



# Extended Annual Review Report

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Project Number: 43936  
Reference Number: LN2628/EI7311  
September 2014

## Loan Solar Power Project (Thailand)

This is a redacted version of the XARR that excludes information that is subject to exceptions to disclosure set forth in ADB's Public Communications Policy 2011.

Asian Development Bank



## CURRENCY EQUIVALENTS

Currency Unit – baht (B)

		<b>At Appraisal</b>	<b>At Project Completion</b>
		1 March 2010	31 December 2013
B1.00	–	\$33.06	\$32.83
\$1.00	–	B0.03	B0.03

## ABBREVIATIONS

ADB	–	Asian Development Bank
CCS	–	cross-currency swap
CER	–	certified emission reduction
CDM	–	Clean Development Mechanism
CLP	–	CLP Holding Limited
CLPTR	–	CLP Thailand Renewables Ltd.
CSR	–	corporate social responsibility
DSCR	–	debt service coverage ratio
EGAT	–	Electricity Generating Authority of Thailand
EGCO	–	Electricity Generating Public Company
EHS	–	environmental, health, and safety
EIRR	–	economic internal rate of return
EPC	–	engineering, procurement, and construction
EPPO	–	Energy Policy and Planning Office
ESCO	–	EGCO Engineering and Service Co., Ltd.
FIRR	–	financial internal rate of return
ITD	–	Italian-Thai Development Public Company
ITE	–	Italthai Engineering Company, Ltd.
LCL	–	local currency loan
MEA	–	Metropolitan Electricity Authority
NED	–	Natural Energy Development Company
NEPC	–	National Energy Policy Council
PEA	–	Provincial Electricity Authority
PPA	–	power purchase agreement
RRP	–	Report and Recommendation of the President
SPP	–	small power producer
SSMA	–	Sharp Solar Maintenance Asia Co., Ltd.
VSPP	–	very small power producer

## WEIGHTS AND MEASURES

GWh	–	gigawatt-hour
km	–	kilometer
kV	–	kilovolt
kW	–	kilowatt
kWh	–	kilowatt-hour
MW	–	megawatt
MWh	–	megawatt-hour
m <sup>2</sup>	–	square meter
tCO <sub>2</sub>	–	ton of carbon dioxide

## NOTES

- (i) The fiscal year (FY) of the Government of Thailand ends on 31 December. FY before a calendar year denotes the year in which the fiscal year ends, e.g., FY2000 ends on 31 December 2000.
- (ii) In this report, "\$" refers to US dollars.

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**BASIC DATA**  
**Solar Power Project (LN2628/EI7311 – Thailand)**

<b>Key Dates</b>	<b>Expected</b>	<b>Actual</b>
Concept Clearance Approval	October 2009	26 October 2009
Board Approval	January 2010	16 April 2010
Loan Agreement	February 2010	17 June 2010
Loan Effectiveness		17 June 2010
First Disbursement		15 November 2010
Commercial Operations Date		29 March 2012
Loan Closing		30 September 2028

  

<b>Financial and Economic Internal Rates of Return (%)</b>	<b>Appraisal</b>	<b>XARR</b>
Financial Internal Rate of Return (project financial rate of return on equity)	<b>6.29%</b>	<b>6.32%</b>
Economic Internal Rate of Return	<b>11.51%</b>	<b>12.53%</b>

  

<b>Project Administration and Monitoring</b>	<b>No. of Missions</b>	<b>No. of Person-Days</b>
Due Diligence	<b>6</b>	<b>32</b>
Negotiation	<b>4</b>	<b>36</b>
Project Administration	<b>7</b>	<b>19</b>
XARR Mission	<b>1</b>	<b>13</b>



## EXECUTIVE SUMMARY

On 16 April 2010, the Board approved a local currency loan (LCL) to Natural Energy Development Company (NED) of up to \$70 million equivalent in baht (B) and a \$2 million grant financed under the Clean Energy Financing Partnership Facility for the Thai Solar Power Project. The project entails the construction and operation of a 55-megawatt (MW) thin-film photovoltaic solar power plant in Lopburi province. The Asian Development Bank (ADB) identified the project as a priority to demonstrate the commercial viability and sustainability of a private sector solar power plant in the country and region. At the time of financing, lending for renewable energy projects in Thailand was at a nascent stage, the regulatory framework for renewable energy was untested, and commercial banks still considered solar technology to be unproven. ADB played a lead role in providing long-term debt and attracting local commercial financing for the project to reach financial close. The project was built within budget and ahead of schedule when it achieved commercial operations in March 2012. Upon completion, the project was the largest solar power plant in Asia and the largest thin-film solar project in the world. In May 2013 NED expanded the project by 8 MW, and in 2014 the company initiated one of the first rooftop solar power projects in the country by installing 0.25 MW of additional solar panels on its administrative building. The project has demonstrated over 2 years of successful operations.

The project is sponsored by three internationally renowned developers and operators: China Light and Power (CLP) Thailand Renewables (a wholly owned subsidiary of CLP Holdings), Diamond Generating Asia (a wholly owned subsidiary of Mitsubishi), and the Electricity Generating Public Company (EGCO). The project entered into a standard power purchase agreement (PPA) with the Electricity Generating Authority of Thailand (EGAT) under the Small Power Producer (SPP) program. The PPA is automatically renewable every 5 years and, in addition to the wholesale tariff, the project receives an adder incentive of B8 per kilowatt-hour (kWh), applicable for 10 years after commercial operation. Renewable energy projects in Thailand benefit from a strong legal and regulatory framework, an adder incentive provision, and favorable government policies and target commitments.

ADB's participation and assistance was critical for reducing the perceived risks of solar power in the industry's early development stage. ADB's fully amortizing, 18-year LCL undergirded the overall financing structure of the project. Long-term financing is essential for renewable energy projects to reduce asset-liability mismatches and better amortize the high up-front costs associated with renewable energy. ADB's Treasury Department also executed an unprecedented 18-year cross-currency swap (CCS) in support of ADB's LCL product that helped reduce the project's currency mismatches. ADB's CCS product also contributes to the development and long-end liquidity of a developing member country's swap market. ADB's assistance also included the design and administration of an innovative grant component by the Clean Energy Fund under the Clean Energy Financing Partnership Facility. The grant aimed to reduce the inherent risks of developing the country's first utility-scale solar power plant. The grant entailed a stand-by facility that covered contingency in the event of construction cost overruns. Because the project was completed on time and within budget the grant was not called upon; however it played an important role during financing by reducing the perceived first-mover risks to mobilize commercial co-financing. With the assistance of ADB's Carbon Market Initiative, the project was able to register and prefinance certified emission reductions (CERs) under the Clean Development Mechanism (CDM) with the United Nations' Framework Convention on Climate Change, the international platform to reduce the effects of climate change globally.

The project has met or exceeded all of its development targets set out in the Report and Recommendation of the President (RRP) to the Board of Directors. The project has, among other indicators, successfully commissioned 55 MW of renewable solar power, delivered over 80,000 MW-hours (MWh) of clean electricity annually, avoided over 50,000 tons of greenhouse gas emissions annually, employed over 490 people during construction and operations, and purchased over B2.2 billion of local goods and services during construction.

