Technical Assistance Report

Project Number: 47054
Capacity Development Technical Assistance (CDTA)
December 2013

People's Republic of China: Strengthening Capacity for Promoting Distributed Renewable Energy Utilization in Hebei Province

Asian Development Bank

CURRENCY EQUIVALENTS
(as of 9 December 2013)

Currency unit	–	yuan (CNY)
CNY1.00	=	$0.1644
$1.00	=	CNY6.0805

ABBREVIATIONS

ADB	–	Asian Development Bank
GW	–	gigawatt
m^2	–	square meter
PPP	–	public–private partnership
PRC	–	People's Republic of China
TA	–	technical assistance

TECHNICAL ASSISTANCE CLASSIFICATION

Type	–	Capacity development technical assistance (CDTA)
Targeting classification	–	General intervention
Sector (subsectors)	–	Energy (renewable energy, energy utility services, energy efficiency and conservation, energy sector development)
Themes (subthemes)	–	**Environmental sustainability** (urban environmental improvement), economic growth (knowledge, science, and technological capacities), private sector development (private sector investment), capacity development (institutional development
Climate change	–	Mitigation
Location (impact)	–	Regional (low), national (medium), urban (high), rural (medium)

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

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CONTENTS

I. INTRODUCTION

1. The capacity development technical assistance (TA) is included in the 2013 nonlending assistance pipeline of the approved People's Republic of China (PRC) country operations business plan, 2013–2015 as Capacity Building for New Energy City Demonstration in Hebei.[1] The concept paper was approved on 4 November 2013.

2. During the TA fact-finding mission, the TA title was changed to Strengthening Capacity for Promoting Distributed Renewable Energy Utilization in Hebei Province to better reflect the scope of the TA, the impact and outcome, outputs, implementation arrangements, cost estimates, and consultants' terms of reference as agreed with the Hebei provincial government and the Ministry of Finance.[2] The design and monitoring framework is in Appendix 1.[3]

II. ISSUES

3. In recognition of the climate change impacts and local environmental problems caused by increasing use of fossil-fuel-based energy sources in the PRC, the central government has initiated several measures to reduce the energy intensity of the economy and to pare back the predominance of coal in energy supply. To meet the challenges posed by the rapid rise in energy consumption and associated emissions, the government is committed to achieve 40%–45% carbon intensity reduction by 2020, compared with the 2005 level.[4] The government also set specific targets to (i) reduce energy intensity by 20% in the Eleventh Five-Year Plan, 2006–2010 and by 16% in the Twelfth Five-Year Plan, 2011–2015; (ii) reduce carbon intensity by 17% during the 12th plan; and (iii) increase the renewable energy contribution in the primary energy supply to 15% by 2020, from 8.9% in 2010.

4. As a result of these policy measures, the PRC has emerged as the leading producer of wind power in the world with a grid-connected capacity of over 62 gigawatts (GW) by 2012. The rapid development of large-scale and centralized solar photovoltaic and wind power capacity is posing new challenges to grid stability due to the intermittent nature of power supplied by these plants. Furthermore, environmental and grid stability concerns have sparked increased interest in small-scale, "distributed" sources of renewable electricity generation, such as building integrated solar photovoltaic and waste- and biomass-based electricity generation.[5]

5. In contrast to the rapid deployment of renewable energy technologies for electricity generation, the PRC has so far not widely applied renewable energy to heat production. Although the PRC is the world's largest market for solar water heating, the concentrated solar thermal technology is not widely deployed for heating applications. There is also a large

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[1] ADB. 2013. *Country Operations Business Plan: People's Republic of China, 2013–2015. Manila.*

[2] The TA fact-finding mission was held on 13–14 November 2013.

[3] The TA first appeared in the business opportunities section of ADB's website on 7 November 2013.

[4] Carbon intensity is defined as amount of carbon dioxide emitted per unit of gross domestic product. National Energy Administration. 2011. *Report on PRC's Energy Development for 2011*. Beijing: Economic Science Press.

