



Technical Assistance Report

Project Number: 49019-001
Policy and Advisory Technical Assistance (PATA)
September 2015

People's Republic of China: Sustainable Management of Fly Ash from Municipal Solid Waste Incineration

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Asian Development Bank

CURRENCY EQUIVALENTS

(as of 11 September 2015)

Currency unit	–	yuan (CNY)
CNY1.00	=	\$0.1566
\$1.00	=	CNY6.3863

ABBREVIATIONS

ADB	–	Asian Development Bank
MSWIP	–	municipal solid waste incineration plant
PRC	–	People's Republic of China
TA	–	technical assistance
TEC	–	Tianjin Safe Disposal of Municipal Solid Waste Incineration Fly Ash Technology Engineering Center
TMG	–	Tianjin Municipal Government

NOTE

In this report, "\$" refers to US dollars.

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CONTENTS

	Page
POLICY AND ADVISORY TECHNICAL ASSISTANCE AT A GLANCE	
I. INTRODUCTION	1
II. ISSUES	1
III. THE POLICY AND ADVISORY TECHNICAL ASSISTANCE	3
A. Impact and Outcome	3
B. Methodology and Key Activities	3
C. Cost and Financing	3
D. Implementation Arrangements	4
IV. THE PRESIDENT'S DECISION	4
APPENDIXES	
1. Design and Monitoring Framework	5
2. Cost Estimates and Financing Plan	7
3. Outline Terms of Reference for Consultants	8

POLICY AND ADVISORY TECHNICAL ASSISTANCE AT A GLANCE

1. Basic Data		Project Number: 49019-001	
Project Name	Sustainable Management of Fly Ash from Municipal Solid Waste Incineration	Department /Division	EARD/EASS
Country Borrower	China, People's Republic of People's Republic of China	Executing Agency	Tianjin Municipal Government
2. Sector	Subsector(s)	ADB Financing (\$ million)	
✓ Water and other urban infrastructure and services	Urban solid waste management		0.30
		Total	0.30
3. Strategic Agenda	Subcomponents	Climate Change Information	
Inclusive economic growth (IEG)	Pillar 2: Access to economic opportunities, including jobs, made more inclusive	Climate Change impact on the Project	Low
Environmentally sustainable growth (ESG)	Environmental policy and legislation Natural resources conservation Urban environmental improvement		
4. Drivers of Change	Components	Gender Equity and Mainstreaming	
Governance and capacity development (GCD)	Institutional development Organizational development	No gender elements (NGE)	✓
Knowledge solutions (KNS)	Application and use of new knowledge solutions in key operational areas Knowledge sharing activities Pilot-testing innovation and learning		
Partnerships (PAR)	Foundations Official cofinancing		
5. Poverty Targeting		Location Impact	
Project directly targets poverty	No	Rural Urban	Low High
6. TA Category:	B		
7. Safeguard Categorization	Not Applicable		
8. Financing			
Modality and Sources		Amount (\$ million)	
ADB		0.30	
Policy and advisory technical assistance: Technical Assistance Special Fund		0.30	
Cofinancing		0.00	
None		0.00	
Counterpart		0.00	
None		0.00	
Total		0.30	
9. Effective Development Cooperation			
Use of country procurement systems		No	
Use of country public financial management systems		No	

I. INTRODUCTION

1. The Government of the People's Republic of China (PRC) has requested policy and advisory technical assistance (TA) from the Asian Development Bank (ADB) to enhance the policies and practices regarding the safe and sustainable management and reuse of fly ash from municipal solid waste incineration plants in the PRC.¹ During a TA fact-finding mission on 17 March 2015 and in further communications, agreement was reached with the government on the impact, outcome, outputs, implementation arrangements, costs, financing plan, and outline terms of reference for the consulting services of the TA. The design and monitoring framework is in Appendix 1.²

