



Technical Assistance Report

Project Number: 43356
Capacity Development Technical Assistance (CDTA)
December 2009

People's Republic of China: Concentrating Solar Thermal Power Development (Financed by the Climate Change Fund)

CURRENCY EQUIVALENTS

(as of 17 November 2009)

Currency Unit	–	yuan (CNY)
CNY1.00	=	\$0.1464
\$1.00	=	CNY6.8270

ABBREVIATIONS

ADB	–	Asian Development Bank
CHEC	–	China Huadian Engineering Company
CST	–	concentrating solar thermal
GW	–	gigawatt
IEA	–	International Energy Agency
kWh	–	kilowatt-hour
MW	–	megawatt
PRC	–	People's Republic of China
SWOC	–	strength, weakness, opportunities, challenges
TA	–	technical assistance

TECHNICAL ASSISTANCE CLASSIFICATION

Type	–	Capacity development technical assistance (CDTA)
Targeting classification	–	General intervention
Sector (subsector)	–	Energy (renewable energy)
Themes (subthemes)	–	Economic growth (knowledge, science, and technological capacities), environmental sustainability (eco-efficiency), capacity development (institutional development)
Climate change	–	Climate change mitigation
Location impact	–	National and regional (high)

NOTE

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

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I. INTRODUCTION

1. During the June 2009 country programming meetings in Beijing, capacity development technical assistance (TA) for Concentrating Solar Thermal Power Development was discussed with the Government of the People's Republic of China (PRC), which led to its inclusion in the 2009 country assistance pipeline of the Asian Development Bank (ADB).¹ During the TA fact-finding mission in October 2009, ADB reached an understanding with the China Huadian Engineering Company (CHEC) and the government on the impact, outcome, methodology and key activities, scope, cost estimates, financing plan, consulting services' inputs, outline terms of reference for consultants, and implementation arrangements of the TA.² The design and monitoring framework is in Appendix 1.

II. ISSUES

2. In the PRC, significant coal consumption and its expected growth trajectory up to 2020 are major concerns for local, regional, and global emissions. The PRC is the world's second-largest energy consumer after the United States and has the fastest-growing energy sector in the world. Its electricity generation in 2008 was 3,433 terawatt-hours, of which almost 81% was from coal, 16% from hydropower, 2% from nuclear, and about 1% from wind and other alternative sources. Also that year, total coal production was more than 2.6 billion tons, and electricity generation consumed about 50% of that total. Thus, diversification of the PRC's energy mix to include more renewable, nuclear, and other alternative sources is a priority. In 2006, the government enacted the Renewable Energy Law, which provides incentives and policy support to accelerate renewable energy development, especially solar, wind, and biomass. The law also includes a regulatory framework for renewable energy development.

3. Since 2007, the PRC has witnessed significant growth in its large-scale wind power development. Recent estimates suggest that 10 gigawatts (GW) of wind power capacity have been added in the past 3 years. In contrast, solar power development has been rather limited. Although solar power is used for off-grid application in smaller installations, large grid-connected solar power capacity was only about 100 megawatts (MW) by the end of 2008, almost all of which was photovoltaic installations of varying capacity. This slower development of solar power is attributable to (i) high project development costs; (ii) high capital investment and cost of electricity compared to wind; (iii) lack of accurate solar resource assessment data and mapping; and (iv) limited in-country technology and technical expertise on concentrating solar thermal (CST) power, which is more cost-effective and uses grid connections.

4. CST power provides electricity by generating medium to high heat, which is then used to operate a conventional steam turbine that drives a generator. Because such technology uses a thermal phase, power production is continuous and can be dispatched, alleviating the intermittence problem associated with wind or solar photovoltaic installations. In addition, a cost comparison of CST and photovoltaic technologies as reflected in a recent International Energy Agency (IEA) report suggests that CST power is more cost competitive.³

5. To jump-start large, grid-connected solar power development, the government has recently set a target of developing 2 GW of solar power by 2011 and 30 GW by 2020.⁴ In

¹ The TA first appeared in the business opportunities section of ADB's website on 5 October 2009.