The project's contribution to private sector development is rated excellent. The project was the first private sector, utility-scale solar power plant in Thailand and, upon completion, was the largest solar power plant in Asia. The project attracted worldwide media attention as it demonstrated the financial viability and sustainability of solar technology in the region.

The project's environmental, social, health, and safety performance is rated excellent. The project has exceeded host country laws and regulations and complies with ADB's Safeguard Policy Statement (2009). Solar power is a clean technology that significantly reduces residual waste, greenhouse gas emissions, harmful pollutants, and noise compared to other forms of power generation. Cleaner air and a lower carbon footprint provide healthier and more sustainable living conditions for the population. The project has generated jobs for non-skilled workers residing in surrounding rural communities, and has set a high standard for corporate social responsibility (CSR) programs that improve livelihood opportunities and promote renewable energy.

ADB's investment profitability is rated excellent. The project was completed under budget and ahead of schedule, complies with all financial covenants, and has been making timely interest and principal payments. ADB's work quality is rated excellent and was recognized by Euromoney Asia Pacific as the 2010 Renewable Energy Project of the Year and by Alpha Southeast Asia as the 2010 Project Finance Deal of the Year. ADB's additionality is rated excellent given its long-term loan, unprecedented 18-year CCS, and innovative grant component that undergirded the overall financing structure and helped catalyze commercial co-financing.

Overall, the project is considered highly successful. The project is financially sound, environmentally sustainable, and has met or exceeded all of its development objectives. The main lessons and recommendations ADB can draw from the project are that ADB should (i) continue to provide long-term financing for renewable energy projects, (ii) continue to provide CCS in support of ADB's LCL product, and (iii) increase the use of innovative grant financing for renewable energy.

## **I. THE PROJECT**

### **A. Project Background**

1. As of May 2014, Thailand had 33,379 megawatts (MW) of installed power generation capacity. The country's electricity production depends heavily on conventional fuels, with 69% produced using natural gas and 21% using coal and lignite. Natural gas has traditionally provided a reliable and low-cost source of energy, but growing demand and dwindling natural gas reserves from the Gulf of Thailand mean the country must diversify and secure alternative fuel sources for power generation. Fortunately, Thailand has abundant renewable energy sources—biomass, biogas, mini-hydro, solar, and wind. Exploiting these clean, domestic

sources of renewable energy can help boost Thailand's energy security, save foreign exchange, and protect the country from global price fluctuations in energy markets.

2. As part of its strategy to diversify Thailand's energy mix and promote renewable energy, the Government of Thailand revised its renewable energy targets in the Alternative Energy Development Plan (2012-2021).<sup>1</sup> Under the revised proportions approved by the National Energy Policy Committee on 16 July 2013, the government is committed to a target of 25% out of the total energy consumption in 2021 to come from alternative sources. The revised targets for each class of renewable energy are listed in Table 1.

**Table 1. Revised Targets for Renewable Energy**

Type of Energy	Unit	Target 2021	
		Old	New
Solar	MW	2,000	3,000
Wind	MW	1,200	1,800
Small Hydro Power	MW	324	324
Hydro Power & Pumped Storage	MW	1,284	-
Biomass	MW	3,630	4,800
Biogas	MW	600	3,600
Municipal Solid Waste	MW	160	400
New Energy	MW	3	3
<b>Total</b>	<b>MW</b>	<b>9,201</b>	<b>13,927</b>

Source: Department of Alternative Energy Development and Efficiency (DEDE).

3. To complement its renewable energy strategy, the Ministry of Energy advocates decentralized power generation, mainly by supporting the country's Small Power Producer (SPP) and Very Small Power Producer (VSPP) programs. The SPP program allows private developers to build, own, and operate 10–90 MW power projects and to enter into power purchase agreements (PPAs) with the Electricity Generating Authority of Thailand (EGAT). Under the VSPP program, producers of up to 10 MW may sell power to the Metropolitan Electricity Authority (MEA) or Provincial Electricity Authority (PEA). Renewable energy SPPs and VSPPs are eligible for an added incentive, a bonus tariff added to the wholesale electricity price.

## **B. Key Project Features**

4. On 16 April 2010, the Board approved a local currency loan (LCL) to Natural Energy Development Company (NED) of up to \$70 million equivalent in baht (B) and a \$2 million grant from the Clean Energy Financing Partnership Facility for the Thai Solar Power Project. The project entails the construction and operation of a 55 MW thin-film photovoltaic solar power plant in Lopburi province. The Asian Development Bank (ADB) identified the project as a priority to demonstrate the commercial viability and sustainability of a private sector solar power plant in the country and region. At the time of financing, lending for renewable energy projects in Thailand was at a nascent stage, the regulatory framework for renewable energy was untested, and commercial banks still considered solar technology to be unproven. ADB played a lead role in providing long-term debt and attracting local commercial financing for the project to reach financial close. The project was built within budget and ahead of schedule when it achieved commercial operations in March 2012. Upon completion, the project was the largest solar power plant in Asia and the largest thin-film solar project in the world.

<sup>1</sup> DEDE. [http://dede.go.th/dede/images/stories/dede\\_aedp\\_2012\\_2021.pdf](http://dede.go.th/dede/images/stories/dede_aedp_2012_2021.pdf)

5. The project is sponsored by a unique partnership that combines regional leadership, operating and technical expertise, and strong local presence. NED is a joint venture of three sponsors—China Light and Power (CLP) Thailand Renewables (a wholly owned subsidiary of CLP Holdings), Diamond Generating Asia (a wholly owned subsidiary of Mitsubishi), and the Electricity Generating Public Company (EGCO)—each holding a 33.33% share. The project entered into a standard PPA with EGAT under the SPP program. EGAT, Thailand’s state-owned utility, purchases all electricity generated from the project. Given EGAT’s dominant market position and critical role in the power sector, the government is expected to provide EGAT with timely and sufficient extraordinary support if needed. The PPA is automatically renewable every 5 years and, in addition to the wholesale tariff, the project receives an adder incentive of B8 per kilowatt-hour (kWh), applicable for 10 years from the date of commercial operation. Renewable energy projects in Thailand benefit from a strong legal and regulatory framework, the provision of an adder tariff, and favorable policies and commitment from the government.

6. The project chose to utilize thin-film photovoltaic technology after an in-depth analysis of local conditions, on-site measurements, and competitive bidding. Thin-film technology solar cells cost less to produce than other type of photovoltaic cells, and the technology suits Thailand’s climate because it does not require near-perfect solar conditions. Clouds and overcast conditions at times create diffuse light, which cannot be concentrated but still produces energy on thin-film photovoltaic panels. Besides irradiation, thin-film solar cells offer better relative performance in climates with higher average temperatures.

