ADB

Technical Assistance Report

Project Number: 49438-001
Policy and Advisory Technical Assistance (PATA)
May 2016

People's Republic of China: National Biomass Heat Supply Development Strategy

Asian Development Bank

CURRENCY EQUIVALENTS

(as of 18 March 2016)

Currency unit	–	yuan (CNY)
CNY1.00	=	$0.1544
$1.00	=	CNY6.4750

ABBREVIATIONS

ADB	–	Asian Development Bank
BMF	–	biomass molding fuel
CHP	–	combined heat and power
GHG	–	greenhouse gas
PRC	–	People's Republic of China
TA	–	technical assistance
tsce	–	tons of standard coal equivalent

NOTE

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

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POLICY AND ADVISORY TECHNICAL ASSISTANCE AT A GLANCE

1. Basic Data — **Project Number:** 49438-001

Project Name	National Biomass Heat Supply Development Strategy	**Department /Division**	EARD/EAEN
Country	China, People's Republic of	**Executing Agency**	National Energy Administration

2. Sector	**Subsector(s)**	**ADB Financing ($ million)**
✓ Energy	Renewable energy generation - biomass and waste	0.40
	Total	**0.40**

3. Strategic Agenda	**Subcomponents**	**Climate Change Information**	
Inclusive economic growth (IEG)	Pillar 1: Economic opportunities, including jobs, created and expanded	Climate Change impact on the Project	Low
Environmentally sustainable growth (ESG)	Environmental policy and legislation		

4. Drivers of Change	**Components**	**Gender Equity and Mainstreaming**	
Governance and capacity development (GCD)	Institutional development	No gender elements (NGE)	✓
Knowledge solutions (KNS)	Knowledge sharing activities		

5. Poverty Targeting		**Location Impact**	
Project directly targets poverty	No	Nation-wide	High

6. TA Category: B

7. Safeguard Categorization Not Applicable

8. Financing

Modality and Sources	**Amount ($ million)**
ADB	**0.40**
Policy and advisory technical assistance: Technical Assistance Special Fund	0.40
Cofinancing	**0.00**
None	0.00
Counterpart	**0.00**
None	0.00
Total	**0.40**

9. Effective Development Cooperation

Use of country procurement systems	No
Use of country public financial management systems	No

I. INTRODUCTION

1. During discussions for the country operations business plan, 2016–2018,[1] the Government of the People's Republic of China (PRC) requested the Asian Development Bank (ADB) to provide technical assistance (TA) to prepare the country's national biomass heat supply development strategy.[2] In March 2016, ADB and the government through the National Energy Administration reached an understanding on the impact, outcome, outputs, implementation arrangements, costs and financing arrangements, and terms of reference for consulting services for the TA. The TA is aligned with ADB's Energy Policy in promoting renewable energy development and regional integration in the energy sector.[3] The design and monitoring framework is in Appendix 1.

II. ISSUES

2. The poverty alleviation and economic growth of the PRC were built on carbon-intensive growth and have resulted in severe air pollution affecting the lives of the country's 1.37 billion residents.[4] Air pollution is further amplified during winter, when the almost exclusive use of coal for heating significantly increases the concentration of air pollutants, especially in the PRC's colder provinces. In contrast to a continuous trend of decreasing air pollution levels in the PRC, some studies and air quality data monitoring have shown that in certain centers of the northern PRC, the concentration of particulate matter less than 2.5 micrometers in diameter during winter actually increased during 2013–2015.

3. Providing heating to the population residing in the northern part of the PRC has posed a challenge to low-carbon development. The municipal governments of major cities have addressed this challenge by banning the use of coal for heating to mitigate poor air quality and encourage the use of low-carbon and renewable energy sources. However, the existence of many institutional and financial barriers makes it difficult for clean and renewable heat sources to compete with cheap and abundant coal. The Government of the PRC therefore aims to create an enabling policy and market environment for renewable energy sources. One of the most promising and widely available renewable resources is biomass.[5] Other renewable energy sources such as photovoltaic, water, and wind have been gradually adopted in the PRC's energy system, whereas biomass remains underexploited despite its potential to replace significant amounts of coal-based heating.

