ADB

Completion Report

Project Number: 40682-013
Loan Number: 2632
Grant Numbers: 0202 and 0203
November 2020

People's Republic of China: Integrated Renewable Biomass Energy Development Sector Project

Asian Development Bank

CURRENCY EQUIVALENTS

Currency unit – yuan (CNY)

		At Appraisal (15 March 2010)	At Project Completion (21 January 2020)
CNY1.00	=	$0.14651	$0.1456
$1.00	=	CNY6.82550	CNY6.8669

ABBREVIATIONS

ADB	–	Asian Development Bank
CDM	–	Clean Development Mechanism
CEFPF	–	Clean Energy Financing Partnership Facility
CER	–	certified emission reduction
CO_2	–	carbon dioxide
EARP	–	environmental assessment and review procedure
EIA	–	environmental impact assessment
EIRR	–	economic internal rate of return
ENPV	–	economic net present value
EPB	–	Environmental Protection Bureau
FECC	–	Foreign Economic Cooperation Center
FIRR	–	financial internal rate of return
FSR	–	feasibility study report
GDP	–	gross domestic product
GEF	–	Global Environment Facility
GHG	–	greenhouse gas
GTZ	–	Gesellschaft für Technische Zusammenarbeit
IEE	–	initial environmental examination
LIBOR	–	London interbank offered rate
MLBGP	–	medium- and large-scale biogas plant
MOA	–	Ministry of Agriculture
MOF	–	Ministry of Finance
NDRC	–	National Development and Reform Commission
PFD	–	provincial finance department
PIO	–	project implementation office
PMO	–	project management office
PPMS	–	project performance monitoring system
PRC	–	People's Republic of China
WACC	–	weighted average cost of capital

WEIGHTS AND MEASURES

kWh	–	kilowatt-hour
m^3	–	cubic meter
mg/l	–	milligram per liter

NOTES

(i) The fiscal year (FY) of the Government of the People's Republic of China ends on 31 December. "FY" before a calendar year denotes the year in which the fiscal year ends, e.g., FY2018 ends on 31 December 2018.

(ii) In this report, "$" refers to United States dollars unless otherwise stated.

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BASIC DATA

A. Loan/Grant Identification

1.	Country	People's Republic of China
2.	Loan/grant numbers and financing sources	2632 OCR/0202 CEFPF/0203 GEF
3.	Project title	Integrated Renewable Biomass Energy Development Sector Project
4.	Borrower	People's Republic of China
5.	Executing agency	Ministry of Agriculture and Rural Affairs[1]
6.	Amount of loan and grants	$66,080,000 for loan, $3,000,000 for CEFPF grant, and $9,199,091 for GEF grant
7.	Financing modality	Sector loan and project grant

B. Loan/Grant Data

1.	Fact finding	
	– Date started	2 March 2009
	– Date completed	6 March 2009
2.	Loan negotiations	
	– Date started	11 March 2010
	– Date completed	12 March 2010
3.	Date of Board approval	16 April 2010
4.	Date of loan agreement	17 June 2010
	Date of grant agreements	30 June 2010
5.	Date of loan effectiveness	
	– In loan agreement	15 September 2010
	– Actual	15 October 2010
	– Number of extensions	1
	Date of grant effectiveness	
	– In grant agreements	28 September 2010
	– Actual	27 October 2010
	– Number of extensions	2
6.	Project completion date	
	– Appraisal	31 December 2015
	– Actual	30 June 2018
7.	Loan and grant closing date	
	– In loan and grant agreements	30 June 2016
	– Actual	31 December 2018
	– Number of extensions	2
8.	Financial closing date	
	– Actual for the loan	21 January 2020
	– Actual for the grants	1 September 2020
9.	Terms of loan	
	– Interest rate	London interbank offered rate-based
	– Maturity (number of years)	25
	– Grace period (number of years)	5

[1] The ministry's name was changed from the Ministry of Agriculture to the Ministry of Agriculture and Rural Affairs in March 2018.

10. Terms of relending (if any)

– Interest rate	London interbank offered rate-based
– Maturity (number of years)	25
– Grace period (number of years)	5
– Second-step borrower	Heilongjiang Provincial Government Finance Bureau Henan Provincial Government Finance Bureau Jiangxi Provincial Government Finance Bureau Shandong Provincial Government Finance Bureau

11. Disbursements

a. Dates – Loan

Initial Disbursement 2 September 2011	**Final Disbursement** 20 June 2019	**Time Interval** 94 months
Effective Date 15 October 2010	**Actual Closing Date** 21 January 2020	**Time Interval** 112 months

Dates – CEFPF Grant

Initial Disbursement 9 December 2011	**Final Disbursement** 5 July 2019	**Time Interval** 92 months
Effective Date 27 October 2010	**Actual Closing Date** 1 September 2020	**Time Interval** 119 months

Dates – GEF Grant

Initial Disbursement 20 May 2011	**Final Disbursement** 29 July 2019	**Time Interval** 99 months
Effective Date 27 October 2010	**Actual Closing Date** 1 September 2020	**Time Interval** 119 months

b. Loan amount ($ ’000)

Category	Original allocation (1)	Increased during Implementation (2)	Canceled during Implementation (3)	Last Revised Allocation (4 = 1 +2-3)	Amount Disbursed (5)	Undisbursed Balance[a] (6 = 4 – 5)
Civil Works - Heilongjiang	1,182.3	0.0	924.1	258.2	258.2	0.0
Civil Works - Henan	7,627.4	5,057.8	0.0	12,685.2	12,901.3	-216.1
Civil Works - Jiangxi	6,934.0	1,090.0	0.0	8,024.0	6,967.8	1,056.2
Civil Works - Shandong	7,166.3	0.0	0.0	7,166.3	6,455.9	710.4
Materials - Heilongjiang	1,747.8	0.0	1,445.9	301.9	301.9	0.0
Materials - Henan	11,276.3	0.0	6,464.5	4,811.8	4,563.4	248.4

Category	Original allocation (1)	Increased during Implementation (2)	Canceled during Implementation (3)	Last Revised Allocation (4 = 1 +2-3)	Amount Disbursed (5)	Undisbursed Balance[a] (6 = 4 – 5)
Materials - Jiangxi	10,251.2	0.0	84.0	10,167.2	9,394.0	773.2
Materials - Shandong	10,594.6	26.6	0.0	10,621.2	6,939.7	3,681.5
Vehicles - Heilongjiang	69.7	0.0	56.5	13.2	13.2	0.0
Vehicles - Henan	449.5	0.0	449.5	0.0	0.0	0.0
Vehicles - Jiangxi	408.6	0.0	327.7	80.9	80.9	0.0
Vehicles - Shandong	422.3	0.0	422.3	0.0	0.0	0.0
Interest and Commitment Charge	7,950.0	0.0	2,017.9	5,932.1	2,334.2	3,597.9
Total	**66,080.0**	**6,174.4**	**12,192.4**	**60,062.0**	**50,210.6**	**9,851.5**