² CHEC is a state-owned enterprise and is a group of company of China Huadian, one of the five large state-owned generating companies in PRC.

³ IEA. 2003. *Renewables for Power Generation—Status and Prospects*. Paris.

⁴ The revised solar power targets were announced by the National Energy Administration in July 2009.

addition, it has recently included a MW-scale, CST power demonstration project for implementation during the Eleventh Five-Year Plan period, 2006–2010. It has also provided policy support through a ceiling tariff of CNY2.00 per kilowatt-hour (kWh) for large grid-connected solar power projects; accordingly, the government concluded the bidding process for a 10-MW photovoltaic installation in Gansu Province, with a tariff of CNY1.09/kWh. It is expected that the construction of a CST power plant will bring down the electricity tariff to an even more agreeable level to policy and decision makers, as such a plant can provide electricity in the range of CNY0.70 to CNY1.0/kWh, with further long-term cost reduction.

6. There is lack of knowledge and expertise to decide appropriate CST power technologies for use in the PRC.⁵ Understanding new technologies through MW-scale pilot projects is crucial to build up knowledge and capacity, which may lead to development of at-scale (50–100 MW) plants. But unlike photovoltaic technology, which uses diffused solar radiation and can be used in wider geographical areas, CST power technology requires direct solar radiation gain. Thus, its competitive market potential is limited to arid and semi-arid areas such as Gansu, Inner Mongolia, Qinghai, Tibet, and Xinjiang. However, most of these areas are far from major load centers and located in relatively underdeveloped provinces, which present further challenges to attract the project developers, who may not prefer to invest higher up-front project development cost for CST plants in remote sites.

7. Being a high-priority area for the government, the TA's focus is expected to receive full support from relevant provincial and national agencies. The current momentum for renewable energy in the PRC is expected to be further intensified by the government in the remainder of the Eleventh Five-Year Plan and carried forward in the Twelfth Five-Year Plan. The government's sector vision—a 15% capacity addition of electricity production from renewable energy by 2020 and policies for higher tariff from renewable energy⁶—have considerably lowered risks for CST power demonstration projects. However, the risks of technology and high costs remain, which can be addressed by implementing a MW-scale pilot and lowering the development cost of at-scale demonstration projects through the TA.

8. The TA has direct relevance to the country partnership strategy, which emphasizes environmentally sustainable development and inclusive growth.⁷ ADB's operational strategy also highlights inclusive economic growth in an efficient, equitable, and sustainable manner. In its long-term strategic framework 2008–2020 (Strategy 2020), ADB has identified energy as a core operational sector and achieving environmental sustainability a strategic priority.⁸ The TA will address relatively weak solar power development in the PRC, which is an integral part of climate change mitigation strategies of the Intergovernmental Panel on Climate Change (IPCC)⁹ and IEA.

9. The TA is ADB's first solar power intervention in the PRC, and capacity strengthening, pilot project implementation, and prefeasibility assessment of an at-scale demonstration project

⁵ A wide range of solar-concentrating technologies exist, including the parabolic trough, dish stirling, concentrating linear fresnel reflector, and solar power tower. Each method is capable of producing high temperatures and correspondingly high thermodynamic efficiencies, but they vary in how they track the sun and focus light.

⁶ As per the Renewable Energy Law (2006), it includes wind, solar, small hydropower, biomass and geothermal.

⁷ ADB. 2008. *Country Partnership Strategy: People's Republic of China, 2008–2010*. Manila.

⁸ ADB. 2008. *Strategy 2020: The Long-Term Strategic Framework of the Asian Development Bank, 2008–2020*. Manila.