II. ISSUES

2. The achievements and positive impacts of industrialization and urbanization in the PRC since the late 1970s have been remarkable. The PRC's reform and opening-up policies as well as its economic miracle have lifted millions out of poverty and created wealth and an urban middle class. The urbanization ratio increased from 19.4% in 1978 to 53.7% in 2013, and the urban population rose to nearly 700 million in 2013. The number of cities rose from 193 in 1978 to 658 in 2013, and the number of townships rose from 2,173 to 20,113 in the same period. Rural–urban migration is expected to continue, resulting in a projected urban population of 816 million by 2020 and more than 1 billion by 2030. However, rapid urbanization in combination with double-digit growth in the PRC's gross domestic product came at a heavy toll on the environment. The environmental impact of urban development caused by polluting industries, urban sprawl, unsustainable transport, consumption-based lifestyles, and illegal dumping of solid waste is massive. The effects are environmental degradation, loss of natural land and farmland, and pollution of air, water, and soil. These have become very serious challenges to livability and pose severe threats to human and environmental health, particularly in large cities in the PRC, which generally suffer from serious air pollution, water pollution, and environmental degradation.

3. Solid waste generation and illegal dumping in public areas—e.g., streets, plazas, parks, riverbanks, lakes, open fields, forests—are key environmental challenges that cities and surrounding suburban and peri-urban areas are exposed to. The lack of adequate solid waste management causes numerous problems that jeopardize public and environmental health, such as pests, clogged-up drainage systems, polluted environments, and degradation of river and lake ecology. Although the 3R principle of reduce, reuse, and recycle is a commonly agreed objective for solid waste management, and while much progress has been made, many cities find it ever more difficult to implement an effective solid waste management system. Further, solid waste generation increases disproportionately faster than urban population growth, mainly because the rising urban middle class is pushing up per capita consumption levels. Integrated, efficient, and sustainable municipal solid waste management, municipal waste incineration, and sustainable management of fly ash and slag are the key goals that PRC cities need to achieve, which will also contribute to better environmental quality across the country. Managing fly ash is particularly challenging because it often contains toxic components and is considered hazardous waste depending on the characteristics of the waste, the incineration technology, and operations. The magnitude of the task is significant. For example, fly ash amounts to an

¹ The TA is included in ADB's country operations business plan as Demonstration Project of Sustainable Disposal of Urban Bulk-Hazardous Waste—A Case Study in Tianjin. ADB. 2015. *Country Operations Business Plan: People's Republic of China, 2015–2017*. Manila.

² The TA first appeared in the business opportunities section of ADB's website on 13 July 2015.

estimated 3.2 million tons per year in the PRC, 300,000 tons per year in the Beijing–Tianjin–Hebei region, and 50,000 tons per year in Tianjin.

4. The past 35 years of urbanization in the PRC also showcase a remarkable evolution of knowledge, environmental laws, administrative regulations, and practices in solid waste management. The authorities are starting to consider the complete material and resource chain—from product design, product manufacturing, component reuse, solid waste segregation, collection and transfer, resource recovery, reuse, recycling, to final disposal on dumpsites and, more recently, well-managed sanitary landfills. In recent years, limitations of land in growing and sprawling urban areas became apparent and made it difficult for cities to locate solid waste landfill sites. A growing number of cities are since regarding waste incineration as a more land-use-efficient solution. An additional benefit can be achieved when producing electricity from the excess heat in so-called waste-to-energy plants. As part of the PRC's Eleventh Five-Year Plan, 2006–2010, the National Development and Reform Commission issued a renewable energy development plan aiming at waste incineration power generation capacity of 500,000 kilowatts by 2010. The Master Plan for National Urban Domestic Solid Waste Treatment Facilities under the Twelfth Five-Year Plan, 2011–2015 aims to increase the capacity of urban incineration of domestic waste by 35% nationwide.³ Thus, an increasing number of municipal solid waste incineration plants (MSWIPs) were built in the PRC, amounting to an estimated 200 at present, and 100 more are planned. While incineration solves some of the solid waste management problems, it leaves large amounts of fly ash and slag in need of environmentally sound reuse and/or sustainable final disposal. In Tianjin, a pilot facility to treat fly ash and convert it into a reusable resource for construction materials is under way, and is expected to be in operation by the end of 2015.

