

## GRANT TERMINATION EVALUATION REPORT

### A. Background

1. The Chief Executive Offer of the Global Environmental Facility (GEF) endorsed the GEF grant on 3 March 2010. The grant was signed on 30 June 2010 and became effective on 27 October 2010. The GEF provided grant funds of \$9.2 million to finance the construction of centralized biogas plants, grid connections of selected subprojects, and capacity development activities in four provinces (Heilongjiang, Henan, Jiangxi and Shandong). Alongside the GEF grant, ADB also administered the ADB financed loan of \$66.08 million from ordinary capital resources and the grant funds of \$3 million by the Clean Energy Fund<sup>1</sup> under the Clean Energy Financing Partnership Facility (CEFPF). The original loan closing was on 30 June 2016, which was extended twice, first to 31 December 2017, and then to 31 December 2018. The main reason for the grant extensions was the slower than expected construction of the centralized biogas plants, medium- and large-scale biogas plants (MLBGPs) and the associated cumbersome coordination for established feed-in tariff to enable on-grid connections with the local grids.

2. The outcome of the project is improved efficiency of rural biomass renewable energy system and rural social benefits. The project outputs were: (i) sustainable development and demonstration of commercial practices of MLBGPs; (ii) effective utilization of biogas sludge in eco-farming; (iii) capacity development for improved sector performance; and (iv) project implementation support. The cost details and project key milestones are presented in Annex A.

3. The project was jointly financed with an ADB loan, a GEF grant, a CEFPF grant, a Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) grant and domestic financing. A total project cost was estimated at \$152.5 million at appraisal, of which \$66.08 million was financed by ADB, \$9.2 million by GEF, \$3 million by CEFPF, \$4.6 million by GTZ and \$69.66 million by domestic financing. At completion, the actual cost of the project was \$88.7 million.<sup>2</sup> There were savings of \$9.9 from the ADB loan, and \$3.03 from the GEF grant. The actual cost by financier was \$50.2 from ADB, \$6.1 from GEF, \$1.5 from the CEFPF, and \$30.8 by the domestic financing.

### B. Terms of Reference

4. The terminal evaluation report is prepared as part of the project completion report for the entire investment project. The GEF grant was an integral part of the baseline project, and it was necessary to apply same methodology with same data for all the inputs and outputs. The evaluation involved desk review of the executive agency's project completion report, all the project performance monitoring reports (PPMS), ADB review mission and management records and audits reports. A national consultant was recruited to conduct field visits in the four provinces

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<sup>1</sup> The financing partners of the Clean Energy Fund were the government of Australia, Norway, Spain, Sweden und the United Kingdom.

<sup>2</sup> The project implementation cost from GTZ is not available from the executing or implementing agencies or from GTZ, so the project cost at completion does not include the investment by GTZ. The figure is being rounded.

and verify the data at fields, in particular to the actual achievement of greenhouse gas (GHG) emissions reduction.

### **C. Implementation**

5. The Ministry of Agriculture (MOA) was the executing agency (EA), and the departments of Agriculture of the four provinces were the implementing agencies (IAs) for the project and the grants. A central level project management office (PMO) was established in the MOA, which was responsible for the overall coordination and project management, supported by Foreign Economic Cooperation Center (FECC). Four project implementation offices (PIOs) were established in the Provincial Rural Energy Office or the Agricultural Foreign Capital Project Office within its provincial Department of Agriculture, and each of the PIOs was responsible for project implementation and compliance with safeguards, procurement, technical design and relevant standards. PMO with five staff and four PIOs with seven staff were established in 2010 and operational during project implementation.

6. The project and GEF grant experienced slow implementation and were extended for twice. The first extension was for 18 months, from 30 June 2016 to 31 December 2017, and the second for 12 months, from 31 December 2017 to 31 December 2018. Many small and medium enterprise owners of MLBGPs were prone to market fluctuations, which led to high incidence of bankruptcy, resulting to replacing of subprojects through rounds of minor project scope change and delayed project and grant implementation. Two rounds of minor scope change were conducted in 2015 and 2017 to reallocate budget of the loan components to reduce the number of MLBGPs for construction and to shift more financing resources to support eco-farming component to maintain financial sustainability of the project and to achieve anticipated GHG emissions reduction. These minor scope changes however did not trigger budget reallocation to the grant. The GEF grant was merely extended twice along with the loan extension to accommodate the slower than expected construction of centralized biogas plants and the MLBGPs to enable the delivering of on-grid connection as the breakthrough achievement to the project. The unused grant amount of \$3.1 million was returned.