⁹ IPCC is the leading body for the assessment of climate change, established by the United Nations Environment Programme and the World Meteorological Organization to provide the world with scientific view on the current state of climate change and its potential environmental and socioeconomic consequences. It embodies a unique opportunity to provide rigorous and balanced information to decision makers.

in a poor western province may spur CST power development throughout this area of PRC. It will build on lower-carbon emission interventions in PRC's energy sector, such as (i) renewable energy (wind and biomass), (ii) clean coal technologies (integrated gasification combined cycle and carbon capture and storage), and (iii) energy efficiency. The TA is fully aligned with the government's priority on saving energy and protecting the environment by seeking a more balanced, diversified energy mix with a stronger emphasis on renewable energy.

III. THE TECHNICAL ASSISTANCE

A. Impact and Outcome

10. The impact of the TA will be that CST power demonstration starts in the PRC by 2012. The outcome will be lowered capacity barriers for such demonstration.

B. Methodology and Key Activities

11. The key outputs of the TA include (i) development of a road map for CST power demonstration and deployment in Gansu Province, (ii) implementation of a pilot MW-scale CST power plant, (iii) identification of a priority demonstration project and prefeasibility assessment in Gansu Province, (iv) capacity assessment and strengthening of CST power demonstration, and (v) dissemination of knowledge products to relevant provinces on lessons learned and challenges in CST power development.

12. Close coordination will be maintained with relevant stakeholders during implementation to ensure that the TA takes previous studies, government priorities, existing plans, and results of pilot tests into account. Experts from relevant research institutes will be consulted on current CST power practices, priorities, and plans, and identifying programmatic options for CST power development. Suitable criteria will be determined for the selection of priority and pilot projects, which will be endorsed by the government.

13. Consultants will examine international best practices and methods that can be used in the development of a road map for the CST power demonstration project, summarize features, and make appropriate recommendations. The essential and desirable features of the road map will be listed at an early stage, and consensus will be built around these. When a preliminary structure and outline are available, consultants will use the information flow from the pilot projects and further analytical and research activities to refine the road map. The road map will also estimate the threshold level of CST capacity that will be critical to achieve the grid parity tariff by eliminating the current preferential tariff adopted by the government for solar power development.

C. Cost and Financing

14. The total cost of the TA is estimated to be \$2,700,000 equivalent. ADB will finance \$1,000,000 equivalent on a grant basis through the Climate Change Fund.¹⁰ The Government will finance the remaining \$1,700,000, including \$850,000 for the pilot project and the rest through in-kind contributions, such as office accommodation and support facilities, counterpart

¹⁰ Established by ADB.

staff members, and data.¹¹ Some office and pilot project equipment will be financed under the TA, which will be procured by the international consultants in accordance with ADB's Procurement Guidelines (2007, as amended from time to time) and handed over to the executing agency upon TA completion.¹² The in-kind contribution will be provided by CHEC or other relevant agencies involved in the pilot project implementation. The cost estimates and financing plan are attached in Appendix 2.

D. Implementation Arrangements

15. CHEC will be the executing agency, responsible for day-to-day implementation of TA activities, coordination with other key stakeholders, and logistical support to the consultants. It has already created a project management office in its head office.

16. ADB will engage international and national consultants, according to its Guidelines on the Use of Consultants (2007, as amended from time to time). A simplified technical proposal will be requested by ADB, and consultants will be recruited using the quality- and cost-based selection method with quality–cost ratio of 80:20. An estimated total of 50 person-months of consulting services will be required—10 person-months for international consultants and 40 person-months for national consultants. The international consultants will have expertise in (i) CST power technology and strategy development, (ii) technical areas of CST power plants, and (iii) financial modeling and analysis. The national consultants will have expertise similar to the international experts and will have in-depth knowledge and expertise in the PRC on these areas. In addition, the national consultants will include experts in key technical areas of (i) reflector optical design, (ii) structural design, (iii) automatic tracking systems, (iv) thermal storage system design, and (v) system integration. The national consultants' team will also include an energy economist and a coordinator. In addition, to support the consultants' team in the pilot project implementation and prefeasibility assessment of demonstration project, two safeguard experts in the areas of environment and social development will be included. The international CST technology and strategy development expert will be the team leader, while a national CST power system integration expert will be the co-team leader. The co-team leader, will closely coordinate among national consultants and with the international team leader to ensure that TA activities are implemented efficiently in a coherent manner. The national coordinator will assist the project management office with key TA administrative tasks to ensure that the TA implementation is smooth. The team leader and co-team leader will manage the consulting team and its interaction with the executing agency, ADB, and stakeholders. The outline terms of reference for the consultants are given in Appendix 3. The proceeds of the TA will be disbursed in line with ADB's *Technical Assistance Disbursement Handbook*.¹³