### **C. Progress Highlights**

7. The project was completed within budget and ahead of schedule. The first stage of the project achieved commercial operations in December 2011, and the final stage achieved commercial operations in March 2012.<sup>2</sup> Project completion under the financing agreements followed on 3 September 2012. The project has demonstrated over 2 years of successful operations. NED expanded the project by 8 MW in May 2013, and in 2014 it initiated a rooftop solar power project by installing 0.25 MW of additional panels on the roof of its administrative building. Both additions were financed through additional equity from the project’s excess cash flows.

## **II. EVALUATION**

### **A. Project Rationale and Objectives**

9. The project has met or exceeded all of its development targets articulated in the RRP by i) successfully commissioning 55 MW of renewable solar power, ii) increasing Thailand’s solar power generating capacity to over 95 MW, iii) increasing the SPP program to over 100 projects by 2012, iv) delivering over 80,000 megawatt-hours (MWh) of clean electricity annually, v) avoiding over 50,000 tons of greenhouse gas emissions annually, vi) reducing capital costs of solar power by \$1 per kilowatt (kW), vii) employing over 450 people during construction and over 40 people during operations, and viii) purchasing over B2.2 billion in local goods and services during construction.

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<sup>2</sup> The project’s construction was divided into seven stages of 9.3–10.7 MW each.

## **B. Development Impact**

### **1. Private Sector Development**

10. The project's contribution to private sector development is rated excellent. The project was the first private sector, utility-scale solar power plant in Thailand and, upon completion, was the largest solar power plant in Asia. The project attracted worldwide media attention as it demonstrated the financial viability and sustainability of solar technology in the region. At the time of financing, lending for renewable energy projects in Thailand was at a nascent stage, the regulatory framework for renewable energy was untested, and commercial banks still considered solar technology to be unproven. The project was at the forefront of Thailand's renewable energy finance market and has provided a foundation and blueprint for the local banking market to replicate and advance similar developments. ADB's Treasury Department also executed an unprecedented 18-year cross-currency swap (CCS) in support of ADB's LCL, which contributes to the development and long-end liquidity of a developing member country's swap market. Private sector development indicators and ratings are in Appendix 2.

### **2. Business Success**

11. The project's contribution to business success is rated satisfactory. Total revenues increased from B1.1 billion in 2012 to B1.4 billion in 2013. Net income likewise increased by 55.0%, from B482 million in 2012 to B747 million in 2013. The project fully complied with its financial covenants under its loan agreement with a significant margin above the minimum requirements.

### **3. Economic Sustainability**

12. The project's economic sustainability is rated satisfactory. The project's economic sustainability is assured because the project offers the economy value for money. The project's continued provision of clean energy has increased the social and economic well being of users.

### **4. Environmental, Social, Health, and Safety Performance**

13. The project's environmental, social, health, and safety performance is rated excellent (Appendix 4 and Appendix 5). The project has exceeded host country laws and regulations and complies with ADB's Safeguard Policy Statement (2009). Solar power is a clean technology that does not generate residual waste, greenhouse gas emissions, harmful pollutants, and noise compared to other conventional forms of power generation such as coal or thermal power plant. As the project was classified as Environmental Category B, NED prepared an Initial Environmental Examination report to meet ADB's Safeguard Policy Statement (2009) requirements.<sup>3</sup> During construction the Consortium was tasked to implement the environmental, health, and safety (EHS) management plan through monitoring and testing for air, water, noise level, and occupational and community health and safety to comply with ADB, NED, and national law requirements.<sup>4</sup> Independent Engineers validated monthly construction progress

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<sup>3</sup> For solar power projects, the Ministry of Natural Resources and Environment does not require the preparation of the Initial Environmental Examination or Environmental Impact Assessment.

<sup>4</sup> Consortium is comprised of Italian-Thai Development Public Company (ITD), Italthai Engineering Co. Ltd. (ITE) and Sharp Corporation (Sharp). ITD is responsible for civil works, ITE is responsible for electrical works, and Sharp is responsible for offshore activities, including the design and supply of photovoltaic modules, inverters, and associated equipment (i.e., combiner box and collection box).

reports through site visits and meetings with NED and the Consortium.<sup>5</sup> Prior to project construction and operation, NED obtained the legally required permits and licenses. The project qualified for carbon credits under the Kyoto Protocol's Clean Development Mechanism (CDM).<sup>6</sup>

14. The project's environmental impacts were assessed in the IEE to be minor and temporary during construction and operation. The project area is neither located in a national forest reserve zone nor a wildlife sanctuary. No endangered flora or fauna species were found in the project area. Impacts on air quality and noise from exhaust of construction equipment and vehicles were localized and temporary due to the short construction period. The project does not generate any harmful atmospheric emissions, effluent, or solid contaminants during operation. NED is responsible to continue the implementation of the EHS management plan during operations.<sup>7</sup> Also NED hired a third party environmental monitoring consultant to assist in the sampling and testing of required environmental parameters.<sup>8</sup> During construction and operation, measurements on air quality, water quality, and noise level met national standards. Impact on groundwater utilization is minimal because NED sourced water for solar cell panel cleaning from different sources, such as irrigation canal water and ground water through shallow wells (less than 20 meters deep). Impact on visibility is low since the selected solar cells are equipped with a film layer that can absorb sunlight and a mirror to prevent light reflection. Deteriorated solar cell panels were collected, temporarily stored, and sent to a recycling facility or licensed waste processor.<sup>9</sup> Separated oil and wastes oil were collected in a 200-liter drum, stored, and later sent to appropriate disposal by a licensed waste processor. A Corporate Emergency Response and Preparedness Plan provided personnel with guidelines to minimize loss of lives and reduce severity of personnel injuries and property damages inside and/or outside solar farm facilities. The Plant Manager acts as the Emergency Manager and is responsible for overall management of emergency operations and coordination between the solar power plant and outside bodies.<sup>10</sup>

15. The project was classified as Category C for both indigenous peoples and involuntary resettlement. No indigenous peoples were living within or close to the project site, and no physical relocation or economic displacement issues were expected during project preparation. Land was procured on a willing buyer-willing seller basis following ADB's Safeguard Policy Statement (2009) requirements. Of the land acquired, 721 rais<sup>11</sup> were used for the installation of 542,000 solar panels and stands; the rest were used for access roads, installation of controllers and transformers, a 22 kilovolt (kV)/115kV substation, and a control building. The 115kV transmission line was constructed in an existing 22kV transmission line corridor without existing physical improvements (such as crops or structures). No one was physically or economically displaced during the construction of the 115kV transmission line. No further land was acquired during project operations.

16. The project has generated jobs for non-skilled workers residing in surrounding communities during plant construction and operation. NED has implemented corporate social

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<sup>5</sup> Mott MacDonald is the Independent Engineer providing construction-monitoring review, including assessment of EHS performance for the Solar Power Project.

<sup>6</sup> For 2013, NED received total certified emission reduction (CER) revenue in the amount of B17.9 million.

<sup>7</sup> Sharp Solar Maintenance Asia Co., Ltd. is the plant's Maintenance Contractor.

<sup>8</sup> Greener Consultant Co., Ltd. is the third party environmental monitoring consultant responsible for the sampling and testing for air, water, noise level, and occupational and community health and safety during operations.

<sup>9</sup> Consortium will be responsible for end-of-life collection and recycling of photovoltaic modules.