4. The PRC's biomass-to-energy potential is 460 million tons of standard coal equivalent (tsce), which includes 200 million tsce of agricultural waste, 200 million tsce of forestry waste, 28 million tsce of animal waste, and 32 million tsce of municipality solid waste.[6] Currently, only 325 million tsce of biomass is used, accounting for 7.6% of total available biomass in the PRC. As for heat supply, the potential from biomass is projected to be 33 million tsce by 2020 and 68 million tsce by 2030 (footnote 7).

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[1] Asian Development Bank (ADB). 2016. *Country Operations Business Plan: People's Republic of China, 2016–2018.* Manila.

[2] The TA first appeared in the business opportunities section of ADB's website on 31 March 2016.

[3] ADB. 2009. *Energy Policy.* Manila.

[4] Government of the People's Republic of China, National Bureau of Statistics. 2016. National Data. http://data.stats.gov.cn/easyquery.htm?cn=C01 (accessed 26 February 2016).

[5] Biomass refers to crop residues, forestry waste, livestock waste, and organic waste from municipal solid waste that can be utilized as energy sources without jeopardizing food security.

[6] China Energy Research Society. 2016. *China Energy Outlook 2030*. Beijing.

5. In the European Union, the technological leader in biomass energy, almost half of 2014 renewable energy consumption came from biomass. France, Germany, and Sweden are the leaders in biomass-to-heat systems.[7] With turnover of close to €42 billion (estimated at $58 billion[8]) in 2013 and employment of 380,200 people, primarily in rural areas, the European biomass and biogas sectors provide a good example for successful commercialization.[9] Yet biomass in the PRC is mostly used by small households and/or communities and lacks a supportive institutional framework that could boost its commercialization to its full potential. Weak enforcement of environmental standards, including restrictions on crop residue burning by farmers that causes extreme air pollution each year after harvesting season, is reducing opportunities to turn biomass, particularly agricultural waste, into renewable energy. To exploit existing opportunities, the PRC needs to improve its regulatory system, develop clear industry standards, tap into foreign expertise on biomass, and close technological gaps, specifically on biomass combined heat and power, biomass pellet boiler, biogas digestion and purification, and biomass gasification.

6. The National Energy Administration plans to support commercialization of biomass by simultaneously designing an adequate policy framework and taking measures to support biomass technology advancement. This aligns with the Thirteenth Five-Year Plan for National Economic and Social Development in the PRC, which indicates that the accelerated development of biomass would support the country's low-carbon and circular economy targets.[10]

7. The proposed TA will support the development of a national biomass heat supply development strategy. In 2006, ADB supported the PRC's efforts towards preparing a national strategy for rural biomass renewable energy development with a TA project,[11] which focused on wood and agricultural residue usage for cooking and heating, as published in ADB's Rural Biomass Energy 2020 report.[12] The major lessons of the TA project were (i) the importance of developing a biomass strategy in a timely manner that matches with country priorities and (ii) having strong ownership from the government. ADB has also financed projects based on commercial-scale biogas demonstration. This TA will build on previous work to improve institutional frameworks and policies not only for biogas but also for other proven technologies utilizing biomass. By supporting the PRC to create a favorable institutional and regulatory environment, this TA will also help the wider use of biomass for heating.

8. The proposed TA aims to assist in developing a clear strategy, policy framework, and specific measures to advance the commercialization of untapped biomass-based heat sources in the PRC. It will (i) conduct an in-depth assessment of the current biomass-to-heat market in the PRC; (ii) produce a sourcebook on biomass-to-heat commercialization to disseminate knowledge on worldwide biomass-to-heat technology advancement; (iii) carry out workshops, conferences, and technical trainings on biomass-to-heat development; and (iv) prepare a policy note that formulates the national strategy to advance biomass-to-heat commercialization in the PRC.

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[7] EurObserv'ER. 2015. *Solid Biomass Barometer 2015*. http://www.eurobserv-er.org/solid-biomass-barometer-2015/

[8] Based on ADB Foreign Exchange rate as of 31 December 2013.

[9] European Parliamentary Research Service. 2015. *Biomass for Electricity and Heating: Opportunities and Challenges*. http://www.europarl.europa.eu/RegData/etudes/BRIE/2015/568329/EPRS_BRI(2015)568329_EN.pdf

[10] Communist Party of China Central Committee. 2015. *Suggestions of the Communist Party of China Central Committee on the Thirteenth Five-Year Plan for National Economic and Social Development*. Beijing.