17. The TA will be implemented over 13 months beginning in February 2010, with an expected completion date of March 2011. The consultants will submit an inception report within 4 weeks, an interim report within 15 weeks, a midterm report within 28 weeks, a draft final report within 45 weeks, and a final report within 55 weeks of field mobilization. Information on the

¹¹ Office accommodation and support facilities include suitable accommodation at the CHEC office for the consultants and office equipment. Office utilities (e.g., electricity and water) will be paid by the executing agency. The consultants will pay the relevant telephone bills. Transport outside of Beijing for visits to the pilot project site or Gansu Province will also be paid by the consultants. However, the executing agency will provide logistic support and pay for travels of its counterpart staff members outside of Beijing.

¹² The indicative list of equipment is at the end of the cost estimates and financing plan (Appendix 2). The list of pilot project equipment will be finalized during the TA implementation by the consultants in consultation with the executing agency.

¹³ ADB. 2008. *Technical Assistance Disbursement Handbook*. Manila.

progress of implementation and on TA outputs will be disseminated through regular workshops and seminars to all relevant provinces with large CST potential. A knowledge dissemination program, including a national level seminar, brochures, etc. will be implemented before the TA is concluded to ensure that all relevant agencies benefit from the TA activities. The outcome of the TA will be subject to evaluation by both ADB and the government in accordance with their respective evaluation policies and requirements.

IV. THE PRESIDENT'S DECISION

18. The President, acting under the authority delegated by the Board, has approved the provision of technical assistance not exceeding the equivalent of \$1,000,000 on a grant basis to the Government of the People's Republic of China for Concentrating Solar Thermal Power Development, and hereby reports this action to the Board.

DESIGN AND MONITORING FRAMEWORK

Design Summary	Performance Targets and/or Indicators	Data Sources and/or Reporting Mechanisms	Assumptions and Risk
<p>Impact CST power demonstration starts in the PRC by 2012</p>	<p>More than 200 MW of CST power projects launched during the period of the Twelfth Five-Year Plan.</p> <p>Specific solar power capacity targets included in the Twelfth Five-Year Plan, and policy and regulatory support are provided.</p>	<p>Renewable energy installation data</p> <p>Eleventh and Twelfth Five-Year annual performance reports</p>	<p>Assumptions The government maintains strong interest in promoting CST power.</p> <p>Required investments are made by the government and enterprises.</p> <p>Enabling international financing and technology transfer mechanisms</p> <p>Risk High costs and technology uncertainties delay CST technology deployment.</p>
<p>Outcome Lowered capacity barriers for CST power demonstration</p>	<p>Adoption of the CST power demonstration road map by the government</p> <p>Decision taken to implement priority demonstration project</p>	<p>Consultants' reports</p>	<p>Assumptions The road map is acceptable to government agencies.</p> <p>Follow-on feasibility reports are approved for the priority demonstration project.</p>
<p>Outputs</p> <ol style="list-style-type: none"> 1. Develop a road map for CST power demonstration in Gansu Province 2. Implement a pilot MW-scale CST power plant 3. Identify a priority demonstration project in Gansu Province and assess its prefeasibility 4. Assess and strengthen capacity in CST power demonstration 	<p>Road map measures supported and adopted by stakeholders in 2010</p> <p>A pilot project is successfully implemented by 2010 building momentum for CST</p> <p>Prefeasibility reports and investment proposals prepared by 2010</p> <p>Staff from planning, research, implementing agencies, and regulating agencies trained in CST power demonstration aspects, 2009–2010</p>	<p>Consultants' report</p> <p>TA review missions</p> <p>TA performance reports</p> <p>National and international training and study tours</p> <p>Material for dissemination of related knowledge and experiences on similar CST power demonstration projects</p>	<p>Assumptions Timely access to records, information, personnel, and relevant geographic sites is given.</p> <p>Active participation of stakeholders in workshops, seminars, surveys, and/or field visits</p> <p>Trained staff members stay in relevant provinces and enterprises long enough to promote CST power development.</p>