5. MSWIPs have been introduced and technically refined in Germany, Japan, the Republic of Korea, United Kingdom, and the United States, among others. In the early days of waste incineration, toxic pollutants such as dioxins had caused serious threats to public health, but current technologies—including sophisticated filtration and detoxification systems—make it possible to situate a MSWIP in urban areas, and to minimize their impact on environmental quality, especially air quality. Solutions to safe management and reuse of fly ash and slag have been developed and mainstreamed in the aforementioned countries. Fly ash and slag are being retrieved, metals and other deposits extracted, and the residue is being reused as supplements to building materials such as asphalt, cement, and bricks. This is seen as one of the sustainable solutions for final disposal of fly ash and slag, compared with disposal in sanitary landfill sites or subgrade deposit areas. In the PRC, research, standards, and administrative regulations for pollution control from MSWIPs and for sustainable management of slag from MSWIPs have been successfully developed and applied.⁴ However, sustainable use and final disposal of fly ash remain a challenge. In some cases, fly ash is categorized as hazardous waste and is treated depending on the composition of the waste that is burned and depending on the incineration process and temperature. Research of policies and practices abroad, and of lessons to be applied to the PRC MSWIPs, as well as the development of technical guidance, standardization, and administrative regulations are urgently needed.

6. The TA is in line with the key policies of the government's Twelfth Five-Year Plan, 2011–2015, which supports increased incineration of total treated solid waste and strategically supports key initiatives planned in the PRC's National New-Type Urbanization Plan, 2014–2020.

³ Master Plan for National Urban Domestic Solid Waste Treatment Facilities under the Twelfth Five-Year Plan (File No. 23 of the General Office of the State Council, 2012).

⁴ One of the key standards is the "Solid waste incineration pollution control standard" (GB18485-2001).

The TA is aligned with the strategic priorities of ADB's Midterm Review of Strategy 2020 and the country partnership strategy, 2011–2015 for the PRC to achieve environmentally sustainable growth.⁵ By supporting the PRC's efforts to promote emission reduction and management of toxic waste, this TA is fully aligned with ADB's Urban Operational Plan, 2012–2020.⁶ The TA complements ADB urban sector loans that include solid waste management components. ADB's Private Sector Operations Department supports waste-to-energy plants in the PRC, and the TA will help boost their environmental sustainability and safety.

III. THE POLICY AND ADVISORY TECHNICAL ASSISTANCE

A. Impact and Outcome

7. The impact will be improved urban environmental quality in the PRC, aligned with the PRC's National New-Type Urbanization Plan, 2014–2020. The outcome will be improved sustainability of fly ash management from municipal solid waste incineration in the PRC.

B. Methodology and Key Activities

8. The TA is expected to have three outputs that will contribute to the achievement of the outcome and impact: (i) technical standards for safe capture, processing, reuse, and sustainable disposal of fly ash from MSWIPs developed; (ii) policy recommendations and implementation action plan for safe reuse and sustainable disposal of fly ash from MSWIPs prepared; and (iii) capacity on technologies and establishing an information and service center on advanced sustainable MSWIP fly ash management in the PRC improved.

9. During TA implementation, the current domestic laws, administrative regulations, practices, and technologies for the reuse and sustainable disposal of fly ash from MSWIP will be analyzed and documented using selected facilities and management practices in Tianjin and Beijing as sample cases. A review and documentation of international best practices; case studies on technologies, materials, and products for safe and sustainable reuse of fly ash; regulatory frameworks; and institutional responsibilities will provide a basis for comparison. Lessons will be drawn and recommendations will be made to apply successful and proven technical solutions, specifications, and standardization in the PRC. To ensure smooth implementation, comments from the Tianjin Municipal Government (TMG), the national, provincial, and other municipal governments on the technical standards and policy recommendations will be considered. The capacity of the Tianjin Safe Disposal of Municipal Solid Waste Incineration Fly Ash Technology Engineering Center (TEC) will be strengthened to set up an information and service hub on fly ash management in the PRC, since it is the only entity with such specialized scope in the PRC. The capacity of the parties concerned will be strengthened through training, seminars, and workshops. Dissemination workshops, training, and the service platform are designed to promote private sector engagement in the industry of safe and sustainable reuse of fly ash.

C. Cost and Financing

10. The TA is estimated to cost \$375,000, of which \$300,000 will be financed on a grant basis by ADB's Technical Assistance Special Fund (TASF-other sources). The government will

⁵ ADB. 2014. *Midterm Review of Strategy 2020: Meeting the Challenges of a Transforming Asia and Pacific*. Manila; ADB. 2012. *Country Partnership Strategy: People's Republic of China, 2011–2015*. Manila.

