%	0%	30%	20%	0%
	ML	0%	0%	0%	0%	0%	0%	20%	20%	0%
	LT	50%	40%	11%	20%	20%	49%	50%	60%	59%
SW	RPL	10%	5%	0%	40%	45%	30%	90%	95%	90%
	FSC	70%	60%	40%	30%	20%	30%	30%	40%	40%
	LCF	25%	20%	10%	20%	20%	20%	20%	40%	60%
	LCP	10%	0%	0%	20%	10%	0%	30%	40%	0%
	LCPU	0%	0%	0%	0%	0%	0%	0%	0%	0%
	MBT	0%	0%	0%	0%	0%	0%	10%	0%	0%
	RL	0%	0%	0%	20%	10%	0%	30%	20%	10%
	ML	0%	0%	0%	0%	0%	0%	20%	20%	0%
	LT	70%	50%	12%	20%	30%	48%	30%	50%	58%
MC	RPL	20%	15%	0%	50%	45%	50%	80%	85%	90%
	FSC	80%	60%	40%	20%	40%	40%	20%	40%	50%
	LCF	25%	20%	10%	20%	60%	40%	0%	30%	60%
	LCP	10%	0%	0%	20%	20%	0%	40%	50%	0%
	LCPU	0%	0%	0%	0%	0%	0%	10%	0%	0%
	MBT	0%	0%	0%	0%	0%	0%	10%	0%	0%
	RL	0%	0%	0%	20%	10%	0%	30%	20%	10%
	ML	0%	0%	0%	0%	0%	0%	20%	20%	0%
	LT	70%	60%	15%	20%	20%	45%	30%	40%	55%

Note: according to the expert judgment