Design Summary	Performance Targets and/or Indicators	Data Sources and/or Reporting Mechanisms	Assumptions and Risk
5. Disseminate knowledge products to relevant provinces on lessons learned and challenges in CST power development	Relevant provinces in western PRC received knowledge products		<p>Risks</p> <p>The CST power road map is not agreed to and endorsed by stakeholders.</p> <p>The pilot project outcome is not satisfactory.</p>
<p>Activities with Milestones</p> <p>1. Assess and map ongoing CST power activities, and develop a road map.</p> <p>1.1 Review and assess existing CST power development activities worldwide and complementary activities being carried out in the PRC (4 weeks).</p> <p>1.2 Capture lessons learned internationally in formulating policies, regulations, programs, and targeted initiatives to promote and support CST power activities (12 weeks).</p> <p>1.3 Undertake a comprehensive SWOC analysis for CST power development, its demonstration, and future application in Gansu Province (14 weeks).</p> <p>1.4 Develop an initial outline of the CST power road map, and seek stakeholder consultations, and refine the outline, if needed (20 weeks).</p> <p>1.5 Prepare the CST power road map, and identify residual critical gaps—capacity, legal, and regulatory—that may potentially delay or prevent CST power demonstration. Make recommendations for all critical areas (32 weeks).</p> <p>2. Identify pilot project, its design, procurement, implementation, and monitoring and verification</p> <p>2.1 Review the current plan to implement a pilot MW-scale project under the Eleventh Five-Year Plan, and identify critical barriers, if any, in its implementation (6 weeks).</p> <p>2.2 Analyze ongoing activities in the pilot project and proposed technology selection, and ascertain government and stakeholder commitment for its implementation (8 weeks).</p> <p>2.3 Assess the financing need of the pilot project and type of funding needed to lower the cost barrier in its implementation (10 weeks).</p> <p>2.4 Evaluate economics of the pilot project and its likely impacts such as social, environmental, financial, and electricity tariff (16 weeks).</p> <p>2.5 Based on the pilot project planning, design, procurement, and implementation, undertake comprehensive risk assessment for CST power, and identify measures to mitigate risks (18 weeks).</p> <p>3.0 Identify priority demonstration sites, and undertake prefeasibility assessment</p> <p>3.1 Develop benchmark standards and criteria for the selection of priority sites for an at-scale demonstration project. Seek stakeholders' acceptance of the criteria for screening and ranking priority demonstration projects (10 weeks).</p> <p>3.2 Evaluate and rank priority demonstration projects and sites in Gansu Province (12 weeks).</p> <p>3.3 Undertake solar resource assessment, and prepare prefeasibility assessment for a priority CST power demonstration project (40 weeks).</p> <p>3.4 Assess the financing needs for the demonstration project, and assess international funding mechanisms and their suitability and relevance to the demonstration project (40 weeks).</p> <p>3.5 Identify the needs and potential funding support for preparing a bankable demonstration project (40 weeks).</p> <p>4.0 Institutional capacity assessment and strengthening, and public outreach</p> <p>4.1 Identify institutional skills and resources needed to implement the CST power road map. Review existing capacity and readiness of planners, research institutes, implementing agencies, and regulatory agencies to support CST power demonstration and identify gaps (10 weeks).</p> <p>4.2 Formulate, recommend, and implement a comprehensive national and international capacity-strengthening program for planners, researchers, implementing agencies, and regulators to bridge capacity gaps (40 weeks).</p>			<p>Inputs</p> <p>ADB: \$1,000,000 (from Climate Change Fund)</p> <p>Consultants: \$452,000 Equipment: \$25,000 Training, seminars and conferences: \$105,000 Dissemination activities: \$50,000 Pilot project implementation: \$250,000 Demonstration project identification and preparation: \$60,000 Representation: \$8,000 Contingencies: \$50,000</p> <p>Government: \$1,700,000 Office accommodation: \$150,000 Remuneration for counterpart staff: \$250,000 Others: \$450,000 Pilot project: \$850,000</p>