### **D. Relevance, Effectiveness, and Impact**

#### **1. Relevance**

7. The project was relevant for its close alignment with the governments' priorities for reducing livestock pollution and promoting the "energy-ecological type" of rural livelihood improvements in the Eleventh Five-Year Plan and the strategic goals of GEF. The project demonstrated a model of circular economy, in which livestock industry reduces non-point source pollution, builds linkage with utilization of animal waste for eco-farming, and generates renewable biogas energy for electricity supply. The project is also aligned with the government's policy in promoting the "energy-ecological type" of biogas plants since the 1990s, the 2007 Medium-and Long-Term Development Plan for Renewable Energy by the National Development and Reform Commission and the Circular Economy Promotion Law of 2009.

8. The project demonstrated the conversion of livestock waste to renewable energy, the substitution of fossil fuel with biogas as a renewable energy supply, and the use of biogas slurry and sludge as organic fertilizer in the expansion of eco-farming, by achieving the essence of circular economy. The GEF grant was used for construction of selected centralized biogas plants, grid connection of MLBGPs and capacity building support, including trainings and special studies, complementing the ADB loan objectives. The grant provided financing opportunities to

enable grid connections and expand awareness on the social and economic benefits of renewable energy utilization in rural areas. The GEF supported capacity building, which includes the development of and training on business models and commercial best practices for MLBGPs, monitoring and evaluation on the construction, operation and maintenance of the MLBGPs for the government officials in MOA and provincial Department of Agriculture, farmers, financiers and business owners. The implementation of this capacity building has encouraged greater uptake and utilization of biogas technologies in rural areas in the PRC.

9. The project is strongly aligned with GEF Strategic Goal 4 on building capacity on access and benefit sharing, and mainly contributed to strategic objectives 4 and 5 on climate change component, which are promotion of on-grid renewable energy and the use of renewable energy for the provision of rural energy services.

## **2. Effectiveness**

10. The project is effective in achieving its intended outcome of improved efficiency of rural renewable energy system and rural social benefits. All the planned four outputs were substantially delivered, including the sustainable development and demonstration of the commercial practices of MLBGPs, the effective use of biogas sludge in eco-farming, capacity development and project implementation. All the key performance targets at outcome levels were successfully achieved.

11. The project contributed to climate change mitigation, adaptation and social benefits. Although the number of MLBGPs were reduced, the expansion of eco-farming enabled the sustainable and significant reduction of GHGs. By the time of project completion, both the amount of biogas production and the reduced GHG emissions doubled the original approved performance targets;<sup>3</sup> and this has not accounted for the CO<sub>2</sub> absorption achieved for soil enhancement through the utilization of organific fertilizer for expanded eco-farming, which contributed as carbon sink for climate change adaptation. In the case of Taiyu subproject in Shandong, it was observed that the utilization of biogas sludge enabled conversion of saline and alkaline land to arable land through soil enrichment practices, which has also contributed to enhanced sustainable crop productivity and eco-farming. On social benefits, about 41,000 households, including 9,200 poor households, benefited from improved access to clean energy in rural areas, and more than 27,000 farmers increased their incomes through expanded contract farming.

## **3. Impact**

12. The project impact and the associated performance targets were all achieved and demonstrated good progress toward longer term impact. The project demonstrated a resource-recycling model in rural PRC through three key elements: (i) livestock waste to biogas, (ii) biogas to clean energy resources, and (iii) biogas to organic fertilizers/ products. More than 90% of livestock waste was collected and treated by the project biogas plants; and more than 10,000 poor households benefited from the use of organic fertilizers and the sales of organic products.