[11] ADB. 2006. *Technical Assistance to the People's Republic of China for Preparing the National Strategy for Rural Biomass Renewable Energy Development*. Manila.

[12] ADB. 2010. *Rural Biomass Energy 2020: People's Republic of China*. Manila.

III. THE POLICY AND ADVISORY TECHNICAL ASSISTANCE

A. Impact and Outcome

9. The impact of the TA will be an expanded biomass supply in the PRC's heating systems. The outcome of the TA will be commercialized biomass-based heat sources in the PRC.

B. Methodology and Key Activities

10. The outputs of the TA will consist of the following: (i) a study on the current biomass-to-heat market in the PRC is prepared; (ii) a sourcebook on advanced biomass-to-heat technologies, institutions, and international best practices on biomass-to-heat commercialization is produced; (iii) capacity strengthening on biomass-to-heat commercialization is implemented; and (iv) a policy note on the PRC's strategy to advance biomass-to-heat commercialization is developed.

11. **Output 1: A study on the current biomass-to-heat market in the People's Republic of China prepared.** An in-depth understanding on the current biomass-to-heat market in the PRC is essential and integral to achieving the TA objectives. Through literature review, field visits, interviews, primary and secondary data collection, and case study research methods, the study will identify challenges and opportunities that the entire biomass-to-heat system faces in the pursuit of commercialization. At present, three commercial-scale biomass-to-heat projects have been identified: (i) the biogas project by the Inner Mongolia Yuan Yi Company in Chifeng City in Inner Mongolia Autonomous Region, (ii) the biomass-based combined heat and power generation project by the National Energy Biopower Generation Company in Nangong City in Hebei Province, and (iii) the biomass briquette-to-heat project by the Guangzhou Devotion Energy Company in Zhuhai City in Guangdong Province. Selected commercial-scale biomass-to-heat project cases will assess biomass generation cycles, biomass collection efficiency, stability and durability of specific technology in use, financial analysis, market acceptability, institutional arrangements throughout the entire value chain, environmental performance, climate change contribution, and economic implications for society. Based on lessons learned from case studies, a comprehensive and analytical study will draw on the current status of the biomass-to-heat market and technologies in the PRC, and identify challenges and opportunities for the PRC biomass-to-heat market focusing on the following aspects: technical knowledge and capacities, market competitiveness, legal and policy frameworks, institutions and governance, environmental improvement, and greenhouse gas emissions.

12. **Output 2: A sourcebook on advanced biomass-to-heat technologies, institutions, and international best practices on biomass-to-heat commercialization produced.** To help disseminate knowledge on biomass-to-heat technology advancement and valuable lessons from international experiences on biomass-to-heat markets and systems, the TA will produce a sourcebook on biomass-to-heat commercialization. The sourcebook will compile (i) detailed information of various biomass-to-heat advanced technologies that are available in international markets; (ii) international best practices of commercialized biomass-to-heat projects and practices; and (iii) information on standards, subsidy schemes, and other policy and institutional measures that other countries provide to advance biomass-to-heat commercialization.

13. **Output 3: Capacity strengthening on biomass-to-heat commercialization implemented.** Through international workshops, conferences, and technical trainings, the TA will provide opportunities for key stakeholders to gain hands-on learning experience from international and domestic technical and policy experts on biomass-to-heat chains. Key

stakeholders include the Ministry of Agriculture, utility bureaus, municipal and county health and sanitation departments, farmers, waste treatment operators, heating companies, and gas companies.

14. **Output 4: A policy note on the People's Republic of China's strategy to advance biomass-to-heat commercialization developed.** Based on outputs 1–3, the TA will prepare a policy note that formulates the national strategy to advance biomass-to-heat commercialization in the PRC. This policy note will discuss broad policy objectives, realistic mid- and long-term targets of biomass's share in the heating sector, and quantified greenhouse gas emissions reduction associated with these targets. It will also detail the proposals of technical standards for various forms of biomass-based heat sources in commercialization, adequate policy subsidy schemes, biomass collection policies, environmental standards for various biomass-to-heat generation technologies and equipment, institutional capacity building, and research and development and technology transfer support to advance biomass-to-heat technologies in the PRC.

