Report and Recommendation of the President to the Board of Directors

Project Number: 46058
November 2013

Proposed Loan
People's Republic of China: Qinghai Delingha Concentrated Solar Thermal Power Project

Asian Development Bank

CURRENCY EQUIVALENTS
(as of 28 October 2013)

Currency unit	–	yuan (CNY)
CNY1.00	=	$0.1643
$1.00	=	CNY6.0829

ABBREVIATIONS

ADB	–	Asian Development Bank
CGN	–	China General Nuclear Power Corporation
CGN-DSE	–	CGN Delingha Solar Energy Co. Ltd.
CGN-SEDC	–	CGN Solar Energy Development Co. Ltd.
CO_2	–	carbon dioxide
CSP	–	concentrated solar thermal power
DNI	–	direct normal irradiation
GW	–	gigawatt
HTF	–	heat transfer fluid
kWh/m^2	–	kilowatt-hour per square meter
MW	–	megawatt
PRC	–	People's Republic of China
TA	–	technical assistance

NOTE

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

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PROJECT AT A GLANCE

1. Project Name: Qinghai Delingha Concentrated Solar Thermal Power Project **2. Project Number:** 46058-002

3. Country: China, People's Republic of **4. Department/Division:** East Asia Department/Energy Division

5. Sector Classification:

Sectors	Primary	Subsectors
Energy	√	Renewable energy

6. Thematic Classification:

Themes	Primary	Subthemes
Economic growth		Widening access to markets and economic opportunities
Environmental sustainability	√	Eco-efficiency
Capacity development		Institutional development

6a. Climate Change Impact

Adaptation	
Mitigation	High

6b. Gender Mainstreaming

Gender equity theme (GEN)	
Effective gender mainstreaming (EGM)	
Some gender elements (SGE)	
No gender elements (NGE)	√

7. Targeting Classification:

General Intervention	Targeted Intervention		
	Geographic dimensions of inclusive growth	Millennium development goals	Income poverty at household level
√			

8. Location Impact:

National	High
Regional	Low
Urban	Medium

9. Project Risk Categorization: Low

10. Safeguards Categorization:

Environment	B
Involuntary resettlement	B
Indigenous peoples	B

11. ADB Financing:

Sovereign/Nonsovereign	Modality	Source	Amount ($ Million)
Sovereign	Project loan	Ordinary capital resources	150.0
Total			150.0

12. Cofinancing:

Financier	Category	Amount ($ Million)	Administration Type
Export Import Bank of China	Official-Loan	75.58	Not ADB Administered
Total		75.58	

13. Counterpart Financing:

Source	Amount ($ Million)
China Nuclear Power Corporation (CGN)	96.68
Total	96.68

14. Aid Effectiveness:

Parallel project implementation unit	No
Program-based approach	No

I. THE PROPOSAL

1. I submit for your approval the following report and recommendation on a proposed loan to the People's Republic of China (PRC) for the Qinghai Delingha Concentrated Solar Thermal Power Project.[1]

2. The project will construct a 50-megawatt (MW) concentrated solar thermal power (CSP) plant in the city of Delingha, Qinghai Province. It is the first-of-its-kind CSP demonstration plant in the PRC. Upon completion, the project will generate 197 gigawatt-hours of clean electricity annually, thereby avoiding 154,446 tons of carbon dioxide (CO_2) per year.[2]

II. THE PROJECT

A. Rationale

3. The power sector in the PRC has grown rapidly in tandem with economic growth. Installed power capacity has expanded by about 70% in the past 5 years (2008–2012) alone.[3] Since the power sector relies heavily on coal-fired power generation, which supplied more than 75% of the electricity in the PRC in 2012, the rapid expansion in capacity has also caused a large increase in CO_2 emission—the key greenhouse gas responsible for climate change.[4] Promoting a more diversified energy mix with a higher share of renewable energy is a core priority to decarbonize the country's power sector. In 2005, the PRC's Renewable Energy Law was enacted to stimulate large-scale renewable energy development. It was accompanied by a set of incentives and policy measures to promote non-hydro renewable technologies. In 2007, the National Development and Reform Commission issued the Medium and Long-Term Development Plan for Renewable Energy in the PRC to increase the share of renewable energy in the total primary energy consumption to 15% by 2020. In 2009, the PRC also announced its target to reduce its carbon intensity (the amount of greenhouse gas emissions per unit of gross domestic product) by 40%–45% by 2020 compared with 2005 levels. The Twelfth Five-Year Plan, 2011–2015 set an intermediate target to increase the share of renewable energy to 11.4%[5] and to reduce carbon intensity by 17%[6] by 2015 compared with 2010 levels.