13. The environmental benefits of the project include the reduction of water and air pollution, improvement of public health, and positive impact to combat climate change. The project used solid and liquid waste from livestock waste and agro-processing as feedstock totaling to 1.85

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<sup>3</sup> The original performance target is GHG emissions reduced by about 770,000 tones of carbon dioxide equivalent. At the time of project completion, GHG emissions was reduced by about 1.72 million tons of carbon dioxide equivalent.

million tons per year and produced about 126.41 million m<sup>3</sup> of biogas per year through anaerobic technologies. About 13.68 million m<sup>3</sup> of biogas was utilized as natural gas, which was transmitted through local gas grids to the village households. Among which, 6.17 million m<sup>3</sup> was used for heating, and the remaining 106.5 million m<sup>3</sup> was used to generate 17.72 million kilowatt-hours of clean energy based electric power. The project produced 1.51 million m<sup>3</sup> of liquid biogas slurry and 0.24 million tons of solid biogas residue, which were reused to produce 1.15 million tons of organic fertilizer per year for eco-farming. The project accomplished a wholistic near zero-waste model for promoting circular economy and reducing GHG emissions, which had demonstration effects on biogas renewable development projects in other provinces in the PRC.

#### **E. Global Environmental Benefits and Catalytic Roles**

14. The project contributed to global environmental benefits through a genuine model of a recycling economy by replacing of fossil fuel for clean energy sources in the rural of the PRC. These are:

- (i) Treatment of about 4.87 million tons of livestock waste for producing of about 126.41 million m<sup>3</sup> of biogas per year;
- (ii) Installation of 62 methane capture devices on the MLBGP's to reduce GHG emissions;
- (iii) Achieving 100% biogas sludge provision to the nearby farms all the MLBGP's, which has reduced the use of chemical fertilizers for about 190,000 tons, more than 50% of reduction per year;
- (iv) Completion of a total of 24,787 mu of eco-farming; and
- (v) Delivering of GHG emissions reduction by 1.72 million tons of carbon dioxide equivalent per year.

15. The project demonstrated a successful model for rural renewable energy utilization through biogas generation of livestock waste and income generation of sustainable and environmentally friendly eco-farming practices. The project promoted commercial sustainability of MLBGP's and economic viability to enhance eco-farming through utilization of biogas slurry and residue for wider replications in the PRC.

#### **F. Sustainability**

16. The project is likely to be sustainable if both operational and financial sustainability, and environmental and social sustainability are taken into consideration. The financial internal rate of returns of the representative subprojects ranged from 1.1% to 17.1% at project completion, in comparison with estimated range of 6% to 11.9% at appraisal. Except for one subproject in Shandong, all other representative subprojects had FIRR's exceeding the weighted average cost of capitals, indicating their financial viability. The sensitivity analysis results indicated that the subprojects were highly sensitive to cost increases, benefit decreases, and operation reductions. Negative changes of less than 10% would put the subprojects in unacceptable situations. It was noted however that the project design constrained the spectrum of biogas technology applications, and the project should have encouraged not only "biogas to electrify" but also "biogas to natural gas" and "biogas purification of organic fertilizer" to obtain higher economic returns.

#### **G. Monitoring and Evaluation Framework and Institutional Arrangements**

17. The PMO and the PIOs followed the requirements for monitoring and reporting and made timely submissions of the progress reports, compliance reporting of environmental and

resettlement safeguards, project performance monitoring system (PPMS) as well as the audit reports. The PPMS incorporated sufficient project and GEF grant implementation info and data for measuring project and grant progress, including financing and disbursement information, physical progress, safeguards reports and project progress indicators against target indicators. The PPMS also measured social, gender, socioeconomic and sector development progress, in accordance with design and monitoring framework. The PMO and PIOs complied with all the monitoring end evaluation requirements in the GEF grant agreement.

#### **H. Rating**

18. The GEF grant is rated successful. The grant was well designed to tackle the weakest component of the project which needed supplementary resources to remove the barriers through a grant financing modality. Due to the GEF grant contribution, the project made breakthrough achievement in enabling grid connections of MLBGPs in three provinces (Jiangxi, Henan and Shandong). Most importantly, there was one wholly privately owned subproject in Jiangxi, not only attained on-grid connection but also sold intermittent biogas-based renewable power to the local grid with established feed-in-tariff. These results exceeded expectations and served as flagship to demonstrate that private MLBGP owner can have a viable business model to sale electricity and gain the income of the byproduct through biogas generation and utilization.