<sup>10</sup> First Aid Team has been organized and trained for advanced first aid needs that might arise during an emergency. A centralized first aid room providing first aid and primary care for injured and sick employees is available at the project site.

<sup>11</sup> The rai is a Thai measure for land area. One rai is 1,600 square meters, and one hectare is 6.25 rais

responsibility (CSR) programs to improve livelihood opportunities and promote renewable energy in the surrounding schools and community. The company has, among many other initiatives, provided 150 scholarships to local students; donated libraries, computers, and solar panels for schools; and built a 750-square-meter (m<sup>2</sup>) museum to educate the public on Lopburi heritage and renewable energy.

### **C. ADB Investment Profitability**

17. ADB's investment profitability is rated excellent. The project was completed under budget and ahead of schedule, complies with all financial covenants, and has been making timely interest and principal payments. The project continues to achieve investment-grade debt service coverage ratios (DSCRs) that provide significant capacity to repay debt and absorb adverse downside scenarios.

### **D. ADB Work Quality**

18. ADB's work quality, consisting of screening, appraisal, structuring, and monitoring, is rated excellent. The work was recognized by Euromoney Asia Pacific as the 2010 Renewable Energy Project of the Year and by Alpha Southeast Asia as the 2010 Project Finance Deal of the Year. At the time of project processing in 2010, the project was the first ADB-assisted private sector infrastructure project in Thailand to achieve financial close in 7 years. It was also the first project under ADB's Asia Solar Initiative, which committed to achieving 3,000 MW of new solar power projects by 2013. Following financial close, ADB developed a strong reputation in the industry that has led to the financing of three other high-profile solar power projects in Thailand. ADB has helped build a critical mass of successful solar power projects in the country during the industry's early development. These first generation solar projects give investors and banks confidence that solar power is a proven technology and a sound investment.

19. Four disbursements on 15 November 2010, 18 January 2011, 15 March 2011, and 18 May 2011 were managed efficiently. ADB closely monitored project implementation through regular site visits, reports, financial statements, operation and capital expenditure reports, environmental and social monitoring and reporting, and annual reviews comprising both field and desk reviews. NED has complied with all reporting requirements in a timely manner, while ADB has been prompt in giving its consent to waivers and requests for amendments to existing agreements, subject to thorough review. ADB has stayed updated on the project and NED's performance in all material areas.

### **E. ADB's Additionality**

20. ADB's additionality is rated excellent. ADB's participation and assistance was critical for reducing the perceived risks of solar power in the industry's early stage development. At the time of financing, the financial sector was in disarray from the global financial crisis, and long-term credit was becoming scarce as international banks began selling-down and retracting from Asia. ADB took the lead by providing long-term debt and attracting local commercial financing for the project to reach financial close. ADB's fully amortizing, 18-year LCL provided a cornerstone for the project's financial structure. As solar power projects have minimal operating costs, debt financing becomes the main driver of economic viability. Long-term financing is essential for renewable energy projects to reduce asset-liability mismatches and better amortize the associated high up-front costs. ADB's Treasury Department also executed an unprecedented 18-year CCS in support of ADB's LCL product that helped reduce the project's

currency mismatches. ADB's CCS product also contributed to the development and long-end liquidity of Thailand's swap market.

21. ADB also designed and administered an innovative grant component by the Clean Energy Fund under the Clean Energy Financing Partnership Facility. The grant objective was to reduce the inherent risks of developing the country's first utility-scale solar power plant. The grant entailed a stand-by facility that covered contingency in the event of construction cost overruns. Because the project was completed on time and within budget, the grant was not called upon; however, it was instrumental during financing in reducing perceived first-mover risks in order to catalyze commercial co-financing. With assistance from ADB's Carbon Market Initiative, the project was also able to register and prefinance certified emission reductions (CERs) under the CDM with the United Nations' Framework Convention on Climate Change, the international platform to reduce the effects of climate change globally.

## F. Overall Evaluation

22. Overall, the project is rated highly successful. The ratings are summarized in Table 3. The project is a strong example of ADB strategy in supporting environmentally sustainable, private sector-assisted development to meet ADB's regional objectives. It also demonstrates the private sector's crucial role in infrastructure financing through public-private partnerships. ADB was able to catalyze commercial co-financing and achieve financial close by being flexible and innovative, and by tailoring its products to address the challenges of financing large-scale solar power projects in Asia.

**Table 3: Evaluation of the THA Solar Power Project**

Indicator/Rating	Unsatisfactory	Partly Satisfactory	Satisfactory	Excellent
<b>Development Impact</b>				
Private Sector Development				X
Business Success			X	
Economic Sustainability			X	
Environment, Social, Health, and Safety Performance				X
<b>ADB Investment Profitability</b>				X
<b>ADB Work Quality</b>				X
<b>ADB Additionality</b>				X
	<b>Unsuccessful</b>	<b>Partly successful</b>	<b>Successful</b>	<b>Highly successful</b>
<b>Overall Rating</b>				X

ADB = Asian Development Bank.

Source: ADB.

## III. ISSUES, LESSONS AND RECOMMENDED FOLLOW-UP ACTIONS

### A. Project Issues

23. **Sharp's Credit.** Sharp, a multinational corporation from Japan, is the project's supplier of solar panels. The company has experienced weak financial performance in recent years due to its poor liquidity position. As the project has already reached commercial operations, its residual exposure to Sharp is limited to the 5-year defect warranty for modules and inverters and the 25-year module performance guarantee. A Sharp subsidiary also provides maintenance services to the project on a 5-year rolling basis. Given that the project's high-energy production

has exceeded estimates in the RRP and that it is currently achieving investment-grade DSCRs, the issue is considered minor.

24. **Offtake.** EGAT, Thailand's state-owned utility, purchases all electricity generated from the project. Given EGAT's importance to the power sector and Thailand's strong mandate for solar power, the government is expected to provide EGAT with timely and sufficient extraordinary support if needed. The PPA has a 5-year automatic extension mechanism, which provides a contractual term exceeding the project's economic life and the full term of the debt repayment schedule. The project, however, will be exposed to variable revenues after 10 years, when it will depend solely on the wholesale tariff without the adder incentive to amortize the remaining portion of ADB's loan. The financial model projections indicate that the project will continue to generate sufficient cash flows to service its debt obligations once the adder incentive falls away.

25. **Operation and Maintenance.** The operation and maintenance of solar power plants is relatively simple, consisting of cleaning, regular inspections, minor repairs and measurements, data verification, reporting, and site security. The lack of moving parts makes the operation of a solar power plant more reliable compared to conventional power generation with components subject to dynamic loads, kinetic loads, thermal stress, or wear and tear. A solar plant's high modularity also decreases the probability that an unexpected breakdown of one part would cause a material decrease in production for a prolonged period of time. The project benefits from an experienced power plant operator that is a subsidiary of EGCO, as well as a 5-year rolling maintenance agreement with a subsidiary of Sharp, which supplies the modules and inverters.