[a] Undisbursed balance was canceled at loan closing.

c. CEFPF grant amount ($ ’000)

Category	Original Allocation (1)	Canceled during Implementation (2)	Last Revised Allocation (3 = 1 – 2)	Amount Disbursed (4)	Undisbursed Balance (5 = 3 – 4)
Gas Flares - Medium-sized farms	741.4	0.0	741.4	308.3	433.1
Gas Flares - Large farms	958.6	0.0	958.6	759.8	198.8
Consulting Services	400.0	0.0	400.0	426.1	(26.1)
Domestic Training, Workshops, and Study Tours	545.0	0.0	545.0	72.3	472.7
Survey and Special Studies	355.0	0.0	355.0	0.0	355.0
Total	**3,000.0**	**0.0**	**3,000.0**	**1,566.5**	**1,433.5**

d. GEF grant amount ($ ’000)

Category	Original Allocation (1)	Canceled during Implementation (2)	Last Revised Allocation (3 = 1 – 2)	Amount Disbursed (4)	Undisbursed Balance (5 = 3 – 4)
Centralized Biogas Digesters and Grid Connection	6,111.1	0.0	6,111.1	4,185.1	1,926.0
Consulting Services	1,781.0	0.0	1,781.0	1,280.8	500.2
Training and Workshops	577.0	0.0	577.0	504.6	72.4
International Conference	150.0	0.0	150.0	0.0	150.0
Special Studies and Surveys	400.0	0.0	400.0	19.7	380.3
Office Equipment, Printing, and Publication	180.0	0.0	180.0	179.6	0.4
Total	**9,199.1**	**0.0**	**9,199.1**	**6,169.9**	**3,029.2**

C. Project Data

1. Project cost ($ million)

Cost	Appraisal Estimate	Actual
Foreign exchange cost	61.5	57.8
Local currency cost	91.0	30.9
Total	**152.5**	**88.7**

2. Financing plan ($ million)

Cost	Appraisal Estimate	Actual
Implementation cost		
Government	10.7	4.4
Livestock farms and agro-enterprises	58.9	26.5
ADB financed	58.1	47.8
GEF	9.2	6.2
CEFPF	3.0	1.5
GTZ	4.6	0.0
Total implementation cost	**144.5**	**86.4**
Interest during construction costs		
Government		
Livestock farms and agro-enterprises		
ADB financed	8.0	2.3
GEF		
CEFPF		
GTZ		
Total interest during construction cost	**8.0**	**2.3**

GTZ (Gesellschaft für Technische Zusammenarbeit) figure is not available.

3. Cost breakdown by project component ($ million)

Component			Appraisal Estimate	Actual
A.	**Base Cost**			
	1	Sustainable Development and Demonstration of Commercial Practices of MLBGPs	119.9	62.3
	2	Effective Utilization of Biogas Sludge in Eco-Farming	6.3	12.8
	3	Capacity Development for Improved Sector Performance	2.9	1.3
	4	Project Implementation Support	4.3	5.6
		Subtotal (A)	**133.4**	**82.0**
B.	**Contingencies**		11.1	4.4
C.	**Financing Charges During Implementation**		8.0	2.3
	Total (A + B + C)		**152.5**	**88.7**

MLGBP = medium-sized and large biogas project.

4. Project schedule

Item	Appraisal Estimate	Actual
Sustainable Development and Demonstration of Commercial Practices of MLBGPs		
MLBGPs		
Date of initiation	15 October 2010	26 October 2011
Completion of works	31 December 2015	31 December 2018
Grid connection		
Date of initiation	15 October 2010	26 October 2011
Completion of works	31 December 2015	31 December 2018
Centralized biogas plants		
Date of initiation	15 October 2010	26 October 2011
Completion works	31 December 2015	31 December 2018
Effective Utilization of Biogas Sludge in Eco-Farming		
Operation manual of bio-fertilizer utilization in eco-farming		
Date of initiation	15 October 2010	8 September 2011
Date of operation	31 December 2012	16 September 2013
Eco-farming		

Item	Appraisal Estimate	Actual
Date of initiation	10 October 2010	8 September 2011
Date of operation	31 December 2014	16 September 2013
Capacity Development for Improved Sector Performance		
Operation manual of MLBGPs		
Date of initiation	15 October 2010	8 September 2011
Date of operation	31 December 2012	31 December 2018
Construction manual of centralized biogas plants		
Date of initiation	15 October 2010	20 February 2012
Date of operation	31 December 2012	31 December 2018
Training on operation and management of biogas plants		
Date of initiation	15 October 2010	8 September 2011
Date of operation	31 December 2012	31 December 2018
Monitoring system for design and operation performance of biogas plants		
Date of initiation	15 October 2010	8 September 2011
Date of operation	31 December 2012	31 December 2018
Business model of centralized biogas plants		
Date of initiation	15 October 2010	8 September 2011
Date of operation	31 December 2015	31 December 2018
Project Implementation Support		
Project performance monitoring system		
Date of initiation	15 October 2010	8 September 2011
Date of completion	31 December 2011	31 December 2011
Annual implementation and performance report on biogas plants		
Date of initiation	15 October 2010	31 December 2010
Date of completion	31 December 2014	30 June 2016

5. Project performance report ratings

	Ratings	
Implementation Period	**Development Objectives**	**Implementation Progress**
From 16 April 2010 to 31 December 2010	Satisfactory	Satisfactory
	Single Project Rating[a]	
From 1 April 2011 to 30 June 2011	Actual Problem	
From 1 July 2011 to 31 December 2013	On Track	
From 1 January 2014 to 31March 2015	Potential Problem	
From 1 April 2015 to 30 June 2015	Actual Problem	
From 1 July 2015 to 30 September 2015	Potential Problem	
From 1 October 2015 to 31 December 2015	Actual Problem	
From 1 January 2016 to 30 June 2016	On Track	
From 1 July 2016 to 30 June 2017	Potential Problem	
From 1 July 2017 to 30 September 2017	On Track	
From 1 October 2017 to 31 March 2018	Potential Problem	
From 1 April 2018 to 30 June 2018	Actual Problem	
From 1 July 2018 to 30 September 2018	Potential Problem	
From 1 October 2018 to 31 March 2019	On Track	
From 1 April 2019 to 30 June 2019	Potential Problem	
From 1 July 2019 to 31 December 2019	On Track	
From 1 January 2020 to 31 March 2020	Actual Problem	
From 1 April 2020 to 30 June 2020	On Track	
From 1 July 2020 to 31 August 2020	On Track	

[a] Rating for Q1 2011 is not available in eOps.