C. Cost and Financing

15. The TA is estimated to cost $440,000, of which $400,000 will be financed on a grant basis by ADB's Technical Assistance Special Fund (TASF-other sources). The government will provide counterpart support in the form of counterpart staff, office accommodation, office supplies, data and information relevant to biomass-to-heat, and other in-kind contributions. The proceeds of the TA will be disbursed in line with ADB's *Technical Assistance Disbursement Handbook* (2010, as amended from time to time). The detailed cost estimates and financing plans are in Appendix 2.

D. Implementation Arrangements

16. The TA will be implemented over 24 months, from 1 June 2016 to 31 May 2018. The executing and implementing agency will be the New Energy and Renewable Energy Department of the National Energy Administration, which will provide support to the consultants, including (i) bilingual counterpart personnel available to work full-time, if required; (ii) assistance with visas, accommodation, and other permits required by the consultants to enter and to work in the PRC; and (iii) access to all data—including documents, and reports—and permission to enter offices, as appropriate and necessary, to undertake the work.

17. The proposed TA will engage a consulting firm consisting of four international consultants (5 person-months) and eight national consultants (31 person-months) with expertise in biomass-to-heat policy, biogas and biomethane technology, gasification technology, biomass molding fuel boiler technology, waste management and policy research, and environmental engineering. The consulting firm will be engaged in accordance with ADB's Guidelines on the Use of Consultants (2013, as amended from time to time) using the quality- and cost-based selection method with a quality–cost ratio of 90:10 by requiring the submission of a simplified technical proposal covering all aspects of the terms of reference. The outline terms of reference for consultants is in Appendix 3.

18. ADB will field inception, interim, and final review missions. During the missions, discussions will be held to review the performance of the consultants, the TA implementation progress, and the completion of deliverables based on the design and monitoring framework as well as the agreed work plan for the consultants. The deliverables submitted by the consultants will be reviewed by the executing and implementing agency as well as ADB. The performance

of the TA, including its outputs and outcomes, will be evaluated during the final review mission. Good practices and lessons learned will be disseminated through the publication of a sourcebook; the completion of a policy note; and arrangement of an international workshop, a conference, and training sessions.

IV. THE PRESIDENT'S DECISION

19. The President, acting under the authority delegated by the Board, has approved the provision of technical assistance not exceeding the equivalent of $400,000 to the Government of the People's Republic of China for the National Biomass Heat Supply Development Strategy, and hereby reports this action to the Board.

DESIGN AND MONITORING FRAMEWORK

Impact the Project is Aligned with Biomass supply in the PRC's heating systems expanded (Environmental Statistical Yearbook of the PRC 2015)[a]			
Results Chain	**Performance Indicators with Targets and Baselines**	**Data Sources and Reporting Mechanisms**	**Risks**
Outcome Biomass-based heat sources in the PRC commercialized	By 2025 (2016 baseline: NA) a. National standards on biomass-based heat sources are issued b. An adequate policy measure to enhance commercialization of biomass-based heat is introduced c. Biomass collection rules in the PRC waste management policy are improved	a–c. One-time administrative notice(s) issued by the National Energy Administration	Government priorities change and the introduction of institutional framework to support commercialization of biomass is delayed
Outputs 1. Study on the current biomass-to-heat market in the PRC prepared	1a. Detailed assessment study on the PRC biomass-to-heat market is produced by June 2017 (2016 baseline: NA)	1a. Consultant's report on the PRC biomass-to-heat market	Due to limited resources, capacity strengthening cannot fulfill the learning demand from potential waste-to-heat project developers.
2. Sourcebook on advanced biomass-to-heat technologies, institutions, and international best practices on biomass-to-heat commercialization produced	2a. All the contents of the sourcebook on biomass-to-heat are developed and finalized by June 2017 (2016 baseline: NA) 2b. The sourcebook is published by December 2017 (2016 baseline: NA)	2a–2b. Consultant's report on international best practices on biomass-to-heat	
3. Capacity strengthening on biomass-to-heat commercialization implemented	3a. International workshop, conference, and training sessions relevant to biomass-to-heat commercialization are organized by May 2018 (2016 baseline: NA)	3a. ADB project data sheet updated quarterly	
4. Policy note on the PRC's strategy to advance biomass-to-heat commercialization developed	4a. A draft policy note is developed by December 2017 (2016 baseline: NA) 4b. The policy note is finalized and accepted by the executing and implementing agency by May 2018 (2016 baseline: NA)	4a–4b. Consultant's report on policy proposal for biomass-to-heat commercialization	