## **B. Lessons, Recommendations, and Follow-Up Actions**

26. **Long-term financing.** Solar photovoltaic has relatively high up-front capital costs and minimal operating costs. The cost structure is highly predictable, with limited expenditure on maintenance and parts replacement and no volatile fuel expenses. As debt financing is the only material expense, it drives the economics and viability of solar power projects. Therefore, long-term financing is essential in order to reduce the asset-liability mismatches and to better amortize solar power's high up-front costs.

27. **Local currency loan.** Following the Asian financial crisis, borrowers in developing member countries could no longer afford significant currency mismatches for infrastructure projects. ADB's LCL product addresses borrowers' needs by providing debt in the same local currency as the project's revenues. ADB's Treasury Department executed an unprecedented 18-year CCS for the project that covers the tenure of ADB's loan.

28. **Grant financing.** During the early stage development of a country's solar industry, grants or concessional financing play a significant role in overcoming challenges and risks associated with developing the first projects. It is also important that a critical mass of first generation solar projects is established in order for investors and financiers to be confident that solar power is a proven technology and a sound investment without special grants.

**PROJECT-RELATED DATA****A. Investment Identification**

1. Country	Thailand
2. Loan Number	LN 2628
3. Industry/Sector	Energy (Renewable Energy)
4. Project Title	Solar Power Project
5. Borrower	Natural Energy Development Company Ltd.
6. Amount of ADB Assistance	B1,922,997,249

**B. Investment Data**

1. Concept Clearance Approval	26 October 2009
2. Date of ADB Approval	16 April 2010
3. Signing of Legal Documents	17 June 2010
4. End of Availability Period	15 May 2011
5. Number of Extensions	None
6. Disbursements	First Disbursement: 15 November 2010 Last Disbursement: 18 May 2011 <sup>1</sup>

**C. Data on ADB Missions**

	No. of Missions	No. of Person-Days
Due Diligence	6	32
Negotiation	4	36
Project Administration	7	19
XARR Mission	1	13

Source: ADB

<sup>1</sup> 15 May 2011 was a Sunday while 16 and 17 May 2011 were public holidays in Thailand. As such, the Last Disbursement date was determined pursuant to Clause 24.6 (Business Days) of the CTA.

## PRIVATE SECTOR DEVELOPMENT INDICATORS AND RATINGS: INFRASTRUCTURE

Impact of the Project	Ratings				Justification/ Annotations
	Impact to Date	Potential Impact (sustainability) and Risk to its Realization		Combined Rate <sup>a</sup>	
<b>1. Beyond Company Impact</b>	Rating <sup>b</sup>	Rating	Risk <sup>c</sup>		Monitoring indicators can be derived in part from RRP. Many indicators are judgmental. Their use and ratings should consider the operating context, ADB objectives and strategies, and project proportions.
<b>1.1. Private sector expansion.</b> Contributes as a pioneering or high-profile project to facilitating or preparing for more private participation in the sector and economy at large	Excellent	Excellent	Low	Excellent	As the first utility-scale solar power plant in the country, the project was a pioneer in demonstrating the feasibility of a large, private sector PV solar power plant in Thailand. Upon completion, the project was the largest solar power plant in Asia and the largest thin-film solar project in the world. The project attracted worldwide media attention as it demonstrated the financial viability and sustainability of solar technology in the region.
<b>1.2. Competition.</b> Contributes new competition pressure on public and/ or other sector players to increase efficiency and improve access and service in the industry	Excellent	Excellent	Low	Excellent	The project has helped establish solar power technology as a legitimate, sound, and reliable source of alternative energy, which is applying competitive pressure on conventional power sources. Installation costs of solar power continue to decline, helping solar power reach grid-parity sooner.

<p>1.3. <b>Innovation.</b> Demonstrates efficient new products and services, including areas such as marketing, distribution, tariffs, production, and technology; and ways to cover or contain cost, manage demand, etc.</p>	Excellent	Excellent	Low	Excellent	<p>The plant is the first of its kind in Thailand and is one of the largest PV plants in the world. The project also introduced thin-film PV technology on a utility-scale level in Thailand. ADB's assistance also included the design and administration of an innovative grant component that helped reduce the inherent risks of developing the country's first utility-scale solar power plant.</p>
<p>1.4. <b>Linkages.</b> Relative to investments, contributes notable upstream or downstream linkage effects to business clients, consumers, suppliers, key industries, etc. in support of growth</p>	Excellent	Excellent	Low	Excellent	<p>NED was the first company to invest in a large-scale solar power project contributing to the grid and providing clean energy to the community. NED was also able to increase community awareness by sponsoring pilot projects, such as the installation of rooftop solar panels in some schools and households within the plant's 5-kilometer radius.</p>
<p>1.5. <b>Catalytic element.</b> Contributes by including pioneering and/or catalytic finance, mobilizing or inducing more local or foreign market financing and/or foreign direct investment in the sector</p>	Excellent	Excellent	Low	Excellent	<p>At the time of financing, lending for renewable energy projects in Thailand was at a nascent stage, the regulatory framework for renewable energy was untested, commercial banks still considered solar technology to be unproven, and the region was still feeling the effects of the global financial crisis. ADB was able to catalyze commercial co-financing by reducing the perceived risks and providing financial products that formed the cornerstone of the project's financial structure.</p>

<p>1.6. <b>Affected laws, frameworks, regulation.</b> Contributes to improved laws and sector regulation for PPP, concessions, joint ventures, and BOT projects; and to liberalizing markets as applicable for improved sector efficiency</p>	Excellent	Excellent	Low	Excellent	<p>As an industry pioneer, the project could test the regulatory framework for renewable energy and pave the way for other developers. NED complies with all the relevant laws in Thailand and has been supportive of government initiatives in promoting alternative energy. NED's success prompted the government to increase their 2021 target of replacing fossil fuels with green energy from 20.3% to 25.0%. The government also started several programs that promoted the use of solar PV technology, such as the Solar PV Rooftop Program and the Solar PV for Community Initiative Program.</p>
<p><b>2. Company Impact with Wider Potential</b></p>					
<p>2.1. <b>Skills contribution.</b> Contributes to new strategic, managerial, and operating skills with actual or potential wider replication in the sector and industry</p>	Excellent	Excellent	Low	Excellent	<p>NED, together with its regulators and contractors, such as ESCO and SSMA, provide regular trainings, and conduct knowledge exchanges with the community. NED also provides extensive training and education to the community and schools through its on-site museum and CSR programs.</p>
<p>2.2. <b>Demonstration of new standards.</b> Demonstrates new ways to operate the business and compete, and investee performance against relevant best industry benchmarks and standards</p>	Excellent	Excellent	Low	Excellent	<p>The project adheres to world-class standards and has set a high benchmark for other solar power projects to follow. The work was recognized by Euromoney Asia Pacific as the 2010 Renewable Energy Project of the Year and by Alpha Southeast Asia as the 2010 Project Finance Deal of</p>

					the Year.
<b>2.3. Improved governance.</b> As evident in set standards in corporate governance, stakeholder relations, ESHS fields, and/or in good energy conservation standards	Excellent	Excellent	Low	Excellent	The project strives for excellence and takes pride in being recognized as one of the best in the industry. It is a recipient of numerous awards, including the Good Governance Environmental (2013) from the Industry Work Department of Thailand. It was likewise conferred with the ISO 9001:2008 Certificate in 2014. NED also spearheads various CSR activities to improve livelihood opportunities and promote renewable energy.
<b>3. Overall PSD Rating.</b> Unsatisfactory, partly satisfactory, satisfactory, and excellent. The rating is not an arithmetic mean of the individual indicator ratings, and does not have fixed weights. Actual positive or negative impacts, future impacts, and risks to its realization need to be considered	Excellent	Excellent	Low	Excellent	Overall, the private sector development is rated excellent. The project is financially sound and environmentally sustainable, and has met or exceeded its development objectives.