<p>4.3 Identify appropriate knowledge and experts' networks needed to support CST power activities and a structured mechanism to facilitate them (10 weeks).</p> <p>4.4 Identify measures to enhance awareness of CST power among stakeholders, and organize appropriate national and international workshops and seminars (28 weeks).</p> <p>5.0 Disseminate knowledge product</p> <p>5.1 Prepare knowledge products on lessons learned and challenges faced, and disseminate them to other relevant western provinces that are suited for large-scale CST power development (40 weeks).</p>	
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ADB = Asian Development Bank; CST = concentrating solar thermal power; MW = megawatt; PRC = People's Republic of China; SWOC = strengths, weaknesses, opportunities, challenges; TA = technical assistance.

COST ESTIMATES AND FINANCING PLAN
(\$'000)

Item	Total Cost
A. Climate Change Fund^a	
1. Consultants	
a. Remuneration and Per Diem	
i. International Consultants	180.00
ii. National Consultants	200.00
b. International and Local Travel	45.00
c. Reports and Communications	10.00
2. Equipment ^b	25.00
3. Training, Seminars, and Conferences ^c	
a. Workshops, Seminars, and Conferences	45.00
b. Training Program	60.00
4. Solar Data Measurement and Verification ^d	60.00
5. Pilot Project Implementation ^e	250.00
6. Miscellaneous Administration and Support Costs	17.00
7. Dissemination Activities ^f	50.00
8. Representative for Contract Negotiations	8.00
9. Contingencies	50.00
Subtotal (A)	1,000.00
B. Government Financing	
1. Office Accommodation and Transport	150.00
2. Remuneration of Counterpart Staff	250.00
3. Others ^g	450.00
4. Pilot Project	850.00
Subtotal (B)	1,700.00
Total	2,700.00

^a Established by ADB.

^b Including six laptops, one digital projector, one photocopier, two laser printers, two digital cameras, and one fax machine. The ownership of the equipment will be transferred to the executing agency at the completion of the technical assistance (TA).

^c Details of training programs will be finalized during TA implementation and submitted to the Asian Development Bank for prior approval. An advance payment facility will be provided where necessary. Workshops, seminars, and conferences will be organized for stakeholder consultations and to discuss TA outputs.

^d Solar data measurement and verification will be undertaken as required at the selected priority demonstration project site during TA implementation.

^e The TA will support a megawatt-scale concentrating solar thermal pilot project. An advance payment facility will be provided for the executing agency to procure relevant goods and works. An advance facility, where applicable, will be provided for the consultants based on the general and special contract conditions.

^f The implementing agency will administer dissemination activities for the public information campaign. It may include setting up a website and/or preparing knowledge products and promotional brochures. It will also prepare a detailed proposal listing activities and estimated costs for review and approval of the Asian Development Bank. An advance payment facility, if appropriate, will be provided.

^g The other costs include \$400,000 as counterpart support for the prefeasibility assessment of the priority demonstration project.

Source: Asian Development Bank estimates.