[5] "Distributed" renewable energy systems generate clean, renewable electricity on-site, i.e., where that energy will be used. The term distinguishes these systems from the large, centralized power plants that provide the vast majority of the nation's power. Distributed renewable energy systems can take many forms, including geothermal systems, micro-hydroelectric systems, solar panels, and wind turbines. There are many programs and policies that can either help or hinder the adoption and integration of distributed energy systems.

potential for using biomass and municipal solid waste to produce electricity and heat, especially in urban areas. Geothermal energy for space heating has large untapped potential to replace the coal boilers in urban areas of the northern PRC, such as Hebei province where coal is the fuel of choice for heating.

6. Hebei Province, which borders the Beijing and Tianjin municipalities, ranks second among the PRC Provinces in overall energy consumption. The energy intensity of the province—at 1.583 tons of coal equivalent per CNY10,000 in 2010—is 1.5 times the national average. Moreover, coal contributes 90.5% of primary energy supply in Hebei Province, against the corresponding national figure of 68%. Given the highly energy-intensive nature of Hebei's economic structure, the provincial government has taken concerted efforts to improve energy efficiency and increase renewable energy penetration in its primary energy mix.

7. The energy consumed for space heating contributed to 7.3% of the final energy demand in Hebei Province. Its centralized heating systems covered about 580 million square meters (m^2) in 2012, and this is expected to increase to 780 million m^2 by 2020. Coal-fired combined heat and power plants meet the heat demand of 250 million m^2 in the larger cities in the province, while heat-only boilers are supplying 330 million m^2 in county-level cities. In addition, natural gas is used for providing heating to 20 million m^2 in neighboring areas of Beijing municipality. Although Hebei has both shallow-ground (i.e., less than 200 meters below the ground level) and deep-ground geothermal resources, the utilization of geothermal energy for space heating is limited to 2 million m^2 at present.

8. The increasing concern about air pollution in Beijing has prompted the government to boost the use of natural gas for power generation and heat production in Hebei Province, as coal burning in Hebei is found to be one of the major contributors to air pollution in Beijing. There is scope to further reduce carbon emissions and air pollutants by complementing natural-gas-based combined heating with renewable energy technologies such as wind-based electric heating, shallow-ground geothermal energy, and waste-to-energy conversion. In addition, the distributed renewable energy sources can also be used for electricity generation subject to availability of adequate feed-in tariffs and grid connectivity.

9. Hebei has emerged as one of the leading wind power basins in the PRC and a major manufacturing base of solar photovoltaic panels, but renewable energy is not widely used for meeting the non-electricity energy needs of urban areas. There is significant potential for increasing the use of renewable energy in urban areas for residential and commercial applications, including heating. The installed wind power capacity in Hebei is more than 7.5 GW and wind power curtailment is prevalent due to excess wind power generation over and above the wind power absorption capacity of the transmission grid.[6] This excess wind energy is not utilized for local application such as space heating in large wind-power-producing counties in Zhangjiakou and Chengde prefectures of Hebei Province.

10. There is lack of understanding of the availability of geothermal resources in close proximity to population centers, technical and financial viability of geothermal energy as a heat

[6] Absorption of power generated by solar photovoltaic and wind power plants into the grid requires more grid flexibility to fully utilize the variable and intermittent output from these plants. In addition, the PRC's interregional power market is relatively underdeveloped, inhibiting trade of electricity between regional power grids. In certain regions of the PRC this resulted in the curtailment of wind power, which is as high as 40% compared with less than 5% in the United States.

source, and use of geothermal energy for heating in combination with heat pumps and natural gas backup. In addition, developing geothermal energy for productive use requires multiple regulatory approvals. Similarly, municipal and agricultural waste is not widely used for electricity generation and heat production due to lack of clarity on institutional responsibilities and financial incentives. Innovative technologies such as plasma combustion and gasification can be deployed to produce heat and electricity in an environmentally sustainable manner in urban areas.

11. Small-scale distributed renewable energy investments in both electricity and heat production are appropriate for private sector investments. However, it would also be necessary to structure public–private partnerships (PPPs) to boost private sector interest in these projects, taking into account the specific risk profiles of different renewable technologies. The provincial government agencies in Hebei need to develop their capacity to structure PPP transactions and to provide technology-specific financial incentives that will attract private investors to these projects.