D. Data on Asian Development Bank Missions

Name of Mission	Date	No. of Persons	No. of Person-Days	Specialization of Members
Fact-finding	2–6 March 2009	5	25	a, b, 2c, d
Inception	22 November–2 December 2010	2	22	e, f
Loan review 1	21–30 November 2011	2	18	e, f
Loan review 2[a]	14–25 January 2013	4	28	g, f, h, i
Loan review 3	14–17 November 2014	3	9	j, i, d
Loan review 4	2–3 and 23–26 November 2015	2	7	j, f
Loan review 5	11–14 September 2016	2	6	j, l
Loan review 6	23–24 October 2017	3	3	m, j, i
Loan review 7	25–26 June 2018	3	3	j, l, i
Project completion review	21–28 October 2019	5	40	j, n, o, l, f

a = counsel, b = natural resources economist, c = project officer, d = staff consultant, e = principal natural resources management specialist, f = project analyst, g = senior environment specialist, h = economics officer, i = associate project analyst, j = senior project officer (energy), l = environmental officer, m = deputy country director, n = senior project officer (financial management), o = senior safeguards officer (resettlement)

[a] Project administration was transferred to the Asian Development Bank Resident Mission in the People's Republic of China effective 10 December 2012.

I. PROJECT DESCRIPTION

1. Rising rural energy consumption and environmental degradation have posed severe concerns to the People's Republic of China (PRC) over the past decades. The annual average energy consumed per person in rural areas increased by 9.81% from 2000 to 2016. Reliance on burning coal and straw in rural areas results in serious rural-urban transboundary pollution and negatively affects climate change mitigation efforts. The project therefore aimed to make use of livestock waste in rural areas to enable wider access to renewable biogas energy, to improve rural environmental management and recycle resources. The expected impact was improved rural environmental management and access to biogas energy, and the outcomes were improved efficiency of the rural system of renewable biomass energy as well as rural social benefits. The project outputs were (i) sustainable development and demonstration of the commercial practices of medium- and large-scale biogas plants (MLBGPs); (ii) effective utilization of biogas sludge in eco-farming; (iii) capacity development for improved sector performance; and (iv) project implementation support.

2. The Asian Development Bank (ADB) approved a loan of $66.08 million from ordinary capital resources on 26 March 2010. The Global Environmental Facility (GEF)[1] provided grant funds of $9.2 million to finance the construction of centralized biogas plants, grid connections of selected subprojects, and capacity development activities. The Clean Energy Fund,[2] under the Clean Energy Financing Partnership Facility (CEFPF), provided grant funds of $3 million to finance activities connected with high-temperature flares and capacity development. ADB administered both the loan and the two grants in four provinces (Heilongjiang, Henan, Jiangxi, and Shandong), and all were completed on 31 December 2018.

II. DESIGN AND IMPLEMENTATION

A. Project Design and Formulation

3. The project was in line with the government's priorities for reducing livestock pollution and thus promoting the "energy-ecological type" of rural livelihood improvement in the Eleventh Five-Year Plan.[3] It was also in line with ADB's country partnership strategy for the PRC 2008–2010,[4] which emphasized inclusive growth through balanced development and environmental sustainability. To demonstrate a model of circular economy, the project took an integrated approach: helping the livestock industry reduce non-point source pollution, building links with eco-farming efforts for residual use of animal waste, and generating renewable biogas energy for electricity service. This integrated resource-recycling solution in rural areas also contributed to efforts to mitigate and adapt to climate change.

4. The project design could be improved. It was prepared through a project preparatory technical assistance (TA). Although it seemed that enough stakeholders participated – including local governments, agribusiness owners, and farmers – the degree of ownership by the agribusiness owners was difficult to assess, as they were accustomed to rely heavily on subsidies from local governments. During implementation, it became apparent that the livestock industry was very prone to market fluctuations, which led to a high incidence of bankruptcies. A minor

[1] Financed on a grant basis by the Global Environment Facility and administered by ADB.
[2] The financing partners of the Clean Energy Fund were the governments of Australia, Norway, Spain, Sweden, and the United Kingdom.
[3] State Council. 2006. *National Economic and Social Development Eleventh Five-Year Plan, 2006–2010.* Beijing.
[4] ADB. 2008. *Country Partnership Strategy: People's Republic of China, 2008–2010*. Manila.

scope change was made to shift more resources to eco-farming, to ensure project sustainability and achieve the anticipated outcome target for reduction of greenhouse gas (GHG) emissions.

5. The project design at appraisal and completion remained relevant but could have been better targeted to key players in the agribusiness industry rather than to small or medium-sized livestock farmers,[5] who were very vulnerable to economic shocks. The criteria for selecting the livestock subprojects should have been defined more rigorously. The key element missing in the project design was facilitation of the adoption of advanced technologies. The essence of this sector project is about the generation of biogas as renewable energy and its application as an alternative form of clean energy to replace consumption of coal for cooking, heating and cooling, and supply of electricity and gas. Thus, the project should have shed light on how key technologies could mainstream the use of biogas in rural areas. Because the design lacked requirements for technological parameters, the project ended up deploying only business-as-usual technologies that met the industry standard level of biogas generation instead of meeting a higher threshold for optimizing technological applications for enhanced energy conservation at affordable cost. Because the design did not raise the bar for technological specifications and require strict financial performance indicators, it led to the selection of subprojects in which many enterprise owners had limited capacity for research and development and low financial resilience against externalities or market failures.

6. The sovereign lending modality coupled with grant financing was appropriate given the financial and economic vulnerability of the livestock industry. This combination enabled the governments of Heilongjiang, Henan, Jiangxi and Shandong provinces to use low-interest loans to support livestock industries in poor rural areas, in particular in national and provincial poverty counties, where 43% of the subprojects were located. The local governments guaranteed the repayment of disbursed loan funds. In case of repayment default, the provincial governments agreed that the Ministry of Finance (MOF) would deduct the amounts from the public budgets of the county governments.