⁶ ADB. 2013. *Urban Operational Plan, 2012–2020*. Manila.

provide counterpart support in the form of counterpart staff time, suitable office space for consultants, support with data and information collection, logistical support, local transport, as well as access to the various MSWIP facilities and pilot fly-ash-reuse facilities to enable the consultants to complete the required field studies (Appendix 3), and other in-kind contributions.

D. Implementation Arrangements

11. The TA will be implemented from 1 October 2015 to 31 March 2017. The executing agency will be the TMG represented by the Tianjin Finance Bureau and Tianjin Environmental Protection Bureau, and with technical support from the Tianjin Science and Technology Commission and the Tianjin Construction Commission. TEC, with its own implementation unit, will be the implementing agency. TEC has an official mandate from TMG to study and develop technical guidelines and standards specifically for the safe and sustainable management of fly ash, and some other topics relating to municipal solid waste incineration. The mandate includes research and development, training and technical support on technologies, practices, laws, and regulations on fly ash to assist MSWIPs, and associated agencies and companies, in implementing new technologies and methods developed under the TA.

12. The TA will require consulting services, including expertise in the fields of solid waste management, waste incineration plant construction and operation, solid waste policies, standards, and institutional, environmental, and information technology and database management. In all, 22 person-months of consulting services are required, i.e., 7 person-months of international and 15 person-months of national inputs. The consultants will be engaged through a firm in accordance with ADB's Guidelines on the Use of Consultants (2013, as amended from time to time) using quality- and cost-based selection method with a quality-cost ratio of 90:10, and simplified technical proposal procedures. The consulting contract will be on a lumpsum basis, and the proceeds of the TA will be disbursed in accordance with ADB's *Technical Assistance Disbursement Handbook* (2010, as amended from time to time). Trainings, seminars, and conferences will be administered by the consultants.

13. Relevant government authorities, practitioners, and operators of MSWIPs, research institutes, and academia will be involved in data gathering and consultations. The TA findings will be shared and discussed at workshops that will be attended by officials from national, provincial, and municipal governments in the PRC, and ADB sector specialists, officials, and practitioners involved in and operating MSWIPs to ensure sound and diverse review and dissemination. A final workshop with broader participation of government, think tanks, practitioners, and academia will be held 1 month after the submission of the draft final report to disseminate the TA findings and recommendations to a broader audience. The key findings and lessons from the TA will be published in the reports in the form of technical guidelines and standards (output 1), and policy recommendations (output 2). A TA synthesis report will be developed as a knowledge product. Further, output 3 includes assistance to TEC in the development of a web-based information platform that will inform and provide access to services, and support to MSWIP operators.

IV. THE PRESIDENT'S DECISION

14. The President, acting under the authority delegated by the Board, has approved the provision of technical assistance not exceeding the equivalent of \$300,000 on a grant basis to the Government of the People's Republic of China for Sustainable Management of Fly Ash from Municipal Solid Waste Incineration, and hereby reports this action to the Board.

DESIGN AND MONITORING FRAMEWORK

Impact the Project is Aligned with

Urban environmental quality in the PRC improved (PRC National New-Type Urbanization Plan, 2014–2020)^a

Project Results Chain	Performance Indicators with Targets and Baselines	Data Sources or Reporting Mechanisms	Risks
<p>Outcome Sustainability of fly ash management from municipal solid waste incineration in the PRC improved</p>	<p>By 2017 Technical standards and policy recommendations for fly ash capture, processing, reuse, and final disposal discussed with and issued for implementation by PRC and Tianjin governments (2015 baseline: 0)</p>	<p>a. BMG, HPG, and TMG annual reports on the environment b. TA review and completion reports, and reports by TA consultants</p>	<p>Lack of cross-departmental and interjurisdictional coordination may lead to serious delay. Insufficient funding to implement action plan</p>
<p>Outputs 1. Technical standards for safe capture, processing, reuse, and sustainable disposal of fly ash from MSWIPs developed</p>	<p>Report for output 1 completed and findings presented by July 2016 (2015 baseline: 0)</p>	<p>TA review and completion reports, and reports by TA consultants</p>	<p>Access to data and facilities is inadequate or delayed.</p>
<p>2. Policy recommendations and implementation action plan for safe reuse and sustainable disposal of fly ash from MSWIPs prepared</p>	<p>Report for output 2 completed and findings presented by September 2016 (2015 baseline: 0)</p>	<p>TA review and completion reports, and reports by TA consultants</p>	
<p>3. Capacity on technologies and establishing an information and service center on advanced sustainable MSWIP fly ash management in the PRC improved</p>	<p>Training events and on-the-job training provided to at least 10 staff at TEC and to at least 20 staff of MSWIP operators in the PRC by 2017 Training on setting up a service center completed and online platform established by 2017 (2015 baseline: 0)</p>	<p>TA review and completion reports, and reports by TA consultants</p>	