12. The integration of distributed energy sources based on a range of renewable energy technologies for heat and electricity production poses various technical, institutional, and financial challenges for provincial authorities. The investment models to be adopted for mobilizing investments in large number of relatively small renewable energy projects would be radically different from the state-owned-enterprise-led approach deployed in developing large-scale power plants, including wind power, in the PRC. It would also be necessary to create an enabling environment through appropriate policy incentives such as transparent regulatory regime, feed-in tariffs, and tax incentives to attract investments in distributed renewable energy projects.

13. The utilization of the renewable energy for non-electricity applications such as heating has not been widely deployed in Hebei Province as well as in other provinces in the PRC. Although there is good potential for increasing the renewable energy in heat supply, there are institutional, technical and capacity issues that are preventing the increased use of renewable energy for non-electricity applications in Hebei Province. The proposed TA is designed to address these barriers.

III. THE TECHNICAL ASSISTANCE

14. The TA will support the central government's strategy to de-link economic growth and greenhouse gas emissions and to increase the use of renewable energy. The TA is also a timely response to the urban air pollution in northern PRC and will support the regulations issued by the National Energy Administration in 2013 to increase nonpolluting energy sources for heat supply. ADB's country partnership strategy, 2011–2015 also prioritized ADB support for innovative technologies and institutional arrangements to mitigate climate change and protect the urban environment, and to promote private sector participation in delivery of public services.[7] The TA will strengthen the capacity of provincial government agencies for using distributed renewable energy for heat supply in urban areas by assessing the feasibility of geothermal energy and wind power as a potential heat source in the context of Hebei Province. In addition, the TA will provide capacity building to provincial agencies to structure PPPs to attract private sector investments to these distributed renewable energy projects.

[7] ADB. 2012. *Country Partnership Strategy: People's Republic of China, 2011–2015*. Manila

A. Impact and Outcome

15. The impact of the TA will be greater use of distributed renewable energy in Hebei Province. The outcome of the TA will be stronger capacity of the government agencies in Hebei Province to promote the use of distributed renewable energy.

B. Methodology and Key Activities

16. The TA will be undertaken in close collaboration with Hebei provincial government agencies responsible for promoting the use of renewable energy for heat supply. The TA consultants will work closely with these agencies to confirm the availability of renewable energy resources such as excess wind energy, biomass, municipal solid waste, and geothermal energy, and to ascertain the feasibility of using these resources to meet the energy needs of urban centers in the province. In addition, demonstration projects deploying these technologies will be selected and institutional arrangements to implement these projects as PPPs will be proposed. The TA will have the following outputs:

(i) The geothermal resource availability in secondary cities in Hebei Province and the feasibility of using geothermal energy for heat supply are assessed.
(ii) The technical and financial feasibility of using excess wind energy and biomass for heat supply in Hebei Province is confirmed.
(iii) Several distributed renewable energy projects are selected for implementation, and the capacity of provincial government agencies to promote PPPs to implement these projects is strengthened.

C. Cost and Financing

17. The TA is estimated to cost $400,000 equivalent, of which $300,000 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 office accommodation, facilities and remuneration of counterpart staff, studies, reports, data, and other in-kind contributions. The cost estimates and financing plan are in Appendix 2.

D. Implementation Arrangements

18. The Hebei provincial government will be the executing agency for the TA. The Demand Side Management Center under the Hebei Development and Reform Commission will be the implementing agency. The implementing agency will maintain close coordination with the Hebei Bureau for Energy and the Hebei Bureau of Housing and Urban Development.

19. The TA will be implemented over 12 months, from 1 January 2014 to 31 December 2014. It will be carried out by a team of national consultants with extensive knowledge and expertise in (i) geothermal resource assessment and geothermal power development for heating, (ii) distributed renewable energy technologies and implementation models for distributed renewable energy projects, (iii) structuring of PPP projects for renewable energy, and (iv) institutional and financial regulations pertaining to wind power and heat supply in the PRC.

20. ADB will recruit consultants through a national consulting firm in accordance with its Guidelines on the Use of Consultants (2013, as amended from time to time) using the quality- and cost-based selection method. Because of the importance of the technical aspects of the consulting services, a quality–cost ratio of 80:20 is proposed. Interested consulting firms will be required to submit a simplified technical proposal covering work plan, team composition, task

assignments, work and personnel schedules, and curriculum vitae of the proposed consultants. The national consultancy firms in the PRC have adequate expertise to undertake this assignment, and the relatively small TA budget and the requirement for extensive fieldwork do not warrant the inclusion of international firms in the short list. Furthermore, the local knowledge is important for developing distributed renewable energy projects.