B. Project Outputs

7. The project had four outputs, among which outputs 1 and 2 constituted the major ones, with clear, quantifiable deliverables and performance targets.

8. **Output 1: sustainable development and demonstration of the commercial practices of MLBGPs.** The key performance targets at appraisal included (i) 118 MLBGPs perform to technical standards; (ii) up to 10 centralized biogas plants operate; (iii) about 80% of the energy source of each livestock farm or agro-enterprise is from a biogas plant; (iv) a methane capture device works about 95% of time when it is required; (v) and business models for centralized biogas plants are established. All these targets except the first were achieved at project completion. Only 65 completed MLBGPs performed to technical standards by the end of 2018. During project implementation, the design and monitoring framework (DMF) was changed through a minor change of project scope in October 2015, in which the target number of completed MLBGPs was reduced from 118 to 69, to be more realistic. The project thus fell slightly short of achieving that target. The results of analysis show that the original performance target was ambitious, and that almost half of the subprojects were not economically and financially viable in the face of external factors. No minimum requirement was set for the number of centralized biogas

[5] Smaller subprojects included in the initially selected core subprojects withdrew for various reasons. RAID analysis conducted on some of the smaller subprojects during loan processing indicated that they were financially and economically viable.

plants to be in operation; the corresponding performance indicator was "up to 10 centralized biogas plants operated." The project delivered six such plants without affecting the attainment of the target at project completion. The remaining performance targets in output 1 were all achieved.

9. **Output 2: Effective utilization of biogas sludge in eco-farming.** The key performance targets at appraisal included (i) a handbook on eco-farming and application of bio-fertilizers for agriculture projection is developed, (ii) about 85% of biogas plants supply sludge to nearby farms as organic fertilizer for fruit, vegetable, and crop production, and (iii) farmers using biogas sludge as fertilizer reduce the use of chemical fertilizers by about 50%. A total of 24,787 *mu*[6] of eco-farming were completed. The project enabled 100% of biogas plants to supply sludge to nearby farms as organic fertilizer. Farmers used more than 1.14 million cubic meters (m^3) of biogas slurry and 147,500 tons of biogas residue annually, reducing the use of chemical fertilizers and pesticides by more than 60%. The eco-farming handbook was developed in 2013. All the performance targets in output 2 were achieved.

10. **Output 3: Capacity development for improved sector performance.** The key performance targets at appraisal included (i) a handbook on operation and maintenance of MLBGPs developed, (ii) guidelines on the establishment of centralized biogas plants are finalized, (iii) four provincial technical service centers support biogas plants, (iv) about 320 technicians trained in the operation and maintenance of biogas plants, (v) a performance monitoring system for the design and operation of MLBGPs is prepared, and (vi) a business model for centralized biogas plants is established. All these targets were achieved; however, their actual policy and commercial impacts were limited.

11. **Output 4: Project implementation support.** The key performance targets at appraisal included (i) one project management office (PMO) and four project implementation offices (PIOs) staffed and operational during project implementation; (ii) adequate budgetary resources allocated annually; (iii) a project performance management system is set up and updated; and (iv) subprojects are prepared, reviewed, and approved in line with the review process. All the key performance targets were achieved. This component was mainly geared toward the daily implementation of the project and had limited value as an output.

C. Project Costs and Financing

12. At appraisal, the project cost was estimated at $152.5 million, consisting of an ADB loan of $66.08 million, a GEF grant of $9.2 million, a CEFPF grant of $3 million, a Deutsche Gesellschaft fur Technische Zusammenarbeit (GTZ) grant of $4.6 million, and domestic financing of $69.66 million. At project completion, the total project cost was $88.64 million.[7] ADB administered its loan and the two grants from the GEF and the CEFPF, totaling $57.75 million in foreign exchange (65.2%). Domestic financing was equivalent to $30.89 million in local currency (34.8%). The project cost underruns were mainly due to the reduced amount of civil works and goods for constructing the MLBGPs and centralized biogas plants. Henan, Jiangxi, and Heilongjiang provinces requested the cancellation of ADB loan proceeds of $6.02 million in August 2017 because of worsening market conditions for the livestock industry, which led to a high number of bankruptcies of subproject enterprises. The last round of cancellation was for $9.85 million, at loan account closing in January 2020. It resulted mainly from even steeper underspending on civil works and goods for constructing MLBGPs, exacerbated by uncontrollable

[6] A *mu* is a Chinese unit of measurement (1 *mu* = 666.67 square meters).

[7] The project implementation cost from the GTZ is not available from the executing or implementing agencies or from GTZ, so the project cost at completion does not include investment by GTZ.

factors on top of the economic downturn, such as the swine flu. The total amount cancelled accumulated to $15.87 million, about 24% of the approved ADB loan proceeds.

13. During implementation, ADB reallocated the loan to achieve better use of loan proceeds and to achieve the outcome performance targets. In August 2017, savings from reduced number of vehicles in Henan and Shandong provinces was reallocated to support the expansion of civil works and goods of MLBGPs and the eco-farming. This reallocation was essential not only for the financial sustainability of the construction and operation of MLBGPs but to generate additional income by expanding the eco-farming element. It also helped attain the outcome performance target for reducing GHG emissions through carbon absorption by the soil and the substitution of bio-fertilizers for chemical fertilizers.

D. Disbursements

14. ADB disbursed loan proceeds totaling $50.21 million and GEF and CEFPF grant proceeds totaling $6.17 million and $1.57 million. The loan and grant proceeds were disbursed in accordance with ADB's *Loan Disbursement Handbook* (2017, as amended from time to time). The loan and two grants were designed to have 14 imprest accounts: four denominated in US dollars for the loan, one for each participating province, and 10 for the CEFPF and GEF grants—one for the Ministry of Agriculture (MOA) and one for each participating province, for each grant. The statement of expenditures procedure was used to liquidate and replenish the imprest accounts and reimburse eligible expenditures not exceeding $100,000 in the case of the loan and $20,000 in the case of the grants, per individual payment from beneficiary enterprises to suppliers or contractors under civil works and goods contracts. During project implementation, 12 imprest accounts were opened. Heilongjiang could not open an imprest account for the CEFPF grant because of the small amount allocated ($13,000 maximum advance), which was lower than the grant's statement of expenditure ceiling of $20,000. Instead, direct payment under the grant was implemented for Heilongjiang to procure high-temperature flares and conduct capacity-building activities. ADB approved a minor change in the implementation arrangement on 9 November 2017 to transfer the imprest accounts of the GEF and the CEFPF from the MOF to the Foreign Economic and Cooperation Center (FECC) of the MOA. In accordance with local policy requirements for opening one general account and the agreed procedures approved in a memorandum dated 2 August 2012, the FECC opened one general account and maintained two separate ledgers.