4. During the Eleventh Five-Year Plan period (2006–2010), the PRC achieved rapid growth in wind power and solar photovoltaic capacity. During this period, the installed capacity of wind power increased from 1.3 gigawatts (GW) to 41.8 GW, and solar photovoltaic capacity increased from 70 MW to 900 MW. The Twelfth Five-Year Plan set a target of 21 GW of solar photovoltaic capacity; by 2012, the total solar photovoltaic capacity surged to 3.2 GW. The rapid growth of wind power and solar photovoltaic capacity poses new challenges for grid integration of the intermittent power supplied by these plants. Since the electricity output of these plants

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[1] The design and monitoring framework is in Appendix 1.

[2] The Asian Development Bank (ADB) provided project preparatory technical assistance. ADB. 2012. *Technical Assistance to the People's Republic of China for Preparing the Qinghai Delingha Concentrated Solar Thermal Plant Project*. Manila.

[3] National Energy Administration. 2013. *Report on China's Energy Development for 2013*. Beijing: Economic Science Press.

[4] According to International Energy Agency (2012), CO_2 emission from the power sector in the PRC accounts for around 50% of total CO_2 emission in the PRC.

[5] Share of renewable energy in the total primary consumption has steadily expanded from 6.95% (or 197 million tons of standard coal equivalent) in 2007 to 10.3% (or 378 million tons of standard coal equivalent) in 2012.

[6] Carbon intensity (kilogram of CO_2/CNY) decreased from 0.28 in 2005 to 0.24 in 2010, which is about a 14.2% reduction as compared with 2005 levels.

cannot be predicted accurately, the grid company finds it extremely difficult to schedule their output dispatch economically, and this is causing grid curtailment.[7]

5. CSP is a state-of-the-art renewable energy technology that converts direct normal irradiation (DNI) into usable heat, generating medium- to high-temperature saturated steam that runs the steam turbine for power generation. Because of this thermal cycle, CSP plants can be combined easily with low-cost thermal energy storage, allowing it to generate electricity even at night. Thus, CSP plants produce reliable, predictable, and dispatchable electricity at any time of the day to allow the grid company to schedule their dispatch economically. This unique feature enables it to overcome grid integration issues posed by unpredictable wind and solar photovoltaic plants. In 2012, more than 2.4 GW capacity of utility-scale CSP plants were in operation and additional 2.36 GW capacity plants are under construction, mainly in Spain and the United States.[8]

6. The CSP plants typically require DNI of at least 1,800 kilowatt-hours per square meter (kWh/m^2) per year. Based on this requirement, more than 700,000 square kilometers is suitable for CSP installation in the PRC, which can potentially generate more than 51,000 terawatt-hours of electricity per year compared to its total electricity generation of 4,980 terawatt-hours in 2012.[9] But CSP development has been rather slow in the PRC because of many factors, such as the (i) limited in-country manufacturing capacity, (ii) higher capital cost of CSP plants, (iii) negligible hands-on experience with the technology, (iv) location of suitable sites far from population centers, and (v) extreme cold weather. Thus, CSP development has been languishing in the PRC, undermining the substantial potential benefits this technology can provide to decarbonize the PRC's power mix. The lack of a CSP-specific development policy, in particular the absence of a feed-in tariff for CSP technologies, has inhibited or slowed investment thereby causing further delays in CSP demonstration and deployment.[10]

7. The Asian Development Bank (ADB) has been promoting CSP in the PRC since 2009 through capacity development technical assistance (TA).[11] The successful implementation of the TA lowered the barriers for demonstrating CSP in the PRC. In 2011, the Government of the PRC decided to construct four utility-scale CSP demonstration projects. The proposed project is one of these four.[12] These demonstration projects will provide valuable hands-on experience and mitigate some of the perceived and real technology risks associated with first-of-its-kind

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[7] Grid curtailment refers to the non-absorption of electricity generated from power plants by the power grid. Solar photovoltaic and wind power generation above a threshold such as 20% requires increased grid flexibility to fully utilize the variable and uncertain output from these plants. In addition, the PRC's interregional grid interconnection is relatively underdeveloped, which constrains wind power utilization in concentrated areas such as Inner Mongolia Autonomous Region, causing the curtailment of wind power as high as 45% compared to less than 10% in Europe.

[8] Utility-scale refers to grid-connected CSP plants with an installed capacity of 10 MW or higher. Spain and the United States offer some of the best sites for CSP installation.

[9] ADB. 2011. *Concentrating Solar Thermal Power Development.* Consultant's final report. Manila (TA 7402-PRC).