<p>Key Activities with Milestones</p> <p>Output 1: Technical standards for safe capture, processing, reuse, and sustainable disposal of fly ash from MSWIPs developed</p> <ol style="list-style-type: none"> 1.1. Assess state-of-the art and proven technology and practices on fly ash processing and reuse in the international context through literature review, web-based resources and interviews, data collection and review, and demand analysis for fly ash reuse materials by July 2016 1.2. Assess and review current application of technologies and practices in the PRC on managing fly ash by July 2016 1.3. Develop draft technical manual and standards for methods of safe and sustainable capture, processing, reuse, and safe final disposal of fly ash by July 2016 1.4. Develop draft technical and environmental standards and eligible products by July 2016 <p>Output 2: Policy recommendations and implementation action plan for safe reuse and sustainable disposal of fly ash from MSWIPs prepared</p> <ol style="list-style-type: none"> 2.1. Review and analyze policies and regulations in the international context and compare with lessons learned for the PRC by September 2016 2.2. Develop draft policy recommendations and outline of legal framework and administrative regulations for safe and sustainable reuse and disposal of fly ash by September 2016 2.3. Prepare draft implementation action plan, including institutional framework, rules, and responsibilities of the participating agencies by September 2016 <p>Output 3: Capacity on technologies and establishing an information and service center on advanced, sustainable MSWIP fly ash management in the PRC improved</p> <ol style="list-style-type: none"> 3.1. Organize and carry out inception, interim, and final workshops with knowledge sharing on TA findings by December 2016 3.2. Train on and assist in developing a web-based database, and resource and support platform for sustainable fly ash management in the PRC by December 2016 3.3. Organize final dissemination workshop and share TA findings with MSWIP operators in the PRC by January 2017
<p>Inputs</p> <p>Asian Development Bank: \$300,000</p> <p>Note: The government will provide in-kind contributions in the form of counterpart staff time, suitable office space for the consultants, support with data and information collection, logistical support, local transport, access to the various MSWIP facilities and pilot fly-ash-reuse facilities to enable the consultants to complete the required field studies, and other in-kind contributions.</p>
<p>Assumptions for Partner Financing</p> <p>Not applicable.</p> <p>BMG = Beijing Municipal Government, HPG = Hebei Provincial Government, MSWIP = municipal solid waste incineration plant, PRC = People's Republic of China, TA = technical assistance, TEC = Tianjin Safe Disposal of Municipal Solid Waste Incineration Fly Ash Technology Engineering Center, TMG = Tianjin Municipal Government. ^a Government of the People's Republic of China. 2014. <i>National New-Type Urbanization Plan, 2014–2020</i>. Beijing. Source: Asian Development Bank.</p>

COST ESTIMATES AND FINANCING PLAN
(\$'000)

Item	Amount
Asian Development Bank^a	
1. Consultants	
a. Remuneration and per diem	
i. International consultants	110.0
ii. National consultants	80.0
b. International and local travel	25.0
2. Training, seminars, and conferences	50.0
3. Surveys ^b	10.0
4. Miscellaneous administration and support costs ^c	15.0
5. Contingencies	10.0
Total	300.0

Note: The technical assistance (TA) is estimated to cost \$375,000, of which contributions from the Asian Development Bank are presented in the table above. The government will provide counterpart support in the form of counterpart staff time, suitable office space for consultants, support with data and information collection, logistical support, local transport, as well as access to the various municipal solid waste incineration plants and pilot fly-ash-reuse facilities to enable the consultants to complete the required field studies, and other in-kind contributions. The value of government contribution is estimated to account for 20% of the total TA cost.

^a Financed by the Asian Development Bank's Technical Assistance Special Fund (TASF-other sources).

^b This may include case studies.

^c This includes translation costs associated with each deliverable of the TA, as well as report editing, printing, and dissemination.

Source: Asian Development Bank estimates.