15. The gaps between projected and actual disbursements for the loan and the grants were mainly caused by slower than expected project implementation and the drop-out of subprojects. The two grants were attached to the project loan, so the underspending and slow disbursement for the grants were caused by the dropouts and slower completion of the MLBGPs and centralized biogas plants. The civil works supported by the two grants, such as installation of high-temperature flares and connection to the grid, depended on the completion of the MLBGPs and plants. Rather than experiencing a high disbursement ratio in the first few years, as projected, the actual disbursement of the ADB loan increased gradually each year. Corrective actions included adding new subprojects, reallocating loan proceeds from dropped MLBGPs, terminating contracts to support the expansion of MLBGPs and eco-farming, and cancelling loan savings in a timely manner. After considering practical disbursement projections in the longer term, a scope change in October 2015 increased the ceiling for advances to the imprest account in Henan from $2.2 million to $5 million (equivalent to 22.7% of the total loan amount of Henan).[8] This helped expedite project disbursements and mitigated the low cash flow generation for some subprojects in Henan.

[8] Minor scope change to the project was approved in October 2015.

Each provincial finance department had different financial management approaches to and priorities in implementing the project that were based on local characteristics and policies.

E. Project Schedule

16. The project was approved on 16 April 2010. The loan was signed on 17 June 2010 and the two grant agreements on 30 June 2010. The loan became effective on 15 October 2010 and the grants on 27 October 2010. The original closing date for both the loan and the grants was 30 June 2016. The loan and the grants were extended twice, in October 2015 and August 2017 to accommodate slower than anticipated progress and achieve the project outputs and outcome. 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. The actual completion of the loan and grants was on 31 December 2018. The winding-up period was extended from the original date of 1 January 2019 to 30 April 2019, and then to 31 July 2019. The financial closing of the loan was completed on 21 January 2020. The balances of the two grants were all returned, and financial closing of the two grants was completed on 1 September 2020. The delays resulted from the provinces' capacity to submit their final liquidation and refund the outstanding balance under the loan and the grants.

F. Implementation Arrangements

17. The MOA was the executing agency (EA), and the departments of Agriculture of the four participating provinces were the implementing agencies (IAs). A PMO established in the MOA was responsible for overall project management, coordination, training, recruitment of consultants, and other implementation and monitoring activities, supported by the FECC. Each PIO was based in the Provincial Rural Energy Office or the Agricultural Foreign Capital Project Office within its provincial Department of Agriculture. Each PIO was responsible for conducting due diligence on (i) financial and economic viability, (ii) compliance of the technical design with relevant standards, (iii) safeguard compliance, and (iv) procurement plans and other implementation arrangements for subprojects. Each IA was responsible for supervising the PIOs and finance departments in the designated municipalities, districts, and counties in their selection and approval of the subloan applications, following the subproject review and approval process. In terms of adequacy to deliver project outputs and achieve the outcome, the design of the implementation arrangement was overly layered. It was very difficult to coordinate all four PIOs to submit a project scope change request, a reallocation, or a cancellation of loan proceeds in a coherent manner, and then report through the line of the provincial finance department to the MOF and/or through the PIO to the PMO. Often one province lagged and ended up delaying progress on the project and grant implementation. Some measures were undertaken to mitigate this cumbersome implementation procedure, such as increasing the ceiling of the imprest account and reallocation of budget categories. This was done province by province to avoid triggering changes in other provinces.

G. Technical Assistance

18. Project preparatory technical assistance (TA) was approved in 2007.[9] The project was designed on the basis of the results of the TA, reports of the government feasibility study, findings of ADB missions, and discussions with government officials and stakeholders. The TA provided all the inputs needed to prepare the project for ADB financing. To determine the project's scope

[9] ADB. 2007. *Technical Assistance to the People's Republic of China for Preparing the Integrated Renewable Biomass Energy Development Project.* Manila.

and implementation arrangements, stakeholders were consulted during planning, design, and implementation.

H. Consultant Recruitment and Procurement

19. The packages awarded under the loan included 105 national competitive bidding (NCB), 61 shopping, and 17 force account packages. Under the GEF grant, one consulting firm and seven individual consultants were recruited. Under the CEFPF grant, 5 firms and 18 individual consultants were recruited to conduct research, supervision, and technical monitoring work for centralized biogas systems, high-temperature flares, eco-farming, grid connections, and special studies.

20. It was noteworthy that the project implemented a change of procurement methods to make consulting packages more practical for the implementation of both grants. Under the CEFPF grant, the original contract value of the seven consulting services packages averaged $30,000; therefore, for economy and efficiency, the consulting services selection method was changed from quality and cost-based selection (QCBS) to individual consultant selection (ICS). Similarly, under the GEF grant, the original consulting service package of $631,000 was split into up to 17 packages for monitoring and evaluation for each province, ranging from $50,000 to $90,000. Consequently, the selection method was changed from QCBS to a combination of consultants' qualification selection (CQS) and ICS. During implementation, special studies and surveys under the GEF grant were designed as shopping packages but should have been designed as consulting service packages. To ensure quality control, the original allocation of eight shopping packages with a total value of $400,000 was changed to four ICS packages and one CQS package.

21. The GEF grant also funded the grid connection of the MLBGPs. The original procurement was designed as NCB for a turnkey project with a total value of $3,697,000. During implementation, for reasons of stability and security, only the grid company's design and construction agencies could engage in grid connection engineering work. Therefore, the procurement method was changed to direct contracting through rounds of internal review. At project completion, 11 direct contracts had been awarded for grid connection. This change of procurement method enabled the project to complete the most challenging task, which was the grid connection of the centralized biogas plants and MLBGPs.

22. All the changes to procurement methods were complicated and came under scrutiny, in particular the change from QCBS to ICS, correcting the shopping packages to consulting service packages, and changing NCB turnkey to direct contracting. Before handling the minor change in procurement and selection methods, there was a gap in organizing rounds of internal and external consultations on these procurement-related issues. The scope change, approved in March 2014, made it possible to catch up with the contract awards projections and ensure that the construction progress of the loan and the two grants was integrated.