[10] A solar feed-in tariff of CNY1.0 per kilowatt-hour was introduced in 2011, which targeted solar photovoltaic plants. This feed-in tariff does not reflect the unique benefits of CSP (para. 5) and does not provide incentives to accelerate investment in CSP. The government is contemplating issuing a feed-in tariff for CSP within 2014.

[11] ADB. 2009. *Technical Assistance to the People's Republic of China for Concentrating Solar Thermal Power Development*. Manila (TA 7402-PRC). The TA has (i) developed a road map for CSP plant development in Gansu and Qinghai provinces, (ii) prepared a pre-feasibility study for a CSP project in Gansu province, and (iii) implemented a 1 MW CSP pilot project in Beijing.

[12] The other three projects are (i) a 50 MW parabolic trough CSP in the Inner Mongolia Autonomous Region, (ii) a 50 MW parabolic trough CSP in Gansu Province, and (iii) a 92.5 MW integrated solar combined cycle (parabolic trough CSP coupled with natural gas combined cycle) in the Ningxia Hui Autonomous Region. The Gansu CSP project is included in the ADB. 2013. *Country Operations Business Plan: People's Republic of China, 2013–2015.* Manila.

projects. These projects are expected to contribute to the knowledge and insight of the government to formulate appropriate policy incentives for the large-scale deployment of CSP in the PRC. ADB financing for the project will provide the much-needed package assistance of low-cost financing, policy advice, and capacity development, which will ensure the sustainability of the project in the short term and lead to the wider uptake of CSP plants in the PRC in the medium term.[13]

8. Qinghai, which is located in the northeastern part of the Qinghai–Xizang Plateau in the western part of the PRC, is particularly suited for CSP plants because of its rich solar resources of 2,100 kWh/m^2 of annual DNI. It is ranked first in solar power capacity concentration throughout the PRC. Qinghai has more than 2 GW of solar photovoltaic installed capacity, which is more than 60% of the national capacity. The province targets installed capacity of 4 GW (including 300 MW of CSP) by 2015 and 10 GW (including 2 GW of CSP) by 2020, which are about 20% of the national targets.

9. The project is included in the country operations business plan, 2013–2015 and is consistent with (i) ADB's Energy Policy, 2009; (ii) the Medium and Long-Term Development Plan for Renewable Energy of the PRC, 2007; and (iii) the Twelfth Five-Year Plan of the PRC.[14] The project will contribute to ADB's Asia Solar Energy Initiative target of adding 3,000 MW solar power capacity by 2013. By demonstrating a potent renewable energy technology in one of the main CSP relevant provinces, the project will lower the barriers to the acceptance of the technology and lead to its deployment, thus contributing directly to low-carbon energy development—a core priority in the country partnership strategy. The package assistance combined with direct value-added cofinancing is reflective of ADB's innovative support for this demonstration project (paras. 7 and 14).

B. Impact and Outcome

10. The impact will be the expanded share of CSP in the renewable energy mix in the PRC. The outcome will be the demonstrated feasibility and reliability of the utility-scale CSP plant with a thermal storage system in Qinghai Province.

C. Outputs

11. The project site is one of the typical locations within Qinghai Province that has 2,187 kWh/m^2 of annual DNI. The project will utilize parabolic trough CSP,[15] which is one of the four major CSP technologies with a 7-hour thermal storage system.[16] The project will have two outputs: (i) the construction of a first-of-its-kind utility-scale CSP plant in Qinghai Province; and (ii) capacity development and training in CSP design, construction, and operation and

[13] A policy recommendation on feed-in tariff and regulatory assistance to further support CSP demonstration and deployment will be submitted to the government in December 2013.

[14] ADB. 2013. *Country Operations Business Plan: People's Republic of China, 2013–2015.* Manila; ADB. 2009. *Energy Policy.* Manila.

[15] Parabolic trough CSP is the most mature and commercially proven technology used in 95% of all utility-scale CSP plants in the world. The parabolic trough CSP is composed of (i) a solar field system, which concentrates DNI to generate around 400°C of thermal energy; (ii) a heat transfer system; (iii) a thermal energy storage system, which stores excess heat from the solar field system to supply heat for power production during nights or cloudy days; and (iv) a power block, which generates electricity using saturated steam produced by thermal energy from the solar field and thermal storage system to drive a steam turbine generator.

[16] Thermal storage for parabolic trough CSP plants in operation or under construction that have a similar system configuration has a maximum of 7.5 hours of thermal storage system.

management.[17] Upon completion, the project will generate 197 gigawatt-hours of clean electricity fed into the existing 110 kilovolt substation in Delingha city, which results in annual reduction of 154,446 tons of CO_2.