Key Activities with Milestones

Output 1: Study on the current biomass-to-heat market in the PRC prepared

1.1 Conduct desktop research and literature review to identify challenges and barriers associated with the entire biomass-to-heat chain in the PRC (August 2016–January 2017).
1.2 Investigate three identified commercial-scale biomass-to-heat projects, identify barriers in commercialization, and prepare case study reports (September 2016–March 2017).
1.3 Conduct thorough and detailed systematic analysis on the current biomass-to-heat market in the PRC, including institutional, financial, technical aspects, and discuss potentials of biomass-to-heat commercialization (March–June 2017).

Output 2: Sourcebook on advanced biomass-to-heat technologies, institutions, and international best practices on biomass-to-heat commercialization produced

2.1 Collect detailed information on advanced biomass-to-heat technologies and prepare case descriptions (July 2016–March 2017).
2.2 Research and collect other countries' experiences in institutional arrangement, policy measures, and other support of biomass-to-heat commercialization (July 2016–March 2017).
2.3 Research and collect international best practices on biomass-to-heat projects (July 2016–March 2017).
2.4 Select cases for the sourcebook and complete contents for the sourcebook (March–June 2017).
2.5 Design and publish the sourcebook on biomass-to-heat (June–December 2017).

Output 3: Capacity strengthening on biomass-to-heat commercialization implemented

3.1 Identify and build networks with international experts on biomass-to-heat (June 2016–May 2018).
3.2 Prepare and organize international workshop, conference, and training sessions on biomass-to-heat (June 2016–May 2018).
3.3 Prepare the proceedings of workshops, conferences, and trainings (June 2016–May 2018).

Output 4: Policy note on the PRC's strategy to advance biomass-to-heat commercialization developed

4.1 Draft a policy note based on outputs 1–3 (March 2017–December 2017).
4.2 Finalize the policy note (December 2017–May 2018).

Inputs

ADB (TASF–other sources): $400,000

Note: The government will provide counterpart support in the form of counterpart staff, office accommodation, office supplies, data and information relevant to biomass-to-heat, and other in-kind contributions.

Assumptions for Partner Financing

Not applicable.

ADB = Asian Development Bank, NA = not applicable, PRC = People's Republic of China, TASF = Technical Assistance Special Fund.

[a] National Bureau of Statistics and Ministry of Environmental Protection of the People's Republic of China. 2015. *Environmental Statistical Yearbook of the PRC*. Beijing: China Statistics Press.

Source: Asian Development Bank.

COST ESTIMATES AND FINANCING PLAN

($'000)

Item	Amount
Asian Development Bank[a]	
1. Consultants	
a. Remuneration and per diem	
i. International consultants (5 person-months)	100.0
ii. National consultants (31 person-months)	155.0
b. International and local travel[b]	56.0
c. Reports, publications, and communications[c]	10.0
2. Training, seminars, workshops and conferences[d]	70.0
3. Contingencies[e]	9.0
Total	**400.0**

Note: The technical assistance (TA) is estimated to cost $440,000, of which contributions from the Asian Development Bank (ADB) are presented in the table above. The government will provide counterpart support in the form of counterpart staff, office accommodation, office supplies, data and information relevant to biomass-to-heat, and other in-kind contributions. The value of government contribution is estimated to account for 9.1% of the total TA cost.

[a] Financed by ADB's Technical Assistance Special Fund (TASF-other sources).

[b] This includes both international and local travel for consultation and data collection.

[c] To include translation costs.

[d] To include travel costs for participation in workshops and relevant conferences in ADB member countries by ADB staff as well as consultants acting as facilitators and/or resource persons.

[e] To include costs for surveys, interviews, printing of questionnaires, and other costs related to conducting the case studies.

Source: Asian Development Bank estimates.

OUTLINE TERMS OF REFERENCE FOR CONSULTANTS

A. Introduction

1. The policy and advisory technical assistance (TA) will be implemented over 24 months from 1 June 2016 to 31 May 2018. The consultants will be responsible for producing the TA outputs and deliverables effectively and on time, and for organizing and carrying out all the tasks indicated.