OUTLINE TERMS OF REFERENCE FOR CONSULTANTS

A. Introduction

1. The policy and advisory technical assistance (TA) has three main outputs: (i) technical standards for safe capture, processing, reuse, and sustainable disposal of fly ash from municipal solid waste incineration plants (MSWIPs) developed; (ii) policy recommendations and implementation action plan for safe reuse and sustainable disposal of fly ash from MSWIPs prepared; and (iii) capacity on technologies and establishing an information and service center on advanced, sustainable MSWIP fly ash management in the PRC improved. The TA will be implemented from 1 October 2015 to 30 September 2017, with a draft final report to be submitted within 18 months of the start of the consulting contract.

2. It is estimated that the TA will require 7 person-months of international and 15 person-months of national consulting services. This includes three international specialists—a solid waste management and waste incineration plant specialist and team leader (4 person-months); a solid waste policy, standards, and institutional specialist (2 person-months); and an environment specialist (1 person-month)—and four national specialists: a solid waste policy, standards, and institutional specialist and deputy team leader (5 person-months); a solid waste management and waste incineration plant specialist (4 person-months); an environment specialist (4 person-months); and an information technology and database management specialist (2 person-months). The specialists will be engaged through a firm in accordance with the Guidelines on the Use of Consultants (2013, as amended from time to time) of the Asian Development Bank (ADB) using quality- and cost-based selection method, with a quality–cost ratio of 90:10.

3. The consultants will be responsible for producing effectively and on time the TA outputs and deliverables, and for organizing and carrying out all indicated tasks. All reports are to be of high quality and produced in English and Chinese. During the inception stage, a detailed TA timeline with the dates of report deliverables and tentative workshop dates will be agreed with ADB, Tianjin Finance Bureau, Tianjin Environmental Protection Bureau (the executing agency of the project), and Tianjin Safe Disposal of Municipal Solid Waste Incineration Fly Ash Technology Engineering Center (the implementing agency of the project).

B. International and National Consultants

4. **Solid waste management and waste incineration plant specialists** (team leader, international, 4 person-months; and national, 4 person-months). The specialists should have a postgraduate degree or equivalent in environmental engineering, civil engineering, chemistry or in similar fields. The international specialist should have at least 15 years of relevant international professional experience; the national specialist should have at least 10 years of relevant experience in the People's Republic of China (PRC) in solid waste management and waste incineration technology, and be familiar with MSWIP fly ash and slag management. Both experts should demonstrate good knowledge and strong research experience in solid waste management and solid waste incineration processes, engineering, and chemistry. The international specialist should have a good track record of leading research and TA projects, managing and guiding international teams, and producing high-quality research and policy reports. As a team leader, the international specialist will be responsible for coordinating and supervising project activities and outputs. Both the international and national specialists will be responsible for all technical tasks and will carry out but not be limited to the following tasks:

- (i) prepare a detailed study framework and work plan for the TA in consultation with the executing and implementing agencies, key stakeholders, and other experts (international specialist);
- (ii) provide guidance and ensure that the team's work progresses according to schedule, and ensure timely delivery and high-quality inception, interim, draft final, and final reports acceptable to ADB and the executing and implementing agencies (international specialist);
- (iii) provide detailed guidance and supervision to the international and national specialists in assessing and recommending best practices, successful and proven technical methods, guidelines, standards, policies, and administrative regulations for the PRC (international specialist);
- (iv) review information and data provided by the executing and implementing agencies on the current practice of fly ash disposal from MSWIPs;
- (v) review the targets under the PRC, Beijing, Tianjin, and Hebei Province thirteenth five-year plans as samples, distinguish the targets between the MSWIP fly ash generation industries and disposal industries, and improve the sustainable fly ash disposal ability of MSWIPs;
- (vi) in consultation with the executing and implementing agencies, review the current generation and disposal of fly ash in MSWIP and the local legislation status in the provinces of the PRC;
- (vii) specify an investigation method, prepare a research plan, formulate a survey questionnaire, finalize the scope of a survey, review and analyze the results carried out by the implementing agency, and provide guidance and quality checks for the development of the service platform;
- (viii) review and assess the technology and technical standards of fly ash generation, and safe and sustainable reuse and disposal of fly ash in MSWIP in the international context, including advanced and emerging countries;
- (ix) prepare a proposal for technical standards for safe reuse of fly ash that should also consider the source–pathway–receptor approach;
- (x) analyze and summarize the current fly ash generated from MSWIPs, and assess the final disposal practices and problems in the PRC;
- (xi) obtain chemical characterization information of fly ash; determine the potential for various kinds of reuse; and recommend adequate technologies, methods, and possible products for safe and sustainable reuse of fly ash from MSWIPs in the PRC;
- (xii) undertake chemical testing of MSWIP fly ash from various incinerators in Tianjin, in the PRC, and from other countries, since the chemical composition may differ and volumes may influence reuse and disposal options;
- (xiii) assess the market demand for safe and sustainable reuse materials and products, and involve ready-mix concrete suppliers and others from the construction material industry to find out if a market exists and what support, if any, would be needed for them to start using fly ash in their processes;
- (xiv) assess the availability of adequate sanitary landfills to receive the possibly hazardous waste in case of final disposal;
- (xv) determine the costs and benefits of the proposed technologies and reuse materials and products, and determine the financial feasibility;
- (xvi) propose a draft implementation action plan and policy framework for sustainable management of fly ash from MSWIPs that will serve the PRC;
- (xvii) help develop a strategic plan to implement the integrated service platform for sustainable disposal of fly ash from MSWIPs, and offer suggestions on how the platform may get wider regional coverage and a bigger industry impact;