D. Investment and Financing Plans

12. The project is estimated to cost $322.26 million (Table 1).

Table 1: Project Investment Plan
($ million)

Item		Amount[a]
A.	**Base Cost**[a]	
	1. Civil works	11.80
	2. Solar field	132.81
	3. Heat transfer fluid system	13.62
	4. Thermal energy storage system	38.68
	5. Power generation system	24.09
	6. Auxiliary equipment and materials	18.03
	7. Other costs	27.53
	8. Engineering services	7.68
	Subtotal (A)	**274.24**
B.	**Contingencies**[b]	**36.72**
C.	**Financing Charges During Implementation**[c]	**11.31**
	Total (A+B+C)	**322.26**

Note: Numbers may not sum precisely because of rounding.
[a] In October 2013 prices. Includes tax and duties estimated at $31.33 million, of which $14.94 million will be for Asian Development Bank-financed components. Tax and duties are not considered to be excessive and are in compliance with the country cost-sharing ceiling and financing parameters for the People's Republic of China, approved on 16 March 2011.
[b] Physical contingencies ($13.71 million) estimated at 5.0% of base cost. Price contingencies ($23.01 million) are based on estimated domestic and international inflation rates during construction.
[c] Includes interest and commitment charges. Interest during construction for the Asian Development Bank loan has been computed at the 5-year forward London interbank offered rate plus a spread of 0.4% and a maturity premium of 0.1%. Commitment charges for an Asian Development Bank loan are 0.15% per year to be charged on the undisbursed loan amount.
Sources: Project feasibility study report and Asian Development Bank estimates.

13. The government has requested a loan of $150 million from ADB's ordinary capital resources to help finance the project. The loan will have a 25-year term, including a grace period of 5 years, straight line repayment method, an annual interest rate determined in accordance with ADB's London interbank offered rate (LIBOR)-based lending facility, a commitment charge of 0.15% per year (the interest and other charges during construction to be capitalized in the loan), and such other terms and conditions set forth in the draft loan and project agreements. Based on this, the average loan maturity is 15.25 years and the maturity premium payable to ADB is 0.10% per annum. A longer grace period than the construction period is envisaged as a risk mitigation measure to this first-of-its-kind project to overcome potential operation and maintenance issues in its first 2 years of operation.

14. The financing plan is in Table 2. The ADB loan will finance $150 million (46.55%) of the total project costs. China General Nuclear Power Corporation (CGN) will finance $96.68 million (30%) as equity contribution, and $75.58 million (23.45%) will be cofinanced by the Export–

[17] The capacity development and training will be conducted by the owner's engineer, and the operation and maintenance contractor, to be employed and fully funded by the implementing agency.

Import Bank of China (China Exim Bank) as a domestic loan, which is considered as collaborative direct value-added cofinancing.[18] The ADB loan will be used for the procurement of equipment and materials; tax and duties; related transportation, insurance, and installation costs; and interest and commitment charges on the loan during construction. The equity contribution and domestic loan will finance civil works, engineering services, land acquisition, environment and social monitoring, other material and equipment costs not funded by ADB, and contingencies.

Table 2: Financing Plan

Source	**Amount** ($ million)	**Share of Total** (%)
Asian Development Bank	150.00	46.55
China General Nuclear Power Corporation	96.68	30.00
Export–Import Bank of China	75.58	23.45
Total	**322.26**	**100.00**

Sources: Asian Development Bank; China General Nuclear Power Corporation.

E. Implementation Arrangements

15. CGN will be the executing agency.[19] It will have overall responsibility for project implementation. CGN Delingha Solar Energy Co. Ltd. (CGN-DSE) will be the implementing agency responsible for day-to-day project management including procurement and contract management, contractor payments, operation and maintenance, and social and environment safeguard monitoring.[20] CGN Solar Energy Development Co. Ltd. (CGN-SEDC) will provide management support for procurement and contract management to the newly established CGN-DSE, under the guidance of CGN.[21]

16. The PRC will be the borrower and will relend loan proceeds to China Exim Bank through the Ministry of Finance with the same terms and conditions as the loan between it and ADB.[22] China Exim Bank will onlend the loan proceeds to the CGN with the same loan terms plus an administration fee for onlending services. CGN will then lend the loan proceeds to CGN-DSE with the same terms and conditions as with China Exim Bank. CGN-DSE shall bear the exchange rate and interest rate fluctuation risks. These onlending arrangements will be done through the respective onlending agreements.

17. The implementation arrangements are summarized in Table 3 and described in detail in the project administration manual.[23]

[18] China Exim Bank is a state policy bank of the PRC under the direct leadership of the State Council. It was established in 1994 and is solely owned by the government. In 2012, it received investment-grade credit ratings from Moody's Investors Service (Aa3), Standard & Poor's (AA–), and Fitch (A+).