21. All procurement will be carried out in accordance with ADB's Procurement Guidelines (2013, as amended from time to time). All equipment purchased under the TA will be turned over to the implementing agency after TA completion. TA funds will be disbursed in accordance with ADB's *Technical Assistance Disbursement Handbook* (2010, as amended from time to time).

22. The consultants will be required to maintain a close working relationship with ADB and the executing and implementing agencies. Tripartite meetings between ADB, the executing and implementing agencies, and consultants will be conducted at the TA inception, midterm, and upon submission of the draft final report to provide guidance to the consultants and to review their reports. Workshops and seminars will be held to collect comments and discuss consultants' reports. The TA's main findings will be largely disseminated.

IV. THE PRESIDENT'S DECISION

23. 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 Strengthening Capacity for Promoting Distributed Renewable Energy Utilization in Hebei Province, and hereby reports this action to the Board.

DESIGN AND MONITORING FRAMEWORK

Design Summary	Performance Targets and Indicators with Baselines	Data Sources and Reporting Mechanisms	Assumptions and Risks
Impact Greater use of distributed renewable energy in Hebei Province	The contribution of non-fossil-fuel energy to primary energy supply in Hebei Province will increase from 4.2 % in 2012 to 6% in 2015 and 10% in 2020.	Hebei Annual Energy Statistics Hebei Statistical Bureau	**Assumptions** The capacity of the pertinent government agencies is strengthened. Financing can be mobilized for distributed renewable energy investments. **Risk** Lack of clarity on financial and regulatory incentives for use of cleaner but more expensive renewable sources of heat supply
Outcome Stronger capacity of the government agencies in Hebei Province to promote the use of distributed renewable energy	Achieve cumulative energy savings of 200,000 tce and CO_2 savings of 450,000 tons by replacing coal-fired heating systems with distributed renewable energy Hebei Province adopts a strategy for using geothermal energy to meet the heating demand of an area of 20 million m^2 of geothermal-based heating by 2020. Several candidate geothermal- and wind-power-based heating projects are identified and investment models are finalized, with heat supply capacity of 5 million m^2. Distributed renewable energy generation projects (solar photovoltaic, solid waste, and small-scale wind power) of at least 100 MW are identified and investment models are finalized.	Hebei Development and Reform Commission Consultants' final report TA completion report	**Assumptions** Adequate geothermal resources are available in close proximity to population centers in Hebei Province. Regulatory mechanisms to overcome the institutional barriers for using excess wind power for heating can be overcome. **Risks** Multiple permitting and approval requirements for geothermal-based heating plants Crowding out of proposed renewable energy based heat supply projects by conventional heat supply companies.

Design Summary	Performance Targets and Indicators with Baselines	Data Sources and Reporting Mechanisms	Assumptions and Risks
Outputs 1. The geothermal resource availability in secondary cities in Hebei Province and the feasibility of using geothermal energy for heat supply are assessed 2. The technical and financial feasibility of using excess wind energy and biomass for heat supply in Hebei Province is confirmed 3. Several distributed renewable energy projects are selected for implemenation, and the capacity of provincial government agencies to promote PPPs to implement these projects is strengthened.	Geothermal resource assessment of at least 10 counties completed. Cities and towns with potential for geothermal-based heating are selected. Technical and financial feasibility of demonstrating wind-based heat supply in Hebei Province is assessed. Prefeasibility study for deploying plasma gasification of biomass for heat supply is undertaken Prefeasibility studies are undertaken for at least 5 projects that would supply heating based on renewable energy. Institutional arrangements and PPP structures for implementing these projects are recommended.	Consultants' reports TA review missions TA completion report	**Assumptions** Geological data for assessing the geothermal resources is made available to the consultants. Sufficient interest from city and county governments to cooperate with consultants in selecting potential heat supply projects based on geothermal and wind energy.
Activities with Milestones 1. Assess the geothermal resource availability in secondary cities in Hebei Province and the feasibility of using geothermal energy for heat supply (March–June 2014) 1.1 Review the available data and studies on geothermal energy availability in Hebei Province. 1.2 Select the locations that have good potential for geothermal-based heat supply. 1.3 Estimate the cost of supplying geothermal-based heating systems under different geological conditions and different configurations. 1.4 Make recommendations on financial incentives and subsidies to be provided for promoting geothermal-based heating systems in Hebei Province. 2. Confirm the technical and financial feasibility of using excess wind energy and biomass for heat supply in Hebei Province (March–September 2014) 2.1 Assess the feasibility for using excess wind power for heat supply in wind-rich counties in Hebei Province from a technical point of view. 2.2 2.2Select candidate counties for demonstrating wind-based heating based on consultations with relevant stakeholders and technical feasibility. 2.3 Undertake prefeasibility studies on plasma gasification of biomass or municipal waste for heat supply.			**Inputs** **ADB: $300,000** Consultants: $230,000 Workshops: $20,000 Reports: $15,000 Equipment: $10,000 Contingencies: $25,000 Note: The government will also provide counterpart support in the form of office accommodation, logistics, facilities and remuneration of counterpart staff, studies, reports, data, and other in-kind contributions.