ADB = Asian Development Bank; BOT = build, operate, and transfer; CSR = corporate social responsibility; ESCO = EGCO Engineering and Service Co. Ltd.; ESHS = environmental, social, health, and safety; ISO = International Standards Organization; NED = Natural Energy Development Company; PPP = public-private partnership; PSD = private sector development; PV = photovoltaic; RRP = Report and Recommendation of the President; SSMA = Sharp Solar Maintenance Asia Co., Ltd.

<sup>a</sup> The combined rating should weigh future impact and risk to its sustainable realization.

<sup>b</sup> Unsatisfactory, partly satisfactory, satisfactory, and excellent. The rating is not an arithmetic mean of the individual indicator ratings, and these have no fixed weights. Consider already manifest actual impact (positive or negative) and the potential for impact as well as risk to its realization.

<sup>c</sup> Rating Scale: Risk: high, medium, modest, and low.

Source: ADB.

## INDUSTRY AND OPERATIONS REVIEW

### A. Sector Framework

1. Thailand's power sector is governed by the Ministry of Energy and managed by the National Energy Policy Council (NEPC), the secretariat of which is the Energy Policy and Planning Office (EPPO). The NEPC recommends national energy policy and energy management and development plans to the Cabinet of Ministers and establishes the tariff structure applicable to energy sales in Thailand. The EPPO is responsible for drafting all energy-related policies and proposing development plans to the NEPC. The Energy Regulatory Commission is an independent body that regulates the power sector. It monitors energy market conditions, reviews tariffs, issues licenses, approves power purchases, and considers development planning and investment in the power sector. Thailand has adopted an enhanced single-buyer model, whereby the state utility allows limited private participation in electricity generation while maintaining control over system planning, operation, and pricing.

2. The Electricity Generating Authority of Thailand (EGAT), Thailand's principal offtaker and system operator, is a state-owned utility that owns and operates most of Thailand's electricity-generating capacity and its transmission network. It sells the power, which it either generates or purchases from private power producers and neighboring countries at a regulated rate set by the EPPO, to two state enterprises: the Metropolitan Electricity Authority (MEA) and the Provincial Electricity Authority (PEA). MEA and PEA distribute the power to retail, commercial, and industrial consumers throughout Thailand. They own the electricity distribution networks in their respective regions of operation: MEA has exclusive rights to distribute and sell power to end users in the Bangkok metropolitan area, and PEA has exclusive rights to distribute and sell power in all other areas.

3. The Government of Thailand introduced programs for independent, small, and very small power producers to encourage private sector participation. The Small Power Producer (SPP) program allows private developers to build, own, and operate 10–90 MW power projects and enter into power purchase agreements (PPAs) with EGAT. Under the Very Small Power Producers (VSPP) program, producers of up to 10 MW may sell power to MEA or PEA. Renewable energy SPPs and VSPPs are eligible for a feed-in tariff, or adder, in addition to the wholesale electricity price.

### B. Electricity Demand

4. Demand for electricity in Thailand has increased annually by an average of 5.0% over the past decade. In 2013, total electricity consumption was 164,341 gigawatt-hours (GWh), or 0.2% lower than the previous year's total of 161,779 GWh. Peak demand as of May 2014 amounted to 26,473 megawatts (MW). Highest loads have been registered from March to May, when temperatures are highest. Lowest loads have been registered in December and January, when temperatures are lowest. Industry has historically been the largest electricity consumer, consuming 44.0% of the total, followed by small general services and other businesses at 30.0% and residences at 23.0%. Of EGAT customers, the industrials are most sensitive to the economic environment.

### C. Electricity Supply

5. As of May 2014, Thailand's installed power-generation capacity was 33,379 MW, of which 14,708.13 MW (44%) were produced by EGAT power plants, 12,742 MW (38%) by independent producers, 3,525 MW (11%) by small producers, and 2,405 MW (7%) were imported.

6. Thailand's electricity production depends heavily on natural gas (69%), coal (13%), and lignite (8%). The country's overreliance on natural gas and its exposure to oil price volatility makes it more prone to political and economic risks, thus the need for alternative energy. Renewable energy sources contribute only a small portion, but fluctuating fossil fuel prices, fuel shortages, and continued government promotion of alternative energy have catalyzed their use.

#### **D. Electricity Supply and Demand Forecast**

7. According to the Thailand Power Development Plan 2012-2030<sup>1</sup>, EGAT projects average annual growth of 4.13% in net electricity demand and 4.16% in peak demand from 2012 to 2030. By 2030, Thailand is expected to be consuming 346,767 GWh, and peak generation will reach 52,256 MW. The plan for estimated increased power development assumes a total installed capacity of 70,686 MW by 2030, including 55,130 MW of additional supply, or more than three times the 16,839 MW of capacity retired by then. The power sector is expected to be more diversified by 2030, when energy generation by fuel type will be: 58% natural gas, 18% renewable energy, 13% coal, 7% lignite, and 5% nuclear. Small and very small producers are expected to supply 17% of the country's total generation.

8. In June 2012 the NEPC approved the third revision of the power development plan, which considered the following energy policy frameworks: (i) the 20-year Energy Efficiency Development Plan, 2011-2030 targeting a 25% reduction of energy intensity, or ratio of energy consumption to gross domestic product, and lowering the country's power demand projection; and (ii) the 10-year Alternative Energy Development Plan, 2012-2021 aiming to increase the share of renewable energy and alternative energy uses by 25% by replacing some planned conventional power plants with renewable power plants. The third revision projects 5.6% lower energy demand and 6.3% lower peak demand than the second revision.

#### **E. Tariff Structure**

9. The electricity tariff rates for EGAT, MEA, and PEA are closely regulated by the Energy Regulatory Commission and approved by the NEPC and the Cabinet of Ministers. The tariff structure is set to (i) reflect economic costs and promote the efficient use of electricity, (ii) secure the financial health of the three state power utilities, (iii) be fair to all categories of power consumer by reducing cross subsidization, and (iv) adjust electricity tariffs through a flexible and automatic mechanism.