2. The TA will engage a consulting firm consisting of four international consultants (5 person-months) and four national consultants (31 person-months). The consulting firm will be engaged in accordance with the Guidelines on the Use of Consultants (2013, as amended from time to time) of the Asian Development Bank (ADB) using the quality- and cost-based selection method with a quality–cost ratio of 90:10 by requiring the submission of a simplified technical proposal covering all aspects of the terms of reference.

B. Consulting Requirements

3. **Biogas and biomethane technology and policy expert and co-team leader** (international, 2 person-months). The expert should have (i) a postgraduate degree in engineering, chemical engineering, environmental science, environmental engineering, environmental management and policy, or in any relevant field; and (ii) at least 10 years of experience working on biogas processing technologies, biogas purification for biomethane, commercial-scale biogas or biomethane projects, and biomass policy design and analysis. Work experience in the region or in the People's Republic of China (PRC) will be an advantage. Oral and written English proficiency is required. Specific tasks are the following:

(i) supervise other experts' work, and encourage quality and timely delivery of all outputs of the other experts;
(ii) lead the preparation of a sourcebook on biomass-to-heat;
(iii) research and compile relevant and useful lessons and international best practices on state-of-the-art biogas or biomethane-to-heat successful implementation for the sourcebook;
(iv) support the national co-team leader in preparing a policy note on the PRC strategy to advance biomass-to-heat commercialization and capacity building activities;
(v) provide supervision to the national biogas specialist in (a) researching and identifying issues and challenges that current commercial-scale biogas or biomethane development in the PRC faces, (b) discussing potential commercial markets of biogas or biomethane and its competitiveness as an energy source for the heating sector, (c) quantifying greenhouse gas (GHG) emissions reduction benefits and other environmental benefits, (d) preparing proper technical standards for commercial-scale biogas or biomethane in the PRC, and (d) preparing policy recommendations for commercial-scale biogas or biomethane; and
(vi) support various capacity building activities, particularly those relevant to biogas commercialization.

4. **Biomass molding fuel and technology expert** (international, 1 person-month). The expert should have (i) a postgraduate degree in engineering, chemical engineering, processing engineering, environmental engineering, or in any relevant field; and (ii) at least 10 years of experience working on biomass molding fuel (BMF) and BMF boiler technology and commercial-scale BMF projects. Work experience in the region or in the PRC will be an advantage. Oral and written English proficiency is required. Tasks include the following:

(i) research and compile (a) international best practices on state-of-the-art BMF and BMF-based heating projects, which will be included in a sourcebook of biomass-to-heat; and (b) technical standards for commercial-scale BMF and BMF boilers that are used in other countries;
(ii) provide supervision to the national BMF specialist in (a) researching and identifying issues and challenges that current commercial-scale BMF and BMF-based heating development in the PRC faces; (b) discussing potential commercial markets of BMF; (c) quantifying GHG emissions reduction benefits, and other environmental benefits; (d) preparing a technical standards proposal for commercial-scale BMF heating in the PRC; and (e) preparing the policy proposal for commercial scale BMF; and
(iii) support various capacity building activities, in particular on BMF technology and other issues related to BMF.

5. **Biomass-based combined heat and power technology expert** (international, 1 person-month). The expert should have (i) a postgraduate degree in engineering, chemical engineering, processing engineering, environmental engineering, or in any relevant field; and (ii) at least 10 years of experience working on biomass-based combined heat and power (CHP) technology. Work experience in the region or in the PRC will be an advantage. Oral and written English proficiency is required. Tasks include the following:

(i) research and compile (a) international best practices on state-of-the-art biomass-based CHP technology projects for a sourcebook of biomass-to-heat, and (b) technical standards for commercial-scale biomass-based CHP technologies that are used in other countries;
(ii) supervise the national biomass-based CHP specialist in (a) researching and identifying issues and challenges that current commercial-scale biomass-based CHP technologies in the PRC face; (b) discussing potential commercial markets of biomass-based CHP technologies, including gasification; (c) preparing technical standards and policy measures for commercial-scale biomass-based CHP technologies in the PRC; and (d) quantifying GHG emissions reduction benefits and other environmental benefits; and
(iii) support various capacity building activities relevant to biomass-based CHP.