[19] CGN is a state-owned enterprise established in 1994 under the supervision of the State-Owned Assets Supervision and Administration of the State Council in the PRC. Since its establishment, CGN has been developed into a large group consisting of wholly owned or controlled 32 affiliated companies in the PRC.

[20] CGN-DSE was established and legally incorporated in April 2012 and is fully owned by CGN-SEDC.

[21] CGN-SEDC, fully owned by CGN, was established in 2009. Its core business is solar PHOTOVOLTAIC and CSP development. CGN-SEDC's current total installed capacity is 287 MW, which it targets to expand to 2 GW by 2015 and 5 GW by 2020. Its extensive previous experience in renewable energy will benefit CGN-DSE.

[22] This onlending arrangement is essential in the PRC's internal system. China Exim Bank involvement helps meet the stringent requirements of the Ministry of Finance for onlending an ADB sovereign-guaranteed loan to a large state-owned enterprise such as CGN. A similar arrangement was successfully implemented in the PRC's first such project—ADB. 2009. *Report and Recommendation of the President to the Board of Directors: Proposed Loan and Grant to the People's Republic of China for the Tianjin Integrated Gasification Combined Cycle Power Plant Project.* Manila (Loan 2616-PRC).

[23] Project Administration Manual (accessible from the list of linked documents in Appendix 2).

Table 3: Implementation Arrangements

Aspects	Arrangements		
Implementation period	October 2013–November 2017		
Estimated completion date	30 November 2017 (Loan closing date: 31 May 2018)		
Management			
(i) Oversight body	Management Group, China General Nuclear Power Corporation (CGN) Chair: Senior vice president in charge of solar power development Members: Heads of departments		
(ii) Executing agency	CGN		
(iii) Implementing agency	CGN Delingha Solar Energy Co. Ltd.		
(iv) Implementation unit	Project implementation unit, Delingha city, Qinghai Province, 50 staff members		
Procurement	International competitive bidding	4 contracts	$145.88 million
Retroactive financing and advance contracting	CGN has requested advance contracting and retroactive financing. This will include procurement of goods. The amount to be retroactively financed will not exceed $30 million (equivalent to 20% of the Asian Development Bank loan) and may finance costs incurred prior to loan effectiveness but not earlier than 12 months before the signing date of the loan agreement.		
Disbursement	The loan proceeds will be disbursed in accordance with the Asian Development Bank's *Loan Disbursement Handbook* (2012, as amended from time to time) and detailed arrangements will be agreed upon between the government and the Asian Development Bank.		

Sources: Asian Development Bank; CGN Delingha Solar Energy Co. Ltd.

III. DUE DILIGENCE

A. Technical

18. **Solar resource assessment.** A comprehensive solar resource assessment was done based on internationally recognized methodologies and practices for the project site in Delingha. The assessment used satellite-derived solar irradiation and meteorological data acquired between 2000 and 2012, and ground monitoring data acquired between 2011 and 2012.[24] The assessment comprised (i) the ground data quality assessment to filter outlier data derived from measurement error, (ii) the statistical comparison and correction of the satellite database using filtered ground measurement data, and (iii) the measurement of DNI which represents solar resource at the project site to simulate electricity yield. The estimated monthly and yearly DNI were also assessed considering statistical uncertainty within 5%. This provided an estimated DNI of 2,187 kWh/m^2 per year, which confirmed the robustness of the estimated DNI included in the project feasibility.

19. **System configuration design, costs, and electricity yield.** Different parabolic trough CSP system configurations were assessed to select the optimal design, which can also meet financial viability and plant performance criteria. The key features of the proposed system are (i) a 7-hour thermal energy storage system with 995 megawatt-hour thermal capacity,[25] and (ii) 621,300 square meters of solar field area to generate sufficient thermal energy to charge thermal energy storage while generating electricity at full capacity. The project is also designed with an anti-freezing feature for the extremely cold temperatures experienced during the winter (para. 20) and a dry cooling system to minimize water consumption. The estimated costs were assessed to be adequate according to costs at a similar CSP plant in Europe.

[24] Ground monitoring data at the project site covered data for 18 months from June 2011 to November 2012.

[25] The project with a 7-hour thermal energy storage system will (i) attain 44.9% of capacity factor and 3,940 annual operating hours, (ii) increase the net electricity yield by 45.9%, and (iii) require the solar collector loop to increase by 35.7%.