## Annex to the GEF Terminal Evaluation Report

### A. Project Identification

1. GEF Project ID: 3744
2. GEF Agency ID: 40682
3. Country: PRC
4. Project Title: Integrated Renewable Biomass Energy Development Sector Project
5. GEF Agency: Asian Development Bank

### B. Dates

Milestone	Actual Date
CEO Endorsement Date	30 March 2010
Actual Start Date	17 July 2010
Actual First Disbursement Date	20 May 2011
Actual Midterm Review Date	30 November 2014
Actual Completion Date	31 December 2018
Project Closing Date	
Terminal Evaluation Completion Date	

### C. Project Framework

Item	(\$ million) At Appraisal			At Completion		
	Foreign Exchange	Local Currency	Total Cost	Foreign Exchange	Local Currency	Total Cost
<b>A. Investment Costs</b>						
1. Civil Works Subtotal (1)	11.5	32.4	43.9	26.6	6.7	33.3
<b>2. Equipment and Materials</b>						
a. Goods and Materials	27.3	32.9	60.3	21.2	0.0	21.2
b. Equipment						
i. Government-Supported Equipment	0.5	0.6	1.0	0.0	0.0	0.0
ii. Multi-Donor CEF-Supported Equipment	0.4	1.4	1.8	1.0	0.0	1.0
iii. GEF Supported Equipment	0.0	0.0	0.0	0.2	0.0	0.2
<b>Subtotal (2)</b>	<b>28.2</b>	<b>34.9</b>	<b>63.1</b>	<b>22.4</b>	<b>0.0</b>	<b>22.4</b>
<b>3. GEF-Supported Centralized Biogas Plants</b>	<b>2.6</b>	<b>4.0</b>	<b>6.6</b>	<b>4.2</b>	<b>4.2</b>	<b>8.4</b>
<b>4. Vehicles</b>	<b>0.8</b>	<b>1.0</b>	<b>1.9</b>	<b>0.1</b>	<b>0.0</b>	<b>0.1</b>
<b>5. Capacity Development</b>						
a. GEF-Supported Capacity Development	0.2	1.1	1.3	0.5	0.0	0.5
c. Multi-Donor CEF-Supported Capacity Development	0.5	0.7	1.2	0.1	0.0	0.1
<b>Subtotal (5 including GEF CEF GTZ)</b>	<b>0.8</b>	<b>2.4</b>	<b>3.2</b>	<b>0.6</b>	<b>0.0</b>	<b>0.6</b>
<b>6. Consulting Services</b>						
<b>Subtotal (6 including GEF CEF GTZ)</b>	<b>2.8</b>	<b>2.5</b>	<b>5.3</b>	<b>1.7</b>	<b>0.0</b>	<b>1.7</b>
<b>7. Survey, Design and Supervision</b>	<b>1.7</b>	<b>7.5</b>	<b>9.2</b>	<b>0.0</b>	<b>15.6</b>	<b>15.6</b>
<b>8. Survey, Design and Supervision (Centralized Biogas Plants, GEF)</b>	<b>0.1</b>	<b>0.2</b>	<b>0.3</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>
<b>Total Base Costs</b>	<b>48.6</b>	<b>84.8</b>	<b>133.4</b>	<b>55.5</b>	<b>26.5</b>	<b>82.0</b>
<b>Contingencies</b>	<b>5.0</b>	<b>6.1</b>	<b>11.1</b>	<b>0.0</b>	<b>4.4</b>	<b>4.4</b>
<b>Subtotal (A)</b>	<b>53.6</b>	<b>91.0</b>	<b>144.5</b>	<b>55.5</b>	<b>30.9</b>	<b>86.4</b>
<b>B. Financing Charges during Implementation</b>	<b>8.0</b>	<b>0.0</b>	<b>8.0</b>	<b>2.3</b>	<b>0.0</b>	<b>2.3</b>
<b>Total Project Cost (A+B)</b>	<b>61.5</b>	<b>91.0</b>	<b>152.5</b>	<b>57.8</b>	<b>30.9</b>	<b>88.7</b>

Note: Numbers may not sum precisely because of rounding.

Source: Asian Development Bank and the Project Management Office.