6. **Gasification technology expert** (international, 1 person-month). The expert should have (i) a postgraduate degree in engineering, chemical engineering, processing engineering, environmental engineering, or in any relevant field; and (ii) at least 10 years of experience working on biomass-based thermal gasification technology and other gasification technologies. Work experience in the region or in the PRC will be an advantage. Oral and written English proficiency is required. Tasks include the following:

(i) research and compile (a) international best practices on state-of-the-art biomass-based gasification projects for a sourcebook of biomass-to-heat, and (b) technical standards for commercial-scale biomass-based gasification that are used in other countries;
(ii) supervise the national biomass-based gasification specialist in (a) researching and identifying issues and challenges that current commercial-scale biomass-based gasification development in the PRC face, (b) discussing potential commercial markets of biomass-based gasification, (c) quantifying GHG emissions reduction benefits and other environmental benefits, and (d) preparing technical standards and policy measures for commercial-scale biomass-based gasification in the PRC; and
(iii) support various capacity building activities relevant to biomass-based gasification.

7. **Biomass and waste policy and program evaluation specialist and co-team leader** (national, 7 person-months). The specialist should have (i) a postgraduate degree in environmental management and policy, public policy and administration, business management, and agriculture engineering, or in any relevant field; and (ii) at least 10 years of experience working on waste management and policy research, policy formation and design, biomass-to-energy project assessment and evaluation, and program and policy evaluation. Oral and written English proficiency is required. Tasks include the following:

(i) closely communicate with ADB and the New and Renewable Energy Department of the National Energy Administration, the executing and implementing agency of the project;
(ii) coordinate with the international co-team leader in (a) leading the research on the current waste management and policy on biomass in the PRC; (b) planning in-depth case studies on current commercial-scale operations of biogas, BMF, and biomass-based CHP in the PRC by providing detailed study outlines, advising on study methodologies and approaches, and providing guidance and supervision to national specialists in assessing PRC's biomass-to-heat market; (c) providing guidance and supervision to other national researchers; and (d) leading the preparation of inception, interim, and final reports;
(iii) prepare thorough analysis of the PRC biomass-to-heat market and systems while consulting with the international co-team leader;
(iv) lead the drafting of a policy note that meets the expectations of ADB and the executing and implementing agency;
(v) translate necessary documents and information from Chinese to English and from English to Chinese; and
(vi) responsible for team meeting logistics and organization, including capacity building workshops and training sessions.

8. **National biogas and biomethane specialist** (national, 4 person-months). The specialist should have (i) a postgraduate degree in engineering, chemical engineering, environmental science, environmental engineering, or in any relevant field; and (ii) at least 8 years of experience working on biogas processing technologies and/or biogas purification for biomethane projects. Oral and written English proficiency is required. Tasks include the following:

(i) plan and perform in-depth case study research on identified commercial-scale biogas project;
(ii) provide information about technical assessment on biogas production, relevant actors, institutional settings, financial arrangements, and environmental performance of selected biogas case studies;
(iii) analyze (a) challenges and opportunities in biomass generation, collection, and transportation in selected cases; (b) biogas technology development in the PRC; and (c) various governance issues and aspects associated with selected biogas case studies;
(iv) conduct comparative market research on biogas as a heat source; and
(v) draft the section on biogas-to-heat as part of the PRC biomass-to-heat assessment study.

9. **National biomass molding fuel specialist** (national, 4 person-months). The specialist should have (i) a postgraduate degree in engineering, chemical engineering, processing engineering, environmental engineering, or in any relevant field; and (ii) at least 10 years of

experience working on BMF and BMF boiler technology projects. Oral and written English proficiency is required. Tasks include the following:

(i) provide information about BMF technical assessment, relevant actors, institutional settings, financial arrangements, and environmental performance of selected BMF case studies;
(ii) analyze (a) challenges and opportunities in biomass generation, collection, and transportation in selected BMF case studies; (b) BMF technology development in the PRC; and (c) various governance issues and aspects associated with selected BMF case studies; and estimate potential commercial-scale BMF production in the PRC;
(iii) conduct comparative market research on biogas as a heat source, and evaluate financial arrangements of selected BMF case studies; and
(iv) draft the BMF-to-heat section in the PRC biomass-to-heat assessment study.