23. During implementation, ADB's PRC Resident Mission found inconsistencies in the bidding documents for the NCB turnkey method used by Henan, Jiangxi, and Shandong provinces for the loan and the GEF grant. The final documents inadvertently did not incorporate comments from ADB, which resulted in errors in the instructions to bidders. It was therefore agreed among the ADB, the EA, and IAs that Henan and Jiangxi provinces would use the new NCB standard bidding documents for civil works for any NCB turnkey packages that included both goods and civil works, and for NCB goods, effective 29 May 2013. It was agreed among the ADB, the EA and IAs that Shandong Province could use the bidding documents approved by ADB for its ongoing and

subsequent NCB turnkey packages. During project implementation, relevant sections of the ADB Anticorruption Policy were incorporated into the bidding documents for procurement of goods and works. The PMO and four PIOs met as needed with supervision offices at the county level to discuss issues related to the project.

I. Gender Equity

24. The project had no gender action plan. The project design intended to involve women to participate more in training workshops to raise awareness of environmental protection and health issues. The social and economic monitoring aspect of the project focused on gender-disaggregated data, such as women's employment, training, and increases in income, and their access to clean energy.

J. Safeguards

25. The project was classified as environment category B, in accordance with the ADB environmental categorization. At appraisal, a summary initial environmental examination (IEE) covering all outputs was developed on the basis of a draft domestic environment impact assessment (EIA) for six core subprojects, in accordance with ADB's Environment Policy (2002) and Environmental Assessment Guidelines (2003). The summary IEE included an environmental assessment and management framework to ensure that the subprojects would comply fully with ADB's environmental requirements. It was uploaded to the ADB website in December 2008. ADB reviewed and approved the IEE for the first noncore subproject in each province before the implementation of the selected subproject. ADB also reviewed the domestic EIAs of subsequent noncore subprojects in accordance with the requirement in the Environmental Assessment and Review Framework, and the provincial Environmental Protection Bureaus (EPBs) approved them, following the PRC's EIA Law of 2003 and relevant regulations. A total of 24 IEEs were uploaded to the ADB website after domestic approval and review, and clearance by ADB, in accordance with the PRC's Environmental Protection Law and Environmental Management Guidelines for Construction Projects. A total of 46 subprojects (2 in Heilongjiang, 3 in Henan, 35 in Jiangxi, and 6 in Shandong) had passed their domestic environment completion acceptance audit by August 2019. The rest were completed by June 2020.

26. The EA and the four provincial IAs carried out adequate environmental mitigation measures and monitoring programs, as stipulated in the environmental management plan during the construction and operation period, and ensured that adverse environmental impacts of the project were minimized. The IAs were responsible for (i) developing relevant requirements of the environmental management plan that were included in the designs and bidding documents, (ii) supervising implementation of mitigation measures during construction and operation, and (iii) coordinating external environment monitoring. The IAs or the subproject operators were responsible for implementing mitigation measures during the operation of the centralized biogas plants and MLBGPs. The environmental management of the project and implementation of these responsibilities were satisfactory. The environmental monitoring results complied with relevant international and national standards, and only minor impacts were observed during construction and operation. During field visits, such impacts were confirmed to be contained locally and only temporary. None of the subprojects reported any significant negative environmental impact or noncompliance with the safeguards documents. No complaints were received. Each provincial EPB conducted an audit of the environmental protection facilities upon completion of construction and issued the approval certificate accordingly.

27. Substantial positive environmental benefits were observed across the subprojects through the development of biogas as a renewable energy source and the sustainable management of agro-processing waste. The quantifiable environmental benefits include (i) the provision to farming households of biogas as a clean energy source; (ii) the attainment of reduced methane emissions from livestock and agro-processing waste; and (iii) the reduction of the use of agrochemicals through the production of organic fertilizer in the form of biogas slurry and sludge. Under the project, subprojects treated about 4.87 million tons of livestock and agro-processing waste and produced about 126.41 million m^3 of biogas annually, which was used instead of fossil fuel or firewood for cooking, heating, and electricity supply. The subprojects also produced about 1.15 million tons of organic fertilizer for eco-farming each year to help sequester carbon in the soil humus and improve soil fertility. The project is estimated to reduce 1.72 million tons carbon dioxide (CO_2) equivalent of GHGs each year by reducing methane emissions from livestock farming and replacing fossil fuel.

28. The project was classified as category C for involuntary resettlement and indigenous peoples safeguards. All subprojects were located within land owned by the livestock businesses or agro-enterprises. No land acquisition or resettlement were required. No subproject was located in an area of ethnic minorities.

K. Monitoring and Reporting

29. The project complied with the majority of the loan covenants and the two grant agreements, except for a minor deviation on the annual sales requirement for pigs. The sector project could not meet the requirement for sales of 3,000 pigs per subproject because of the serious effect of the swine flu, restrictions on land for pig farming, and subproject dropouts and bankruptcies; however, the annual sales volume averaged above 10,000 per subproject in three provinces (Henan, Jiangxi, and Shandong).[10] Therefore, the total local investment in pigs reached about 35%, falling slightly short of the 40% planned (Project Agreement, Schedule, para 18, Appendix 10).

30. For the monitoring and reporting arrangements, the PMO and the PIOs made timely submissions of quarterly and annual progress reports, environmental monitoring reports, and audit reports. A project performance monitoring system was established to monitor, measure, and assess implementation progress against the agreed time-bound indicators, as well as the risks and assumptions specified in the DMF for project activities, outputs, outcome, and impact. The project performance monitoring system incorporated the submission of progress reports and provided sufficient information and data for measuring project progress, covering socioeconomic, social, gender, and sector development, in accordance with the DMF.

31. The PMO and the four PIOs submitted audited project accounts and financial statements to ADB in a timely manner, as required in the loan and grant agreements. The workflow and timeliness of financial management were satisfactory. However, uncontrollable factors such as subproject enterprises' legal disputes at court over shareholder structure and unresolved debt issues resulted in the issuance of a qualified opinion for the Shandong Dadi subproject for fiscal year (FY) 2015 and Tengzhou Kunda subproject for FY 2016. Shandong province continuously received a qualified opinion for the audited project financial statement for FY 2017, 2018 and 2019 due to the above mentioned issues caused by Shandong Dadi and Tengzhou Kunda.. The Shandong Dadi and Tengzhou Kunda enterprises ceased operations, and three completed projects failed to be put into use. The completed works and equipment procured under the two

[10] Heiongjiang Province was not counted as it had only one subproject at project completion.

companies were abandoned, involving ADB funds of $2.6 million and grant funds of $0.04 million. The relevant local governments and the Shandong Provincial Department of Finance agreed to terminate the subprojects and shoulder the repayment obligation on behalf of the subproject enterprises.

