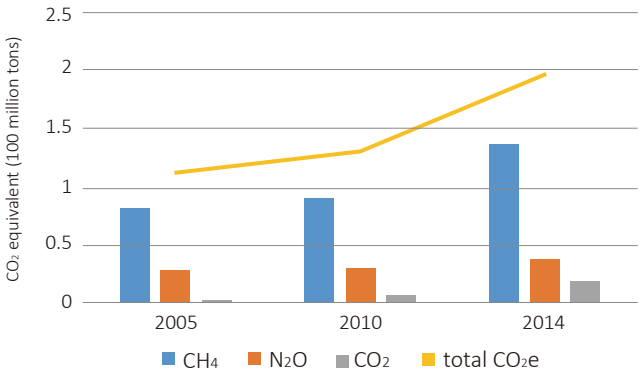
绿色创新发展中心
Innovative Green Development Program

Current Status and Prospects of Non-CO_2 Greenhouse Gas Emission Reduction in China's Waste Management Sector

In the past, China has attached great importance to the utilization of domestic waste and the treatment of municipal sludge, but the emphasis has been on controlling pollution, rather than greenhouse gas (GHG) emissions. While pollution prevention and control can have positive effects on GHG emissions, urbanization and industrialization in China mean that the emissions regulation aspect of the waste management sector will become ever more important in China's push for carbon neutrality. With the 30/60 decarbonization goals, China intends to promote a green, low-carbon transition which will require cities to take action to reduce non-CO_2 GHG emissions such as methane and nitrous oxide in domestic waste and municipal sludge treatment and disposal.

According to *The Second Biennial Update on Climate Change in the People's Republic of China* published in 2018[1], methane emissions from the waste management sector accounted for 11.9% of China's methane emissions in 2014, and between 2005 and 2014, GHG emissions from China's waste disposal sector increased from 113 million tons of Carbon Dioxide Equivalent (CO_2e) to 195 million tons. With the continuation of existing policies, methane emissions from China's waste sector will reach 269 million tons CO_2e in 2050, and with the adoption of existing emissions reduction technologies, methane emissions from China's waste sector will still climb to 218 million tons CO_2e in 2050, putting pressure on the waste sector to reduce methane emissions[2].

Figure 1: GHG emissions from China's waste disposal

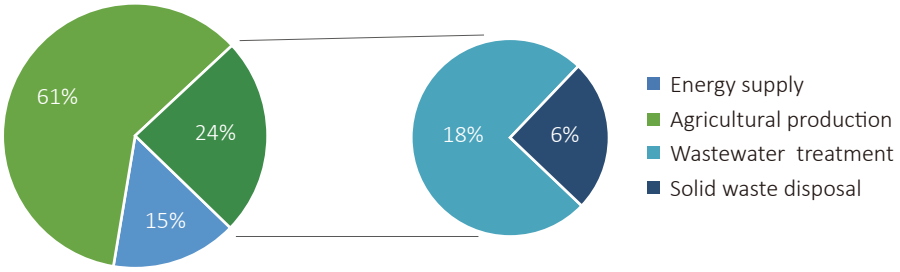


Data source: 'The Third National Information Disclosure of the People's Republic of China on Climate Change' and 'The Second Biennial Update on Climate Change in the People's Republic of China'

[1] Ministry of Ecology and Environment of the People's Republic of China, (2019). The Second Biennial Update on Climate Change in the People's Republic of China.https://www.mee.gov.cn/ywgz/ydqhbh/wsqtkz/201907/P020190701765971866571.pdf

[2] Teng, F., Su, X., & Wang, X. (2019). Can China Peak Its Non-CO_2 GHG Emissions before 2030 by Implementing Its Nationally Determined Contribution? Environmental Science & Technology, 53(21), 12168–12176. https://doi.org/10.1021/acs.est.9b04162

Figure 2: 2050 remaining Non-CO_2 GHG by sector after deep mitigation measures[3]



Data source: Lin et al., 2021

Waste Management Policy Summary

From the 1980s to the present, China has managed non-hazardous treatment of domestic waste. A waste treatment and management system based on waste separation exists, and a domestic waste classification system has been clearly defined in legislation. This legislation contains scope for further expansion of waste separation and the utilization of waste as a resource.

Policies	Key measures
Notice on the Announcement of the First Batch of Model Cities (Districts) for Domestic Waste Classification	• Set up a domestic waste classification pilot. • Classify waste into hazardous, kitchen and recyclable waste. • Implement green development methods, promote clean manufacturing and the circular economy. • Promote a domestic waste classification system at the national level. • Improve national domestic waste classification, collection and transportation capacity to about 700,000 tons per day by 2050, meeting the demand of cities at the prefecture level and above for domestic waste collection, transportation, and treatment after classification. Encourage counties to promote the construction of domestic waste classification and treatment facilities.
Implementation Plan for a Domestic Waste Classification System	
The Law of the People's Republic of China on the Prevention and Control of Environmental Pollution by Solid Waste	
Development Plan for Urban Domestic Waste Classification and Treatment Facilities in the 14th Five-Year Plan	

Similarly, municipal wastewater treatment has been rapidly developed. China has issued a series of supporting documents to regulate sludge treatment and disposal methods in wastewater treatment plants, as well as in stabilization of sludge.