10. **National biomass-based combined heat and power specialist** (national, 4 person-months). The specialist should have (i) a postgraduate degree in engineering, chemical engineering, processing engineering, environmental engineering, or in any relevant field; and (ii) at least 8 years of experience working on biomass-based CHP technology. Oral and written English proficiency is required. Tasks include the following:

(i) provide information about technical assessment on specific biomass-based CHP technology used, relevant actors, institutional settings, financial arrangements, and environmental performance of selected biomass-based CHP case studies;
(ii) analyze (a) challenges and opportunities in biomass generation, collection, and transportation in selected CHP case studies; (b) biomass-based CHP technology development in the PRC; and (c) various governance issues and aspects associated with selected biomass-based CHP case studies; and estimate potential commercial-scale biomass-based CHP production in the PRC;
(iii) conduct comparative market research on the heat from biomass-based CHP generation and evaluate financial arrangements of selected biomass-based CHP case studies; and
(iv) draft the biogas-to-heat section as part of the PRC biomass-to-heat assessment study.

11. **National gasification specialist** (national, 4 person-months). The specialist should have (i) a postgraduate degree in engineering, chemical engineering, processing engineering, environmental engineering, or in any relevant field; and (ii) at least 8 years of experience working on various biomass utilization technologies. Oral and written English proficiency is required. Tasks include the following:

(i) describe various types of gasification technologies, with a focus on advantages and disadvantages in terms of technical performance, cost implication, environmental performance, and other aspects of gasification technology application;
(ii) prepare technical and emissions standards for commercial-scale gasification technology, estimate potential commercial-scale gasification application in the PRC, and describe challenges and opportunities of gasification in the PRC; and
(iii) draft the section on biomass-based gasification-to-energy as a part of the PRC biomass-to-heat assessment study.

12. **National financial analyst** (national, 2 person-months). The analyst should have (i) a postgraduate degree in economics, finance, environmental management and policy, business administration and management, or in any relevant field; and (ii) at least 8 years of experience

working on financial biomass technologies, biomass-to-energy projects, supply chain management, and/or biomass business development. Oral and written English proficiency is required. Tasks include the following:

(i) perform financial analysis of all the selected case studies, including analysis and evaluation of financial arrangements;
(ii) conduct market research on biomass-based heating sources compared to other heating sources, and describe the potential of biomass-based heat sources and their competitiveness;
(iii) develop financial and economic modeling on biomass-to-heat development scenarios in the PRC; propose adequate financial arrangements throughout the biomass-to-heat value chain, enabling policies; and
(iv) draft market assessment section for the PRC biomass-to-heat assessment study.

13. **National economic modeling specialist** (national, 2 person-months). The specialist should have (i) a postgraduate degree in economics, finance, business administration and management, or in any relevant field; and (ii) at least 8 years of experience working on economic modeling for energy sector assessment. Oral and written English proficiency is required. Tasks include the following:

(i) develop an economic model to assess biomass-to-heat potential in the PRC;
(ii) review case study results and plan for economic assessment for potential biomass-to-heat in the PRC (economic modeling needs to incorporate environmental benefits of biomass-to-heat); and
(iii) prepare the section on economic modeling and evaluation of biomass-to-heat potential in the PRC for the PRC biomass-to-heat assessment study.

14. **National environmental engineer** (national, 4 person-months). The engineer should have (i) a postgraduate degree in environmental engineering, chemical engineering, environmental science, or in any relevant field; and (ii) at least 8 years of experience working on biogas, biomethane processing technologies, BMF boilers, biomass-based CHP technologies (including gasification), and environmental impact assessment of biomass-to-heat projects. Oral and written English proficiency is required. Tasks include the following:

(i) conduct research and assess current emission standards for biomass-based heat processing equipment in the PRC and other countries;
(ii) assess environmental performance and environmental impact of all the selected cases (with a focus on biomass processing lines), and draft environmental performance sections for all the case studies;
(iii) estimate GHG emissions using internationally proven methodologies for all selected case studies;
(iv) propose and prepare emission standards for commercial-scale biogas or biomethane processing equipment, BMF boilers, biomass-based CHP, gasification, and other relevant technologies for biomass utilization; and
(v) translate necessary documents and information from Chinese to English and from English to Chinese.

C. Reporting Requirements

15. The consultants will submit (i) an inception report within 1 month; and (ii) an interim report within 5 months after signing the consulting contract. A draft consolidated final report will be provided upon completion of each output. For the final versions of each report, the consultants will incorporate all the comments provided by ADB and the executing and implementing agency. The final report will be provided in English and Chinese.