10. Thailand's electricity tariff structure is divided into two components. The first component is the base tariff, which is a bulk supply tariff summing the wholesale tariff that EGAT charges MEA and PEA and the fixed retail tariff that MEA and PEA charge power consumers each regulatory period. The base tariff is calculated using several factors including forecast demand for electricity; fuel prices; expected expenses related to power generation, transmission, and distribution; and capital expenditures of EGAT, MEA, and PEA, including a return on invested capital. It is subject to an incentive factor to encourage utility efficiency and generally remains in

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<sup>1</sup> EGAT. <http://www.egat.co.th/en/images/about-egat/PDP2010-Rev3-Eng.pdf>

effect for the tariff structure's duration, while the fuel adjustment charge is subject to revision every 4 months.

11. The second component is the fuel adjustment charge, which the power consumers pay. The fuel adjustment charge is an automatic mechanism applied to modify tariffs to the extent that there are changes in the base-case assumptions beyond the control of EGAT, MEA, and PEA (i.e., fuel prices increasing at a higher rate than anticipated). It is effectively a pass-through mechanism, allowing unexpected increases in costs to be passed on to end-users. It is designed to be added to base tariffs for the next 4-month period to provide reasonable tariff stability for consumers.

12. In support of its Renewable Energy Development Plan, the government introduced the adder tariff program, which gives solar projects a B8 per kWh addition, or adder, to the base tariff for the first 10 years of commercial operations.

## **F. Operations Review**

13. The project entails the construction of a 55 MW solar generation plant in Lopburi province in central Thailand. The project was built within budget and ahead of schedule. The first stage of the project achieved commercial operations in December 2011, and the final stage achieved commercial operations in March 2012.<sup>2</sup> Facility Completion under the engineering, procurement and construction (EPC) contract was achieved on 15 June 2012, and Project Completion under the financing agreements followed on 3 September 2012. The Natural Energy Development Company's (NED's) additional 8 MW expansion phase, financed purely through equity, achieved commercial operations in May 2013.

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<sup>2</sup> The project's construction was divided into 7 stages of 9.3–10.7 MW each.

## ENVIRONMENTAL IMPACT

### I. Introduction

1. Natural Energy Development Company (NED) has initiated a 55 MW<sub>NET</sub> solar power plant project located on about 176 hectares of land about 200 kilometers north of Bangkok in Wang Pleng Subdistrict, Khok Samrong District, Lopburi Province. The project has installed a total of 565,630 solar cell panels using innovative thin-film photovoltaic technology for power production.<sup>1</sup> The project is considered to have safe and clean renewable energy, which causes minimal environmental impacts compared with power generation that uses coal or natural gas as fuel. The project has qualified for carbon credits under the Kyoto Protocol's Clean Development Mechanism (CDM).<sup>2</sup> An evaluation of the project's implementation and of the degree of compliance with environmental, health, and safety requirements was conducted.

### II. Review Findings

2. **Compliance with ADB safeguards requirements and national environmental regulations.** As the project was classified as Environmental Category B, NED prepared an Initial Environmental Examination report to comply with the Asian Development Bank's (ADB's) Safeguard Policy Statement (2009) requirements.<sup>3</sup> ADB and other commercial lenders hired an Independent Engineer to monitor construction works, including the Consortium's implementation and compliance with environmental, health, and safety (EHS) management plan.<sup>4</sup> NED obtained the legally required permits and licenses prior to project construction and operation. The EHS management plan outlined key issues and concerns and mitigating measures for impacts during construction and operation.

3. **Environmental impacts during construction.** The project's environmental impacts were assessed to be minor and temporary during construction and few and limited during operation. The project area is neither located in a national forest reserve zone nor a wildlife sanctuary. No endangered flora and fauna species were found in the project area. Impacts on air quality and noise from exhaust of construction equipment and vehicles were localized and temporary due to the relatively short construction period. Measurements on air quality (total suspended particulates) and noise level monitoring showed satisfactory results and met national standards. During construction stage the Consortium was tasked with implementing the EHS management plan in compliance with the requirements of ADB, NED, and national laws. Independent Engineers validated the Consortium's monthly construction progress reports through field site visits and meetings with NED and Consortium.

4. **Environmental management and monitoring during operation.** The project does not generate any harmful atmospheric emissions, effluent, or solid contaminants during operations. NED is responsible for the project's security, health, safety, and environmental aspects during

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<sup>1</sup> Solar cells shall be produced from amorphous silicon (a Si:H) and micro-crystalline silicon (*u* c-Si). The cell has the a-Si/ *u* c-Si tandem structure.

<sup>2</sup> For the year 2013, NED received total certified emission reduction (CER) revenue in the amount of B17.9 million.

<sup>3</sup> For solar power projects, the Government of Thailand through the Ministry of Natural Resources and Environment does not require the preparation and submission of environmental impact assessment

<sup>4</sup> Consortium is comprised of Italian-Thai Development Public Company (ITD), Italthai Engineering Co. Ltd. (ITE), and Sharp Corporation (Sharp). ITD is responsible for civil works, ITE is responsible for electrical works, and Sharp is responsible for offshore activities, including design and supply of photovoltaic modules, inverters, and associated equipment (i.e., combiner box and collection box).

operation.<sup>5</sup> NED is responsible to continue the implementation of the EHS management plan during project operations. Also NED hired a third party environmental monitoring consultant to help monitor: (i) air quality, noise level, and surface water quality; and (ii) occupational and community health and safety, including safety training activities and emergency drill.<sup>6</sup> Impact on groundwater utilization is minimal since NED sourced water for cleaning of solar cell panels from different sources such as irrigation canal water and ground water through shallow wells (less than 20 meters deep).<sup>7</sup> Impact on visibility is low since the selected solar cells are equipped with a film layer able to absorb sunlight and a with mirror to prevent light reflection. Separated oil or generated wastes oil were collected in a 200-liter drum, stored, and later sent to appropriate disposal by a licensed waste processor. All deteriorated solar cell panels were collected, temporarily stored, and sent to a recycling facility or a licensed waste processor.<sup>8</sup> The project has allocated a green space of about 90 rai to be planted with grass and, along its boundary, trees.<sup>9</sup> The corporate EHS division is tasked with overseeing and monitoring the Maintenance Contractor's performance during the project's operations stage.

**5. Occupational and community health and safety plan.** NED has established emergency preparedness and response procedures to provide guideline, direction, and supporting information to all personnel and outside personnel to respond expeditiously, in order to minimize loss of lives and reduce severity of injuries and property damage.<sup>10</sup> The Plant Manager acts as the Emergency Manager and is responsible for the overall management and coordination of emergency operations. In his absence, this function will be the responsibility of the Maintenance Manager, Operations Manager, Safety Coordinator or Shift Supervisor. A First Aid Team has been trained for more advanced needs that might arise during an emergency. The Operations Manager or Maintenance Manager provides the team with upgraded and systematic in-house and external training and first aid drills. A centralized first aid room to provide first aid and primary care services for injured and sick employees is available at the project site. Staff members are also required to undergo annual medical checkups.

### III. Conclusion and Recommendation

6. Based on review and evaluation of the safeguards documents and the site visit, it is concluded that the ADB and national EHS and social requirements of the project have been adequately met. NED's performance has been satisfactory in proper implementation of relevant EHS mitigating measures during construction and operation stage. Although there were few and limited EHS impacts during operation, NED is committed to continue the implementation of the EHS and social management plan through hiring a full-time Maintenance Contractor to achieve satisfactory project operation. NED will continue to update and revise the EHS and social management plan as and when appropriate.