[3] Lin, J., Khanna, N., Liu, X., Wang, W., Gordon, J., & Dai, F. (2021). Opportunities to Tackle Short-lived Climate Pollutants and other Greenhouse Gases for China.

Policy actions	Major measures
Guide on Best Available Techniques for Sludge Treatment and Disposal and Pollution Prevention and Control in Municipal Wastewater Treatment Plants (for Trial Implementation)	• Select the best feasible technologies for sludge treatment and disposal. • Regulate the sources and quality of sludge from municipal wastewater treatment plants. Implement technical routes for sludge treatment and disposal, sludge disposal methods and related technologies, and emergency response and risk management. • Require that sludge be stabilized and made harmless for resource utilization, and prohibit sludge with substandard treatment and disposal from entering arable land. • Encourage the application in landscaping of sludge that meets the treatment criteria.
Technical Guideline for Sludge Treatment and Disposal in Municipal Wastewater Treatment Plants (for trial implementation)	
Action Plan for Water Pollution Prevention and Control	
Action Plan for Soil Pollution Prevention and Control	

However, owing to the long-standing practice of prioritizing treatment of wastewater over sludge, standards are not will defined and provide insufficient guidance for sludge disposal practices, with the result that the sludge problem remains unresolved.

Challenges for Waste Management

There are still significant challenges to be overcome in waste treatment and disposal in China, particularly at the urban level.

Taking anaerobic digestion as an example, there are still barriers to including purified biogas and implementing subsidized tariffs for biogas power generation, and there is no clear policy support for the utilization, treatment and disposal of digestate.

The treatment and disposal of municipal sludge also faces inter-sectoral coordination and planning challenges. In practice, since the development and implementation of sludge standards covers multiple government departments – agriculture, forestry, environmental protection, and others – the utilization of certified digestate on the land depends largely on their cooperation.

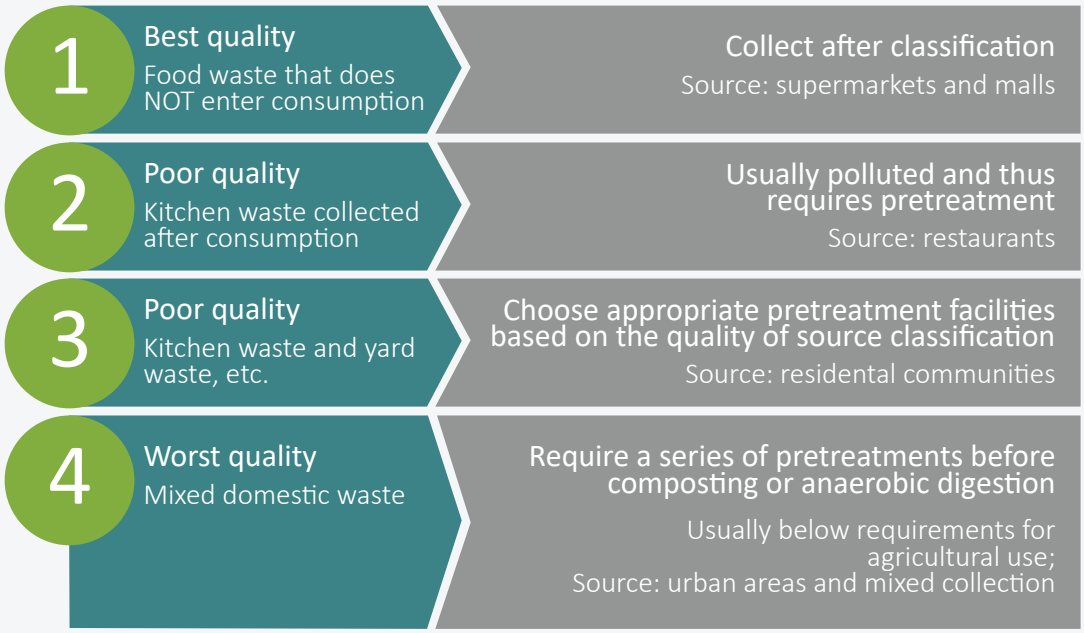
Resource utilization of domestic waste shows little economic advantage. Most landfill facilities only calculate operating costs without considering land footprint and environmental impacts, which leads to the current waste treatment pattern in China, which is still landfill-dominated (at over 60% of waste), generating high GHG emissions.