III. EVALUATION OF PERFORMANCE

A. Relevance

32. Overall, the project is rated as *relevant.* The project is aligned with the government's priorities 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. The project was also consistent with ADB's core area of operation on climate change in ADB's long-term strategic framework 2008–2020 (Strategy 2020).[11] The two grants associated with the sovereign loan buffered financial difficulties and mitigated policy complexity to enable on-grid connection of the centralized biogas plants and MLBGPs in some provinces.[12] Installation of special equipment such as the high-temperature flares to capture methane, supported by grant financing, improved the social and environmental impact.[13]

33. The design of the four outputs could have been better balanced. Output 1 and 2 should have played a more enhancing role in the DMF, such as establishing quantifiable indicators to measure the number of grid connections for centralized biogas plants and MLBGPs, the level of the feed-in tariff and degree of energy conservation, the minimum number of provinces for achieving on-grid connection, and the total required area of eco-farming. The design of outputs 3 and 4 as capacity development outputs was weak. The published handbook, guidelines, and business models for MLBGPs or centralized biogas plants of output 3 served the purpose of implementing the project but lacked technical parameters to optimize the use of biogas as renewable energy. No technical requirements existed for pilot-testing or adopting cutting-edge biogas technologies for scaling up heating and cooling and utility supply. All the key performance indicators designed for output 4 merely supported routine project implementation and therefore had limited value as key performance indicators. To create better synergy between outputs 1 and 2, a separate output should have been created to capture the recycling nature of the circular economy model by combining (i) the conversion of livestock waste to renewable biogas energy, (ii) the substitution of fossil fuel with biogas as a renewable energy supply, and (iii) the use of biogas slurry and sludge as organic fertilizers in the expansion of eco-farming. The minor scope changes carried out in 2015 and 2017 aimed, to the extent possible, to incorporate the essence of the circular economy by expanding eco-farming to generate better economic and financial returns to the subproject enterprises and by enhancing carbon absorption through eco-farming, taking into consideration measures to adapt to climate change. The breakthrough achievements made by this eco-farming expansion include the conversion of saline and alkaline land to arable land through soil enrichment practices by the Taiyu subproject in Shandong. The project as a whole demonstrated best practices such as the sale of electricity to the grid by the Wannianxinxing subproject in Jiangxi and the business model for biogas utility supply and the use of organic fertilizers. These can be replicated across all the provinces in the PRC.

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

[12] The GEF grant supported the financing of grid connection.

[13] The CEFPF grant helped finance the installation of high-temperature flares in the biogas plants.

B. Effectiveness

34. The project is *effective* as it achieved its expected outcome of "improved efficiency of rural biomass renewable energy system and rural social benefits." All four outputs were substantially delivered, including the sustainable development and demonstration of the commercial practices of the MBLGPs, the effective use of biogas sludge in eco-farming, capacity development, and project implementation support.

35. It is noteworthy that the project had no biomass element and instead focused solely on biogas as a renewable energy source. It appears that "biomass" was a typographical error at the design stage and in the project title. Two original key performance targets for outcomes were modified: (i) the annual production for rural energy use was reduced from "about 70 million m^3" of biogas to "about 55 million m^3," and (ii) GHG emission reductions were reduced from "about 1 million tons of carbon dioxide equivalent" to "about 770,000 tons of carbon dioxide equivalent" through the project scope change approved in 2015. This adjustment was based on the EA's determination that these targets had been miscalculated at the project design stage. The formula for calculating biogas production per year and GHG emissions reductions should have been based on the 113 subprojects approved instead of the 119 subprojects identified during the loan negotiation. At project completion, all key performance targets for outcomes were achieved. It is particularly worth highlighting that both the biogas production and the GHG emissions reduction achieved were double the original approved performance targets for outcomes for 2019.

36. The two original key performance targets for output 1 were ambitious. Instead of "118 MLBGPs perform to technical standards by 2014", this indicator was lowered to "69 MLBGPs perform to technical standards by 2018" through the minor scope change approved in 2017. At project completion, 65 MLBGPs were operating. Instead of "up 10 centralized biogas plants operated effectively by 2015", 6 plants were operating. All other key performance targets in outputs 2, 3, and 4 were achieved.

C. Efficiency

37. The project is rated *efficient*, taking into account the following factors: (i) replacement of fossil fuel with renewable biogas energy in rural areas; (ii) reduction of methane gas generated from the animal waste of livestock farms; and (iii) promotion of eco-farming systems and practices, which were identified as part of the economic benefits at project appraisal. It was noted that biogas generated amounted to about 126.41 million m^3, the methane captured from high-temperature flares amounted to about 3.06 million tons of CO_2 equivalent, and the organic fertilizers used reached about 1.15 million tons annually through eco-farming. The project's overall economic rates of return (EIRRs) ranged from 11.5% to 24.1% at project completion – close to the appraisal estimates, which ranged from 12.2% to 23.6%. The EIRRs for all subprojects were higher than the opportunity cost of capital, indicating their economic viability. The project was implemented on time, but the completion of the project and the GEF and CEFPF grants were delayed by two and half years.

D. Sustainability

38. The project can be rated as *likely sustainable* if both operational and financial sustainability, and environmental and social sustainability are taken into consideration. The financial reevaluation was conducted for each representative subproject using the estimation of cash flow over the project life; the weighted average cost of capital (WACC); the project financial viability based on the financial internal rate of return (FIRR) and the WACC; and sensitivity

analysis. The FIRRs of the representative subprojects ranged from 1.1% to 17.1% at project completion, in comparison with the estimated range of 6% to 11.9% at appraisal. Except for the Lihai subproject in Shandong, all other representative subprojects had FIRRs exceeding their respective WACCs, indicating their financial viability (Table A8.1, Appendix 8).

39. The sensitivity analysis assessed the impact of increased operations and maintenance and reduced benefits from these economic and financial perspectives. The 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.

40. The environmental sustainability of the project is significant. Despite the dropout of subprojects by almost half at project completion and the associated reduction in biogas energy generated, the project still attained all its key performance indicators for its outcome. It is worth highlighting that the annual reduction in GHG emissions exceeded the original target by more than 2.2 times.