OUTLINE TERMS OF REFERENCE FOR CONSULTANTS

1. The capacity development technical assistance (TA) for Concentrating Solar Thermal Power Development will be implemented by the China Huadian Engineering Company. Implementation will be closely coordinated with relevant stakeholders, including the Ministry of Science and Technology, Chinese Academy of Sciences, relevant research institutions, and other well-known international and national knowledge centers. The team of international consultants (10 person-months) will coordinate their work with the national consultants (40 person-months). The international consultants will have expertise in (i) concentrating solar thermal (CST) power technology and strategy development, (ii) technical areas of CST power plants, and (iii) financial modeling and analysis. The national consultants will have expertise similar to that of the international experts as well as in-depth knowledge and expertise in the People's Republic of China (PRC).

2. The international CST power technology and strategy development expert will be the team leader, while a national CST power system integration expert will be the co-team leader. Together, they will coordinate the activities of the consultants.

A. International Consultants

1. Concentrating Solar Thermal Power Technology and Strategy Development Expert and Team Leader (3.5 person-months)

3. This consultant will be responsible for pulling together outputs from other international and national experts in a coherent report covering all areas of the TA. The consultant will also

- (i) review existing CST power development activities worldwide and activities being carried out in the PRC under ongoing programs;
- (ii) map these activities and their relevance to TA activities, and establish information and knowledge networks with other CST power initiatives, if any, in the PRC;
- (iii) summarize results of previous studies and initiatives, and capture lessons learned internationally in formulating policies, regulations, programs, and targeted initiatives to promote CST power activities;
- (iv) with national consultants, examine the strategic importance of CST power in the national energy mix, especially comparing it with other solar power options, and evaluate impacts of its deployment on electricity pricing, society, and the environment;
- (v) analyze CST power development, demonstration, and potential future deployment in the PRC;
- (vi) with other consultants, design a framework for a CST power demonstration road map, seek stakeholders' acceptance of it, and prepare a draft;
- (vii) review existing capacities and readiness of planners, research institutions, regulators, and implementing agencies, and identify critical capacity gaps, if any;
- (viii) formulate, recommend, and implement a comprehensive capacity-strengthening program to bridge these gaps, and identify appropriate knowledge and experts' networks needed to support CST power demonstration;
- (ix) in consultation with key stakeholders, develop benchmark standards and criteria for selection of a priority demonstration project and a set of performance indicators for this Project;
- (x) Undertake an analytical assessment to determine the level of CST capacity in the grid that may allow grid parity tariff;

- (xi) With other consultants, investigate possibility for reduced component and system cost (a) due to improved design and manufacturing techniques, (b) improved power plant efficiency, (c) improved capacity factor, (d) economy of scale; and (e) reduced operation and maintenance costs and parasitic losses;
- (xii) seek stakeholders' acceptance of the criteria, develop a shortlist of potential demonstration sites, and identify and rank demonstration sites in Gansu province; and
- (xiii) coordinate tasks among team members, and seek regular coordination with key stakeholders on TA implementation.