20. **Freezing protection.** Synthetic oil will be used as the heat transfer fluid (HTF); it will be heated to around 400°C by direct solar irradiation and will generate saturated steam for electricity generation. The project site is located in a cold climate where mid-winter minimum temperatures could fall overnight to –27°C, compared to the planned safe temperature of 50°C for the HTF. Cold spots due to HTF freezing can cause serious damage to the piping system. To avoid this, the plant will be equipped with (i) a freezing protection circulation pump, which forces HTF circulation in pipes all the time; (ii) mineral wool insulated pipes, valves, and instruments in the HTF system; and (iii) a natural gas auxiliary heater to prevent the HTF from falling below 50°C.

B. Economic and Financial

21. The financial internal rate of return is calculated for the project at a tariff of CNY1.15 per kilowatt-hour.[26] This results in a 4.82% financial internal rate of return, which is higher than the 1.97% of the weighted average cost of capital. The sensitivity analysis shows that the financial internal rate of return would decrease to (i) 4.05% if the project experiences a capital cost overrun of 10%, (ii) 4.57% with a 10% operating cost overrun, (iii) 3.54% if the project benefit is reduced by 10%, and (iv) 3.38% if the project experiences a commissioning delay of 1 year. The project is considered both financially viable and sustainable.

22. The economic benefits include avoided coal usage for power generation, incremental electricity sales, the improvement of grid reliability, and the associated emission reduction. The calculations include all project-related costs and economic benefits. The economic internal rate of return for the project is 13.3%, which is more than 12.0% of the economic cost of capital. The sensitivity analysis shows that the economic internal rate of return could fall to (i) 12.7% if all the economic benefits were reduced by 10%, (ii) 12.0% if the project experienced a cost overrun of 10%, and (iii) 13.2% if the operation and maintenance costs rose by 10%. Thus, the project is considered economically viable.

C. Governance

23. A financial management assessment was conducted for CGN and CGN-DSE. The financial management and accounting procedures used by CGN and CGN-DSE are aligned with the regulations and policies issued by the Ministry of Finance, and are considered effective and adequate for the project. CGN has developed and maintained the group company-wide financial management monitoring and supervising structure in budgeting, asset management, funding management, internal and external auditing, and reporting, with internal financial management rules and a centrally managed online financial management system. CGN-DSE also follows these internal financial management rules and has incorporated them into the online financial management system. The assessment indicates that accrual-based accounting and the PRC business accounting standards are followed; the separation of functions for authorization, transaction, recording, and asset management are well established; and a robust financial management and internal auditing system are in place.

24. Procurement capacity assessment was also conducted. CGN and CGN-DSE have experienced and trained personnel in procurement and contract management supported by

[26] A tariff of CNY1.15 per kilowatt-hour is assumed in the project feasibility study report approved in February 2013. Based on ADB's previous experience in many similar projects, the approved tariff in the feasibility report is the best estimate for such purpose.

well-established internal procedures and management systems, which is consistent with ADB requirements. The accountability mechanism is also deemed effective with the following activities performed by different groups: procurement and contract awards, disbursement, and internal audit. Both CGN and CGN-DSE lack experience in procurement with international financing institutions. To overcome this capacity gap, procurement training seminars were provided through the project preparatory TA (footnote 2), and a tendering agent with extensive experience in ADB-financed infrastructure projects has been engaged to provide assistance to conduct procurement in line with ADB guidelines.

25. ADB's Anticorruption Policy (1998, as amended to date) was explained and discussed with the government, CGN, CGN-SEDC, China Exim Bank, and CGN-DSE. The specific policy requirements and supplementary measures are described in the project administration manual (footnote 23).

D. Poverty and Social

26. The project will have a positive social impact by avoiding air pollution associated with coal use for power generation. While direct benefits to low-income households are not anticipated, the project has a positive side-benefit of employment opportunities for the local population in Delingha by generating 4,010 person-months (334 jobs) per year of unskilled labor during construction and 360 person-months (30 jobs) per year during operation and maintenance. Priority will be given to the affected local population (para. 29) and adjacent local community.

E. Safeguards

27. **Environment (category B).** The potential adverse environmental impacts of the project include (i) soil erosion, noise, fugitive dust, solid waste, and safety risks during construction; and (ii) noise, solid waste and wastewater, and the leakage of synthetic oil HTF during operation. The initial environmental examination (IEE) concludes that the potential adverse environmental impacts can be adequately mitigated by measures outlined in the IEE, and the project will result in environmental and socioeconomic benefits that significantly outweigh potential negative impacts.[27] The project is also designed to reduce water consumption by 73.5% compared with a wet cooling system to minimize impact on available water. [28]

28. CGN and CGN-DSE shall ensure the project is designed, constructed, and operated in accordance with the PRC's relevant national environmental laws, regulations, procedures, and guidelines; ADB's Safeguard Policy Statement (2009); and the project environmental management plan attached to the IEE. Environmental monitoring reports will be submitted to ADB twice a year during construction and annually during operation. The environmental management plan will be updated during the engineering design and incorporated in the bidding documents and civil works contracts.