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<sup>5</sup> Sharp Solar Maintenance Asia Co., Ltd is the Maintenance Contractor for this project.

<sup>6</sup> Greener Consultant Co., Ltd. is the third party environmental monitoring consultant responsible for the sampling and testing of all required environmental parameters during operation. Greener Consultant Co., Ltd. annual environmental and social monitoring reports from 2011 to first quarter of 2014 have been submitted to ADB for review and posting to ADB website.

<sup>7</sup> The total water consumption for cleaning of solar cell panels is about 542 m<sup>3</sup>/year or 1.48 m<sup>3</sup>/day.

<sup>8</sup> Consortium will be responsible for handling the end-of-life collection and recycling of photovoltaic modules.

<sup>9</sup> The rai is a Thai measure for land area. One rai is 1,600 square meters, and one hectare is 6.25 rai.

<sup>10</sup> Emergency preparedness and response describes the characteristics of different types of emergencies (e.g., fires and explosions, oil and chemical spillages, medical emergencies, bomb threats, floods, adverse weather, and pandemics) and set out measures to be taken by all project site personnel in the event of an emergency.

## SOCIAL IMPACT

### I. Project Overview

1. The project was classified as Category C for both indigenous peoples and involuntary resettlement. No indigenous peoples were living within or close to the project site and no physical relocation or economic displacement issues were expected during project preparation. Land was procured on a willing buyer–willing seller basis following the requirements set forth in the Asian Development Bank’s (ADB’s) Safeguard Policy Statement (2009). Land purchase option agreements were executed during project processing in July 2009, and sale and registration of the transfer of land ownership to Natural Energy Development Company (NED) was completed in May 2010. The project was also expected to generate jobs for non-skilled workers residing in surrounding communities during plant construction and operation. Following technical completion, a review of the project’s actual social impacts was undertaken.

### II. Review Findings

#### A. Involuntary Resettlement Impact

2. A total of 1,142 rais (about 182 hectares) were acquired at market value from 13 landowners on a willing buyer–willing seller basis in May 2010, prior to project construction in August 2010.<sup>1</sup> Mr. Virat Romjumba owned a majority of these parcels of land (604 rais). He also brokered the sale of the land adjoining his property, some of which belonged to his sister. Except for Mr. Romjumba, who now resides in Bangkok, NED no longer has a record of the whereabouts of the previous landowners. However, NED confirms that no complaints were received from the landowners with respect to the purchase of land for the project.

3. While some parcels of land were idle and unproductive, others were used for planting low-value cash crops, such as tapioca. Initial arrangements with landowners provided for the harvest of existing crops found in the project area prior to beginning construction. The land purchase option agreement provided a period of 8 months to clear the subject land of any asset prior to the land transfer registration.

4. A preliminary arrangement that one landowner residing in the project area will stay and be employed in the project did not materialize, as the landowner asked for a purchase price higher than what was offered in the land purchase option agreement. It was confirmed during site inspection that the subject parcels of land were not included in the project area and no one was residing in the solar plant.

5. From the total land acquired, 721 rais were used for the installation of 565,630 solar panels and stands; the rest were used for access roads, installation of controllers and transformers, a 22 kilovolt (kV)/115kV substation, and a control building. The 115kV transmission line was constructed in an existing 22kV transmission line corridor where there were no existing physical improvements (such as crops or structures). No individuals were physically or economically displaced during the construction of the 115kV transmission line.

#### B. Indigenous Peoples Impact

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<sup>1</sup> The purchase price per rai for all parcels of land was B55,000, which is equivalent to prevailing market price as confirmed by the client. NED and the landowners entered a land purchase option agreement for this purpose.

6. The project site is located about 200 kilometers (km) north of Bangkok in Wang Ploeng Subdistrict, Khok Samrong District, Lopburi Province. Within a 5-km radius from the project site is another subdistrict called Khao Laem. Wang Ploeng has 13 villages and Khao Laem has 8 villages, which mostly rely on low-value cash crops as their main income source. No indigenous peoples reside in these areas.

### C. Other Social Dimensions

7. **Employment opportunities.** During construction from 2010 to 2012, NED provided 1,753 jobs to local construction workers. During operation from 2012 to 2013, Sharp Solar Maintenance Asia Co., Ltd. (SSMA) employed 827 maintenance workers for its solar power plant area, green area, and office building. Female workers accounted for 30% of all workers during construction and 15% of all maintenance workers. For technical staff, NED, EGCO Engineering and Service Co. Ltd. (ESCO), and SSMA hired 55 employees from 2010 to 2014. Female employees are hired mostly for administrative positions (e.g., office supervisors, corporate service officers, finance officers) and account for 27% of technical or skilled employees.

8. NED, ESCO, and SSMA each maintain their own staff complement and are separately responsible for complying with labor laws for the standards and conditions of employment (e.g., working time, holidays, remuneration). Non-skilled workers are sourced from labor contractors and receive minimum wage (B182 per day in 2010-2011 and B300 per day in 2012-2013) in compliance with applicable regulation. No work-related grievances were reported during project construction and operation.

9. **Corporate social responsibility activities.** To implement its corporate social responsibility (CSR) policy, NED has had partnerships with the nearest local community (about 600 meters away in Ban Chonmuang, Wang Ploeng), and with the three schools within a 5-km radius. NED's CSR programs aim to improve livelihood opportunities and promote renewable energy in these two groups. One activity was the creation of a savings groups comprising 30 members from the local community, which produced and marketed local products (e.g., oil and shampoo) under the government's "One Tambon One Product" local entrepreneurship program. Another was providing a renewable energy course in partner school Baan Kao Tian. The course mainstreamed renewable energy across the school's curriculum at all levels and was recognized and awarded by the Electricity Generating Public Company Limited (EGCO), an independent power producer in Thailand, the Ministry of Energy, and the Ministry of Education. In addition to partnerships with the local community and schools, NED also constructed GreenNEDeducation, a renewable energy learning center located at the Lopburi solar power plant site. The center is open to the public and designed to inform visitors about Lopburi heritage and renewable energy through interactive media and learning.

10. **Grievance procedure, consultations, and community relations.** A community and public relations officer was hired during project construction to liaise between NED and the local community and manage grievances arising from the power plant's construction. The position was retained during project operation to oversee the implementation of NED's CSR programs and manage grievances arising from the plant's operations. To maintain good community relations, monthly meetings and tripartite committee meetings (comprising representatives from the local community, local administrative organization, and NED) are held. Thus far, NED has not received any complaints with respect to plant operation. Most of the concerns received were funding requests for educational, cultural, and recreational activities.

### **III. Conclusion**

11. Based on the review and evaluation of safeguards documents; ADB's inspection of project facilities in Lopburi; and interviews with staff at corporate office, contractors (i.e., ESCO), and the local community, NED has complied with ADB's social safeguard requirements. ADB also notes NED's strong CSR as illustrated in para. 9.