- (xviii) propose a management improvement plan for technology transfer, disposal process, and product and technical service following the recommendations of the TA assessments;
- (xix) provide training to technical personnel of MSWIPs and fly-ash-reuse facilities on (a) international best practices and relevant technologies to manage and handle fly ash; (b) suitable materials and products for safe reuse of fly ash and also slag; (c) effective public and stakeholder information, communication, and support; and (d) others as defined in the training needs assessment also carried out by these specialists;
- (xx) develop a public information and dissemination strategy, facilitate workshops, and present TA findings; and
- (xxi) organize and administer workshops, trainings, seminars, and conferences for the governments.

5. **Solid waste policy, standards, and institutional specialists** (international, 2 person-months; national and deputy team leader, 5 person-months). The specialists should have a postgraduate degree or equivalent in environmental policy, environmental management, public policy, public administration, or in similar fields. The international specialist should have at least 15 years of relevant international professional experience and the national specialist should have at least 10 years of relevant experience in the PRC in the field of solid waste and/or environmental management policy design and evaluation. Both should have sound experience and knowledge in environmental and solid waste policies, and in policy formulation. They should have a good track record of conducting TA and research projects on solid waste management, waste incineration, and environmental policy with proof of high-quality publications. Also, it is required that they demonstrate project-related policy research experience in the PRC. The national specialist will be the deputy team leader and support the international team leader, and will be responsible for coordinating and supervising project activities and outputs, and interaction with the executing and implementing agencies. The specialists will carry out but not be limited to the following tasks:

- (i) analyze environmental laws, and solid waste management and incineration laws and administrative regulations, their implementation and enforcement practices, and policy trends on sustainable MSWIP fly ash (and slag) reuse or disposal mechanisms in Europe, Japan, the United States, and other advanced countries;
- (ii) highlight lessons learned elsewhere that can be transferred to the PRC's legal and administrative system for fly ash (and also slag);
- (iii) assess and document the regulatory system of fly ash (and also slag) from MSWIPs in the PRC, and analyze the various regulatory systems in the governments of the PRC;
- (iv) analyze and document the existing related policy support and institutional framework for waste incineration and safe disposal of fly ash (and also slag) from MSWIPs in the PRC;
- (v) analyze gaps and shortcomings in the legal and regulatory systems for fly ash management (and also slag) in the PRC and international regulatory systems, and provide a comparative analysis;
- (vi) review existing institutions and policies, identify implementation obstacles to safe and sustainable reuse and disposal of fly ash from MSWIP, and propose a possible solution;
- (vii) provide policy recommendations and develop institutional framework with roles and responsibilities of concerned agencies at various administrative levels;
- (viii) provide recommendations for the prevention of municipal solid waste pollution, including control plans, in Tianjin and the PRC at large; and

- (ix) propose a draft technical and environmental standard system of sustainable reuse and disposal of fly ash from MSWIP suitable for Tianjin and the PRC.