29. **Involuntary resettlement and indigenous peoples (category B).** Land acquisition under the project will affect people of the Mongolian ethnic group, and a land acquisition and

[27] Initial environmental examination (accessible from the list of linked documents in Appendix 2). It has been disclosed in May 2013.

[28] 0.38 million cubic meters per year of water consumption is estimated for the project with dry cooling, compared to 1.45 million cubic meters per year with wet cooling.

ethnic minority development plan has been prepared.[29] The project will permanently acquire 246 hectares of jointly contracted grassland with a 50-year land usage right since 1985, which belongs to 153 people from 31 Mongolian ethnicity households.[30] The land to be acquired is semiarid unused land, which is 0.7% of the total grazing area owned by the affected households and will not cause loss of income and fixed assets, and physical displacement. All affected households are entitled to cash compensation for loss of land, and in-kind assistance such as employment opportunities during the construction and operation of the project, portable solar photovoltaic sets and high insulation yurts (nomad tents), and livelihood skills development training. CGN and CGN-DSE shall ensure that (i) the land acquisition and ethnic minority development plan is implemented, and the compensation and in-kind assistance for affected people are carried out promptly and efficiently in accordance with the government's applicable laws and ADB's Safeguard Policy Statement; and (ii) the implementation of the land acquisition and ethnic minority development plan is monitored, evaluated, and reported to ADB.

F. Risks and Mitigating Measures

30. Overall, the associated risks have been adequately mitigated through measures included in the project design and implementation arrangements. Major risks and mitigating measures are summarized in Table 4 and described in detail in the risk assessment and risk management plan.[31]

Table 4: Summary of Risks and Mitigating Measures

Risks	Mitigating Measures
Poor performance of key equipment or contractors causing plant to operate at less than design performance.	CGN-DSE will employ international experts as owner's engineers for engineering design and construction supervision. As all major equipment and materials for the project will be funded by ADB, technical specifications for each package will be rigorously reviewed in coordination with the owner's engineer. Performance-based O&M contract will be introduced to ensure the designed project performance within the estimated O&M costs.
Less electricity generation than planned due to the uncertainty of direct solar irradiation.	The estimated direct normal irradiation at the project site is within 5% of the statistical uncertainty level. However, a continuous solar resource assessment by CGN-DSE is carried out to improve the accuracy of hourly and daily electricity yield forecasts.
Unsatisfactory financial performance of CGN-DSE deteriorated due to the poor project performance and cost overrun.	Capital and O&M costs were thoroughly reviewed. Owner's engineers and the O&M contractor will enhance quality control on design, construction, and O&M of the project. Adequate loan covenants requiring China General Nuclear Power Corporation to oversee and support CGN-DSE in maintaining sound financial management is agreed upon.

ADB = Asian Development Bank, CGN-DSE = CGN-Delingha Solar Energy, O&M = operation and maintenance.
Source: Asian Development Bank.

[29] Resettlement Plan: Land Acquisition and Ethnic Minority Development Plan (accessible from the list of linked documents in Appendix 2). It has been disclosed in December 2012.
[30] Mongol ethnic minority is one of the officially recognized 55 ethnic minority groups in the PRC.
[31] Risk Assessment and Risk Management Plan (accessible from the list of linked documents in Appendix 2).

IV. ASSURANCES AND CONDITIONS

31. The government and CGN have assured ADB that the implementation of the project shall conform to all applicable ADB policies including those concerning anticorruption measures, safeguards, procurement, and disbursement as described in detail in the project administration manual and loan documents. The government and CGN have agreed with ADB on certain covenants for the project, which are set forth in the loan and project agreements.

32. The disbursement is conditional upon the borrower's certification that all onlending agreements will have been duly executed and delivered, and all conditions precedent to their effectiveness will have been fulfilled.

V. RECOMMENDATION

33. I am satisfied that the proposed loan would comply with the Articles of Agreement of the Asian Development Bank (ADB) and recommend that the Board approve the loan of $150,000,000 to the People's Republic of China for the Qinghai Delingha Concentrated Solar Thermal Power Project, from ADB's ordinary capital resources, with interest to be determined in accordance with ADB's London interbank offered rate (LIBOR)-based lending facility; for a term of 25 years, including a grace period of 5 years; and such other terms and conditions as are substantially in accordance with those set forth in the draft loan and project agreements presented to the Board.