Activities with Milestones	
3. Strengthen the capacity of provincial government agencies to select, structure, and implement several distributed renewable energy projects as PPPs (June 2014–Dec. 2014) 3.1 Select at least five candidate cities with good potential for developing demonstration projects on renewable-energy-based heat supply. 3.2 Prepare prefeasibility studies for these projects, including detailed assessment of renewable energy availability, geographical coverage. 3.3 Propose an investment framework that outlines the roles of public and private sector entities in implementing these projects as PPPs.	

ADB = Asian Development Bank, CO_2 = carbon dioxide, MW = megawatt, m^2 = square meter, PPP = public–private partnership, TA = technical assistance, tce = ton of coal equivalent.
Source: ADB staff estimates.

COST ESTIMATES AND FINANCING PLAN

($'000)

Item	Amount
Asian Development Bank[a]	
1. Consultants	
a. Remuneration and per diem	215.0
b. National travel	15.0
2. Reports and communications	15.0
3. Equipment[b]	10.0
4. Training, seminars, study tour, and conferences[c]	20.0
5. Contingencies	25.0
Total	**300.0**

Note: The technical assistance (TA) is estimated to cost $400,000, 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 office accommodation, logistics, facilities and remuneration of counterpart staff, studies, reports, data, and other in-kind contributions. The value of government contribution is estimate to account for 25% of total TA cost.

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

[b] Equipment will mainly include four laptops, one photocopier, two laser printers, and one facsimile machine. The equipment will be transferred to the implementing agency upon TA completion.

[c] The budget for dissemination activities has been included in this line item. An advance payment facility will be provided to the executing and implementing agencies to undertake these activities.

Source: Asian Development Bank estimates.

OUTLINE TERMS OF REFERENCE FOR CONSULTANTS

1. The technical assistance (TA) will be implemented in consultation with the executing agency, the implementing agency, and other stakeholders. The Asian Development Bank (ADB) will recruit consultants through a national consulting firm in accordance with its Guidelines on the Use of Consultants (2013, as amended from time to time) using the quality- and cost-based selection method. Because of the importance of the technical aspects of the consulting services, a quality–cost ratio of 80:20 is proposed. Interested consulting firms will be required to submit a simplified technical proposal covering work plan team composition, task assignments, work and personnel schedules, and curriculum vitae of the proposed consultants.

2. The TA will be carried out by a team of national consultants with extensive knowledge and expertise in (i) geothermal resource assessment and use of geothermal energy for heating, (ii) distributed renewable energy technologies and implementation models for distributed renewable energy projects, (iii) structuring of public–private partnership projects for renewable energy, and (iv) institutional and financial regulations pertaining to wind power and heat supply in the People's Republic of China (PRC). In addition to the team of consultants to be recruited through a national consultancy firm, a national consultant experienced in ADB TA administration procedures will be recruited to help the implementing agency monitor the consultants' output and to ensure that the TA outputs are of required quality. The national consultancy firms in the PRC have adequate expertise to undertake this assignment, and the relatively small TA budget and the requirement for extensive fieldwork do not warrant the inclusion of international consultancy firms in the short list.