In addition, the promotion of anaerobic digestion in China requires financial and policy support. Carbon emissions from sludge disposal are about 40%[4] of those from the wastewater treatment system, but only some regions have included sludge treatment and disposal fees in their wastewater treatment budgets due to the aforementioned tendency to prioritize wastewater over sludge. In Jiangsu Province for example, the amount allocated to sludge disposal accounts for only 15%[5] of the wastewater treatment budget. Despite the maturity of the technologies for anaerobic digestion, there is a lack of investment in facilities, forming one of the main barriers to sludge treatment.

Technology path: Anaerobic digestion as a breakthrough in waste treatment and disposal for non-CO_2 GHG emission reduction

Kitchen waste can be treated to obtain valuable products, as well as fuel and energy. Figure 3 summarizes the different sources and respective qualites of perishable organic waste. Anaerobic digestion can be used to treat waste of types 1-3 in Figure 3. Type 4 mixed waste has limited potential for use as digestate. Anaerobic digestion technology is currently used in domestic waste treatment both domestically and internationally.

Figure 3: Source and quality of food waste



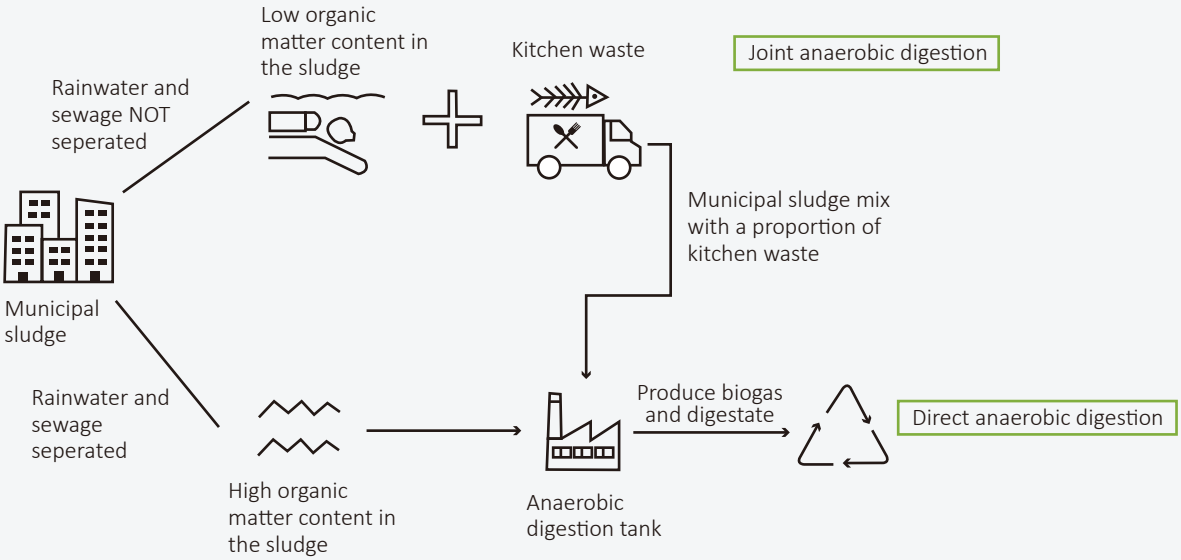
The *Guide on Sludge Treatment and Disposal*[6] suggests huge potential emissions reductions from 'anaerobic digestion + land use changes'. In practice, realizing this potential requires different approaches based on consideration of sludge quality: direct anaerobic digestion for municipal sludge with a high organic matter content, versus combined anaerobic digestion for sludge with a low organic matter content, as shown in Figure 4.

[4] Carbon trading will be introduced in the field of sludge treatment and disposal to promote industrial carbon emission reduction https://www.chndaqi.com/news/235813.html

[5] How much per ton is appropriate for sludge treatment subsidy? Where does the money come from? https://huanbao.bjx.com.cn/news/20210729/1166581.shtml

[6] Guide on Best Available Techniques for Sludge Treatment and Disposal and Pollution Prevention and Control in Municipal Wastewater Treatment Plants (for Trial Implementation)

Figure 4: Two methods for the anaerobic digestion of municipal sludge



In the case of municipal sludge rich in organic matter, such as in cities where rainwater and sewage separation pipes have been built, wastewater treatment plants can be upgraded to perform anaerobic digestion directly by upgrading the equipment. Due to the high water content, low organic matter content and high sand content in municipal sludge in China (especially in cities that are not yet able to separate rainwater from sewage), biogas production will also be reduced. In this case, cities can consider treating municipal sludge with a low-carbon approach by combining anaerobic digestion of kitchen waste with municipal sludge. This option is technically feasible and has been well demonstrated, and the gas production efficiency of anaerobic digestion can be improved by adjusting the ratio of sludge and kitchen waste in the mix.