2. Concentrating Solar Thermal Power Technical Expert (3.5 person-months)

4. The consultant will assist the team leader and national technical experts in a comprehensive analysis of CST power technology. In particular, the consultant will
- (i) review existing and planned CST power technology options, and undertake a comprehensive cost–benefit comparative analysis of different technology options and their strategic relevance to the PRC;
 - (ii) with the relevant national technical expert, identify the key parameters of high-temperature trough collectors by computer simulation calculation;
 - (iii) with the relevant national technical expert, review the key component of the trough collector's structural design, including main load-bearing frame structure, glass mirror support structure, and transmission system, and develop some benchmark standards and criteria for the design;
 - (iv) with the relevant national technical expert, review research and development of vacuum heat collector-sealing technology;
 - (v) with the relevant national technical expert, review the key design criteria for the programmable logic controller program to track the motion of the sun;
 - (vi) review the integration design and pilot test results of the 200-kilowatt trough collector pilot system installed at the Langfang technology base, review the initial results, and recommend ways to improve the system integration design for the at-scale demonstration project (50–100 megawatts) based on the pilot project results;
 - (vii) develop benchmark standards and reliability performance specifications for a demonstration project;
 - (viii) develop strategic choices and potential technical routes for CST power demonstration, summarize results and analysis, and prepare a technical road map for CST power demonstration;
 - (ix) undertake capacity assessment in implementing a CST power demonstration project, identify critical gaps, and propose a capacity strengthening plan to overcome critical capacity gaps;
 - (x) develop criteria for identifying and ranking demonstration sites, and identify additional in-depth technical analysis needed on selected demonstration sites and associated estimated costs;
 - (xi) review existing solar resource data in Gansu province, and map priority demonstration sites in these provinces; and
 - (xii) with other team members, prepare prefeasibility assessment reports for a selected priority demonstration project.

3. Financial Analyst (3.0 person-months)

5. The consultant will assist the team leader and CST power technical expert. In particular, the consultant will

- (i) undertake extensive analysis of relevant policies, regulations, and incentive schemes to identify barriers, if any, in financing of CST power projects;
- (ii) identify existing financing tools and lending instruments available internationally, especially from multilateral development banks, to finance a CST power demonstration project;
- (iii) assist the team leader and CST power expert in identifying benchmark standards and selection criteria for priority investment and pilot projects;
- (iv) analyze existing financing mechanisms, and identify innovative financing tools and approaches to promote CST power development;
- (v) prepare financial analysis of selected priority demonstration and pilot projects; and
- (vi) assist the team leader and other team members in developing an information brochure on various aspects and elements of CST power for wider dissemination within the PRC.

B. National Consultants

6. The national consultants will comprise (i) a co-team leader and CST power system integration expert (8 person-months); (ii) three CST power technical experts (5 person-months each) in the areas of mirror surface collection, structural design, and tracking system design; (iii) one thermal storage system design expert (5 person-months); (iv) one energy economist (4 person-months); and (v) one coordinator (4 person-months). They will assist the international team leader and CST expert in all technical aspects. The national consultants will generally pair with the corresponding international consultants. In addition, the energy economist will assist the team leader in strategy development, and policy and regulatory aspects while the coordinator will coordinate the team of consultants; conduct procurement activities related to the pilot project and its implementation; organize training, seminars, and conferences; and generally administer the TA. The national consultants will have extensive knowledge of CST power development in the PRC, and they will assist the international consultants in reviewing relevant reports, analytical data, policies, and regulations, and will translate relevant documents into English.

7. There will be two additional national experts: (i) an environmental analyst (2 person-months), and (ii) a social development specialist (2 person-months). These experts will ensure that relevant environmental and social safeguard measures are integrated in the pilot project design and in the prefeasibility studies of a priority demonstration project. They will prepare a summary environment impact assessment of these projects, as well as social impact analysis reports. The social development analyst will ensure that extensive consultations are held with affected persons and project beneficiaries. The social development specialist will also assist in information dissemination on the benefits of CST power development.

C. Reports

8. The consultants will submit the following reports. One copy will go to ADB in English and two copies to the Government in Chinese. The Inception report will include an updated TA implementation program and confirm timing and contents of subsequent TA reports. The draft final report should cover all TA activities and will be the major output for TA which will be

discussed extensively with key stakeholders. The comments received from stakeholders should be considered by the consultants in the final report. The timing of each TA reports is indicated below

- (i) **Inception report.** It will be submitted within 4 weeks after commencement of services.
- (ii) **Interim report.** It will be submitted within 15 weeks after commencement of services.
- (iii) **Midterm report.** It will be submitted within 28 weeks after commencement of services.
- (iv) **Draft final report.** It will be submitted within 45 weeks after commencement of services.
- (v) **Final report.** It will be submitted within 55 weeks of field mobilization.