3. The task-oriented outline terms of reference and the preliminary estimates of the type of experts to be recruited through the national consulting firm, and the level of effort in person-months required from each type of expert are summarized below. The consultancy inputs required to undertake the different outputs are summarized in the table below.

Breakdown of Consulting Inputs

	Person-Months		
National Consultants[a]	**Task 1**	**Task 2**	**Task 3**
Heat supply expert and team leader	3	2	2
Geothermal energy specialist	3		2
Geologist	2		1
Geographic information system specialist	2		
Solar thermal or photovoltaic expert			1
Solid-waste and biomass-to-energy expert		2	1
Economist		2	2
Public-private partnership expert			3
Power system operation expert		1	
Wind power integration expert		1	

Source: ADB staff estimates.
[a] Excludes the project coordinator (4 person-months), who is to be recruited as an individual consultant.

4. The qualifications of consultants are summarized below.

(i) Heat supply expert and team leader: professional qualifications in mechanical engineering and more than 15 years' experience in heat supply system design.
(ii) Geothermal energy expert: academic qualifications in mechanical engineering or geothermal engineering and 10 years' experience in in designing geothermal based heat supply system.
(iii) Geologist: academic qualifications in geology and 10 years' experience.

(iv) Geographic information system (GIS) expert: professional qualifications in GIS systems and at least 5 years' experience related to GIS applications in urban infrastructure planning.
(v) Solar thermal expert: academic qualifications in mechanical and solar engineering and at least 5 years' experience in solar thermal applications.
(vi) Public–private partnership (PPP) expert: academic or professional qualifications in project finance and at least 5 years' experience in structuring PPP transactions in the PRC.
(vii) Solid-waste and biomass-to-energy expert: professional qualifications in mechanical or thermal engineering and at least 10 years' experience in designing thermal systems.
(viii) Economist: master's degree or equivalent qualifications in energy economics and at least 10 years' experience in economic analysis of energy projects.
(ix) Power system operations expert: academic qualifications in electrical engineering and 10 years' experience in power system operations.
(x) Wind power integration expert: academic qualifications in electrical engineering and 5 years' experience in wind power integration.

A. Consulting Requirements

5. **Task 1. Assess the geothermal resource availability in secondary cities in Hebei Province and the feasibility of using geothermal energy for heat supply.** This task will be undertaken by a team of consultants consisting of (i) heat supply expert and team leader (3 person-months), (ii) geothermal energy specialist (3 person-months), (iii) geologist (2 person-months), and (iv) GIS specialist (2 person-months). The task includes the following:

(i) Review the available data on geological data about the geothermal energy availability in Hebei Province.
(ii) Based on the review of available geological data, assess the suitability of geothermal resources for heating with and without heat pumps and natural gas backup.
(iii) Prepare GIS maps to correlate the geothermal resource availability, population centers, coverage of existing heat supply systems, availability of natural gas, and new residential areas to be developed within the next 10 years.
(iv) Propose locations that have good potential for geothermal-based heat supply.
(v) Undertake preliminary discussions with local government officials regarding the possibility of geothermal-based heat supply after taking into account the existing heat supply systems and the possibility of extending the coverage of conventional heat supply systems.
(vi) Make a realistic assessment of the market size for geothermal-based heat supply systems in Hebei Province.
(vii) Review the permitting and approval requirements for geothermal-based heating systems and recommend streamlining the approval requirements.
(viii) Estimate the cost of supplying geothermal-based heating systems under different geological conditions and different configurations (with or without heat pumps and natural gas backup).
(ix) Recommend financial incentives and subsidies to be provided for promoting geothermal-based heating systems in Hebei Province.