Takehiko Nakao
President

5 November 2013

DESIGN AND MONITORING FRAMEWORK

Design Summary	Performance Targets and Indicators with Baselines	Data Sources and Reporting Mechanisms	Assumptions and Risks
Impact Expanded share of CSP in renewable energy mix in the PRC	Share of CSP increases to 3 GW by 2020 (baseline: 0 GW in 2013) CSP capacity avoids more than 5 million tons of CO_2 emissions per year by 2020	The statistical year book of the PRC	**Assumptions** The government remains committed to expand renewable energy. The government and private sector provide required investment in a timely manner. **Risks** The costs and reliability of CSP plants do not meet investors and policy makers' requirements.
Outcome Demonstrated feasibility and reliability of the utility-scale CSP plant with thermal storage system in Qinghai Province	50 MW Qinghai Delingha plant operates reliably delivering designed output (baseline: 0 MW in 2013) 197 gigawatt-hours of clean electricity generated annually, thereby avoiding 154,446 tons of CO_2 per year by 2017 (baseline: 0 gigawatt-hours in 2013)	Electric power year book of the PRC	**Assumptions** The project operates reliably at design output. Offtake tariffs are adequate for the project, ensuring financial viability. **Risks** Poor performance of key equipment or contractors causing the plant to operate at less than design capacity. Less electricity generation as planned due to the uncertainty of direct solar irradiation.
Outputs 1. The construction of a first-of-its-kind utility-scale CSP plant in Qinghai Province constructed 2. Capacity development and training in CSP construction, and operation and management	50 MW parabolic trough CSP plant with 7 hours thermal storage capacity is commissioned and commercially operational by 2016 (baseline: 0 MW in 2013) Capacity development training provided in design, construction supervision, and operation and management for 50 counterpart engineers and operators by 2016	Electric power year book of the PRC Corporate annual report of China General Nuclear Power Corporation Design, construction, and operation and maintenance manuals Project completion report	**Assumption** Grid connection agreement concluded in a timely manner. Procurement and construction works implemented as planned. Sufficient counterpart funds available. Adequate technical guidance in design and supervision, and operation and maintenance manuals are developed. Trained counterpart staff are retained for design, supervision, and operation and maintenance stages.

Activities with Milestones	Inputs
1. Construction of 50 MW parabolic trough CSP plant 1.1 Engineering design (Q4 2013–Q4 2014) 1.2 Bidding and contract awards (Q1 2014–Q2 2015) 1.3 Construction supervision (Q2 2014–Q4 2016) 1.4 Civil works (Q2 2014–Q2 2016) 1.5 Solar field system (Q3 2014–Q2 2016) 1.6 Heat transfer fluid system (Q3 2014–Q2 2016) 1.7 Thermal energy storage system (Q3 2014–Q2 2016) 1.8 Power generation system (Q2 2014–Q2 2016) 1.9 Test run (Q3–Q4 2016) 1.10 Commercial operation (Q4 2016) 1.11 Defect liability (Q1–Q4 2017) 2. Capacity development of counterpart engineers and operators 2.1 Design, construction, and operation and maintenance manuals (Q2–Q4 2015) 2.2 Training for engineers and operators of the implementing agency (Q1–Q4 2016) 2.3 Implementation of the environment and social safeguard actions (2014–2017)	ADB: $150.0 million Export–Import Bank of China: $75.58 million China General Nuclear Power Corporation: $96.68 million Total: $322.26 million

ADB = Asian Development Bank, CO_2 = carbon dioxide, CSP = concentrated solar thermal power, GW = gigawatt, MW = megawatt, PRC = People's Republic of China.
Source: Asian Development Bank estimates.

LIST OF LINKED DOCUMENTS

http://www.adb.org/Documents/RRPs/?id=46058-002-3

1. Loan Agreement
2. Project Agreement
3. Sector Assessment (Summary): Renewable Energy
4. Project Administration Manual
5. Contribution to the ADB Results Framework
6. Development Coordination
7. Financial Analysis
8. Economic Analysis
9. Country Economic Indicators
10. Summary Poverty Reduction and Social Strategy
11. Initial Environmental Examination
12. Resettlement Plan: Land Acquisition and Ethnic Minority Development Plan
13. Risk Assessment and Risk Management Plan

Supplementary Documents

14. Concentrated Solar Thermal Power Technology
15. Solar Resource Assessment
16. Technical Risks and Mitigation Measures in Design, Construction, and Operation
17. Information on the Export–Import Bank of China
18. Financial Management Assessment, and Financial Performance and Projections
19. Procurement Capacity Assessment Report and Recommendations