Joint anaerobic digestion allows for cost-sharing among participants, making the most of the existing capital and infrastructure, and thus better leverages the effect of scale. In addition, it can reduce more volatile solids and accelerate biogas production, while avoiding the building of separate anaerobic digestion facilities for kitchen waste (or sludge). The biggest challenges to overcome for joint anaerobic digestion are policy support and sectoral cooperation.

Case study: Joint anaerobic digestion practice in Shenzhen, Guangdong Province

Shenzhen Municipal Administration Bureau and Shenzhen Lisai Environmental Protection Technology Co., Ltd (hereafter referred to as Lisai) agreed to design and build a biomass waste disposal project with a treatment rate of 500 tons/day, which would take sludge (300 tons/day) and kitchen waste, food waste and market waste (200 tons/day). The project investment is CNY 250 million.

In December 2015, Shenzhen Longhua New District Municipal Administration Bureau signed an agreement with Lisai to provide collection, transportation and disposal services for kitchen waste, food waste, vegetable market waste and other biomass waste of a similar nature within Longhua New District. The project focuses on kitchen waste and municipal sludge. The sludge (water content: 80%) coming from the wastewater treatment plant will be anaerobically digested together with kitchen waste through pyro hydrolysis and dehydration. The project treats 182,500 tons of biomass organic waste per year, with an annual emissions reduction of 65,000 tons CO_2e and an annual biogas production of 8.76 million m^3, all of which is used for power generation.

Case source:
https://www.mee.gov.cn/home/ztbd/2020/wfcsjssdgz/dcsj/ztyj/201912/W020191203564453552984.pdf

Policy Recommendations to Promote GHG Emissions Reduction in Waste Management

1. Systematically manage domestic waste and municipal sludge through legislative guarantees and policy synergy. Since different administrative departments are involved in generation, transportation, treatment and finally disposal of domestic waste and municipal sludge, institutional regulation through legislation can change the process of waste management, break management barriers and promote policy convergence across departments. Successful examples show that low-carbon treatment and disposal of both domestic waste and municipal sludge, as well as the resource utilization of biogas for power generation or integration into the pipeline network, all require the cooperation of different departments, while digestate treatment in particular requires convergence between departmental policies.

2. Improve the economics of waste treatment and disposal through integrated planning and joint treatment. As the case studies show, in cities that have already implemented domestic waste classification, if there is already a kitchen waste treatment plant, joint anaerobic digestion with local municipal sludge can be considered. Coordinated infrastructure use to increase biogas production while reducing costs and thus improve economic efficiency should be planned for. In addition, reasonable planning and site selection for wastewater treatment plants and kitchen waste sites in urban planning also facilitates cooperation.

3. Seize market opportunities provided by voluntary carbon emissions trading mechanisms and policy opportunities such as green finance. Emissions-controlled enterprises can use Chinese Certified Emission Reductions (CCERs) to offset carbon emissions allowances under the national carbon market, with the offset

ratio not exceeding 5%, and the CCER offset projects include methane recycling. In addition, joint disposal of food waste and sewage sludge, reduction and resource utilization of solid waste, as well as green finance support for methane emissions reduction in waste disposal have all been addressed in circular economy, zero-waste cities, and green finance policy documents at various levels of government throughout China.

4. Promote the establishment of a powerful monitoring, reporting and verification (MRV) system for the waste industry. The waste industry is an area important to the prepartation of China's GHG inventory, but the MRV system for the municipal waste disposal industry is still in its initial stages. Most systems have only basic regulations, lacking a targeted and systematic approach to design and construction. The focus should be on clearly calculating GHG emissions and areas for emissions reduction to provide a solid basis for mitigating non-CO_2 GHG emissions such as methane and nitrous oxide.

Authors:

Contributing authors: Zhu Tongxin, Hu Min, Kevin Mo

Editors: Diego Montero, Yefren Nye

Translator: Song Manjiao

About iGDP:

innovative Green Development Program is a non-profit consultancy that focuses on green and low-carbon development. It works to strengthen China's low-carbon environmental policy design and implementation through interdisciplinary, systematic and empirical research. We work with all stakeholders to promote a zero-emissions future and tell the story of China's green and low-carbon development. iGDP's research, consulting and communications focus on the following areas:

- Energy Transition
- Green Economics
- Climate Strategies
- Sustainable Cities
- Strategic Communication

iGDP
Address:7-1-51, JIANGUOMENWAI DIPLOMATIC RESIDENCE COMPOUND, NO.1 XIUSHUI STREET, CHAOYANG DISTRICT, BEIJING, 100600, PEOPLE'S REPUBLIC OF CHINA, 100600
TEL: 86-10-8532-3096
FAX: 86-10-8532-2632
EMAIL: igdpoffice@igdp.cn
WEBSITE: www.igdp.cn