6. **Task 2. Confirm the technical and financial feasibility of using excess wind energy and biomass for heat supply in Hebei Province.** This task will be undertaken by a team of consultants consisting of (i) heat supply expert and team leader (2 person-months), (ii) power

system operation expert (1 person-month), (ii) wind power integration expert (1 person-month), (iv) economist (2 person-months), and (v) solid waste and biomass-to-energy expert (2 person-months). The task includes the following:

(i) Assess seasonal wind power generation, and demand for electricity and heat supply in Zhangbei County in Hebei Province.
(ii) Assess the balancing generation capacity available in north Hebei, and incidence of wind power curtailment as a result of inadequate balancing of generation capacity and transmission capacity to load centers.
(iii) Assess the technical feasibility for using excess wind power for heat supply in wind-rich counties in Hebei Province.
(iv) Select candidate counties for demonstrating wind-based heating systems where institutionally and technically feasible.
(v) Conduct prefeasibility studies for a couple of wind-based heating projects.
(vi) Based on (v) assess the cost of wind-based heat supply systems and propose transfer payment arrangements between wind power producers, electricity companies, and heat supply companies to ensure the financial viability of use wind-based electricity for heat supply.
(vii) Assess the feasibility of converting biomass and municipal waste to energy for heat supply.
(viii) Conduct the prefeasibility studies of deploying plasma gasification for heat supply in a selected town in Hebei Province.

7. **Task 3. Strengthen the capacity of provincial government agencies for identifying, structuring, and implementing several distributed renewable energy projects as PPPs.** This task will be undertaken by a team of consultants consisting of (i) heat supply system expert and team leader (2 person-months), (ii) geothermal energy specialist (2 person-months), (iii) solar thermal or photovoltaic expert (1 person-month), (iv) solid-waste and biomass-to-energy expert (1 person-month), (v) geologist (1 person-month), (vi) economist with experience in heat supply (2 person-months), and (vii) PPP specialist (3 person-months). The task includes the following:

(i) Based on the results of outputs 1 and 2, select at least five candidate cities with good potential for developing demonstration projects for renewable-energy-based heat supply. The renewable energy sources may include geothermal energy, biomass, and solid waste.
(ii) Prepare prefeasibility studies for these projects, including detailed assessment of renewable energy availability, geographical coverage, and need for additional heat sources such as heat pumps and natural gas backup (subject to availability of natural gas).
(iii) Estimate the investment requirement, and operation and maintenance costs for different heat supply technologies and plant configurations.
(iv) Make recommendations on how cost differences (if any) with conventional heat supply systems can be bridged to make the proposed technologies competitive.
(v) Assess the interest of potential private sector investors to undertake these projects as PPPs and capabilities of potential private investors to implement and manage these projects.
(vi) Propose an investment framework that also outlines the roles of public and private sector entities implementing these projects as PPPs.
(vii) Undertake training and capacity development for government officials in Hebei Province on structuring PPPs to attract private sector investments in heating projects based on distributed renewable energy.

(viii) Disseminate lessons learned during the TA implementation for the benefit of local government officials of Hebei Province.

8. **Project coordinator** (national, 4 person-months). The consultant is expected to have extensive experience in working with development partners and coordinating activities of TA-financed consultants and government policymakers. The task includes the following:

(i) Coordinate the activities under different components of the TA and ensure the timely delivery of outputs.
(ii) Ensure that the consultants recruited through the national consultancy firm closely coordinate with the implementing agency, and with city and county government units.
(iii) Assist the implementing agency in monitoring TA implementation and in quality control of consultants' outputs.
(iv) Organize consultation meetings with government policymakers, potential private sector investors, and financial institutes.
(v) Organize knowledge-sharing events to disseminate the TA findings and innovative features identified during the TA.
(vi) Maintain correspondence with the implementing agency, ADB, and other national government agencies, and provide translation services as required.

B. Reporting Requirements

9. The consultants will submit (i) an inception report within 1 month after signing the consulting contract, (ii) a midterm report 4 months after starting consulting services, (iii) a draft final report 1 month before TA completion, and (iv) a final report within 1 month after receiving feedback from executing and implementing agencies and ADB on the draft final report.

10. All TA deliverables and progress reports will be written in English. The national consultants will be responsible for translating documents into Chinese. Three copies of each TA deliverable will be submitted to ADB in English, and 10 copies will be submitted to the executing and implementing agencies, two in English and eight in Chinese. The deliverables and progress reports should address the terms of reference with details appropriate to that stage of the TA. The consultants will present key findings in workshops and seminars. Officials from the National Development and Reform Commission, Ministry of Finance, National Energy Administration, and Hebei provincial government will be invited to the workshops.