6. **Environment specialists** (international, 1 person-month; national, 4 person-months). The specialists should have a postgraduate degree or equivalent in environmental sciences, engineering, environmental management, or in similar fields. The international specialist should have at least 15 years of relevant international professional experience, and the national specialist should have at least 10 years of relevant experience in the PRC in the field of environmental impact assessment, environmental research, engineering, and management. The specialists should have a good track record of producing high-quality TA and research reports on similar environmental topics. The specialists will carry out but not be limited to the following tasks:

- (i) analyze the MSWIP fly ash generation and pollution situation in the PRC, and provide estimates for fly ash generation and pollution from MSWIP for the near future;
- (ii) analyze and evaluate the energy, material, and water efficiency, and the environmental impact of the various methods of reuse and disposal of fly ash from MSWIPs in Europe, Japan, United States, and other developed countries;
- (iii) compare and evaluate various techniques of reuse and disposal of fly ash from MSWIPs, and international and domestic processes with respect to their environmental impact and ecological efficiency;
- (iv) analyze the feasibility of reuse of fly ash from MSWIP as a supplement in construction materials, and the relevant outputs of standard specification, and issue a feasibility study report;
- (v) analyze the environmental impact and eco-efficiency of typical methods of safe reuse and disposal of MSWIP fly ash in the PRC, considering both the direct and indirect environmental benefits of safe reuse, e.g., less raw material extraction impacts, less transportation, less carbon dioxide from using cement, less landfill space used;
- (vi) provide recommendations for environmentally sustainable technologies and methods, and construction materials suitable for safe and sustainable reuse and disposal of fly ash from MSWIPs in the PRC; and
- (vii) provide training for technical staff of governments and stakeholders on environmental risk and mitigation measures concerning the capture, processing, and application of reused and disposed fly ash and fly ash composites.

7. **Information technology and database management specialist** (national, 2 person-months). The specialist should have a postgraduate degree or equivalent in information technology, computer science, or in similar fields. The specialist should have at least 8 years of relevant experience in the PRC in developing, programming, operating, and maintaining databases, websites, and web-based service platforms. The specialist will carry out but not be limited to the following tasks:

- (i) provide guidance and training to staff of Tianjin Safe Disposal of Municipal Solid Waste Incineration Fly Ash Technology Engineering Center on the development of web-based database and interactive service platform through the establishment of a website and use of the database system, including training on development of applicable approaches to access service that will help identify relevant information in national sites and other information services on fly ash from MSWIPs;
- (ii) assess the quality of the current databases and systems and assist in specifying additional information, as needed;

- (iii) provide hands-on assistance to the system developer and operator;
- (iv) hold meetings with stakeholders and the system developer to map out the needs and specific requirements of the database and platform;
- (v) provide practical guidance to the concerned counterpart staff on the design of the database format and the design of the data center and web server, as needed;
- (vi) recommend a management structure and partnership arrangements between stakeholders to ensure sustainable operation and maintenance of the data center and network server;
- (vii) review and assist in the design of specifications for hardware and software requirements that will be purchased by the executing and implementing agencies;
- (viii) train in and provide hands-on guidance for the design of guidelines for operation and maintenance of the database and service platform;
- (ix) assess initial operation of the database and the need for corrective actions and provide training and instructions to the concerned counterpart staff; and
- (x) design a training program, provide presentations during the workshops, and organize capacity development meetings with the concerned experts and staff.

C. Reporting and Deliverables

8. All reports should be submitted in both English and Chinese. The expected deliverables of the consulting services shall include but will not be limited to the following:

- (i) **Inception report and workshop.** To be submitted and held within the first month of the start of the TA consulting contract, summarizing the initial findings and TA approach, methodology, work plan, and suggested changes, if necessary.
- (ii) **Interim report and workshop.** To be submitted and held 6 months after commencement of the TA consulting contract.
- (iii) **Draft final report and final workshop.** To be submitted and held by the 18th month of the start of the TA consulting contract. It will include all components required in the study and cover all aspects of TA implementation.
- (iv) **Final report.** To be submitted within 1 month of the final dissemination workshop. The consultants will incorporate comments from stakeholders in the final report. An executive summary and knowledge products will also be submitted.
- (v) **Dissemination workshop.** The workshop will be held within 1 month of the submission of the draft final report to present TA findings and recommendations to the stakeholders.