E. Development Impact

41. The project had a *satisfactory* development impact, particularly on income generation and on social and environmental aspects. The project benefited poor farmers by creating new jobs, including construction and operation of centralized biogas plants and MLBGPs, and by expanding eco-farming and sales of organic fertilizer. During project construction, 3,069 local workers were employed, including 1,519 female workers (49.5%) and 375 workers from poor households (12.2%). A total of CNY99.54 million was paid for the wages of 535,456 person-days services, among which 255,235 person-days were attributed to female workers, accounting for 47.7% of the total. On average, each worker earned CNY32,562 through his or her engagement in project construction. A total of 1,450 workers were recruited for the operations and maintenance of the biogas plants and MLBGPs, among which 805 were women, accounting for 55.5% of the staff. Salaries ranged from CNY1,500 to CNY3,500 per month. Through the eco-farming expansion, 1.48 million tons of biogas slurry manure were used for producing organic fertilizer on 97,672 *mu* of farmlands annually. This benefited 16,047 rural households in 281 villages, reducing chemical fertilizer expenditures and raising the sale prices of their agricultural products.

42. In terms of environmental benefits, the project demonstrated a genuine model of a recycling economy. In terms of climate change mitigation and adaptation, the value addition includes reducing a significant volume of CO_2 by replacing coal consumption and by absorbing carbon (see the outcome performance indicators in the DMF, Appendix 1). The expanded eco-farming also enabled the conversion of barren land to arable eco-farming land through the Taiyu subproject in Shandong, not to mention other benefits derived through the use of renewable biogas for generating electricity and the use of organic fertilizer in enriching soil and producing crops. Health benefits include improved air quality through less reliance on burning coal for electricity supply and a safer food supply chain for crops. The project also promoted community awareness of environmental protection, air pollution reduction and public health protection measures, which benefited local people including poor households and female workers. The project achieved the impacts of improved rural environmental management and improved access to biogas energy. The project also met the key performance indicators for these impacts, such as “performance monitoring mechanism of biogas plants is adopted by the government” and “business model of centralized biogas plant are established in other livestock farms or ago-enterprises.”

F. Performance of the Borrower and the Executing Agency

43. The overall performance of the borrower, the EA and the four IAs can be considered *satisfactory.* They fulfilled their obligations in the loan agreement, the project agreement, and the two grant agreements. The MOF fulfilled its responsibilities, including submitting official requests to ADB for project scope changes and extensions of the loan and the two grants. Although no major deviations from the loan covenants occurred, gaps did exist in the level of commitment and capacity among the PIOs, representing the IAs, and the PMO, representing the EA. The IAs in Jiangxi and Shandong provinces demonstrated strong leadership and were persistent in overcoming many rounds of technical hurdles and external risk factors to use loan proceeds and grants efficiently. They actively promoted or proposed innovative solutions to resolve the stagnated or slow implementation of the project. For example, the Jiangxi PIO worked closely with the subproject enterprises to lobby the local energy bureau and the local grid company in negotiating subsidies and the feed-in tariff to enable on-grid connection of the MLBGPs. Jiangxi become the first province to achieve sales of electricity back to the grid through use of biogas. The Shandong PIO was the first to recognize the constraint of this project and to try to revise and diversify the technological aspect of biogas use from “biogas to electricity” to “biogas to natural gas,” as well as “biogas purification of organic fertilizer,” aiming for significantly higher economic returns. The PMO played only a moderate role in demonstrating leadership and ownership of the project.

G. Performance of the Asian Development Bank

44. ADB’s performance is rated *satisfactory.* The project preparation and design were intended to deliver an ambitious impact, to reduce rural environmental pollution and improve rural ecological livelihood by turning livestock waste into convertible resources, so ADB aimed to include six provinces. Before the loan effectiveness date, the six provinces were reduced to four to be pragmatic in geographic coverage and reflect the prominent characteristics of the regional differences between the north and the south of the country. ADB’s PRC Resident Mission provided timely support to correct and streamline issues related to procurement packages for the loan and two grants, in accelerating contract awards and disbursements after project delegation. Amid the worsening livestock market, ADB cancelled loan savings and extended the loan and grants in a timely manner to ensure the achievement of key performance indicators for the outcome. To improve the low investment returns of the project, ADB made a timely scope change and expanded the coverage of eco-farming in Henan, Shandong, and Jiangxi provinces. Through these measures, ADB maintained the ratio of cancellation of loan proceeds at less than one-third of the original loan amount by project completion. ADB also worked closely with the Shandong PIO to include new subprojects that could offer technical breakthroughs, such as the “biogas to organic fertilizer” purification technology, as they fit within the scope of output 2. It was unfortunate that after the scope change approval for the inclusion of this subproject, the enterprise owner decided to withdraw because of its urgent need for an initial public offering. ADB also worked very closely with the secretariats of the GEF and the CEFPF to obtain their endorsement of the grant extensions and actively disseminated the best practices of the GEF-sponsored on-grid connection experiences in Jiangxi through internal and external media channels.

H. Overall Assessment

45. Overall, the project is considered *successful*. It was highly relevant to the government’s development strategy, ADB’s country partnership strategy, and thematic priorities, both at appraisal and at completion. It was effective, as it attained the anticipated outcome and all four outputs except for one key performance indicator of output 1 that fell slightly below the level

targeted. The project demonstrated a resource-recycling model through three models: livestock waste to biogas, biogas to commodities, and biogas ancillary commodities to improved ecological well-being. The most crucial achievement was connecting the MLBGPs to the grid, led by Jiangxi province and then Henan and Shandong provinces. Most important, one subproject (Wannianxinxing) that was entirely privately owned delivered the grid connection of its MLBGPs and sold intermittent biogas-based power to the local grid through strong coordination with concerned local governments. This significant deliverable, with the support of the Jiangxi PMO, is the key achievement of the sector project and represents a breakthrough for the livestock industry in rural areas in all four provinces. It also encouraged other privately owned enterprises to spin up their efforts to replicate this successful model.

Overall Ratings

Criteria	Rating
Relevance	Relevant
Effectiveness	Effective
Efficiency	Efficient
Sustainability	Likely Sustainable
Overall Assessment	Successful
Development impact	Satisfactory
Borrower and executing agency	Satisfactory
Performance of the Asian Development Bank	Satisfactory

Source: Asian Development Bank.

IV. ISSUES, LESSONS, AND RECOMMENDATIONS

A. Issues and Lessons

46. The implementation arrangement for the project was complicated. It particularly affected project progress when minor scope changes were needed, as four provinces had to be coordinated, as well as the secretariats of the GEF and the CEFPF on issues concerning the two grants. The government's divisional counterparts for the ADB loan, the GEF grant, and the CEFPF grant were also different, and a lengthy coordination procedure was required for each change to the project or the grants.

47. In terms of primary counterpart selection for project implementation in biogas use, the National Energy Administration should have had a leading role. It possesses the technological know-how on biogas use in rural areas to guide and demonstrate policy commitment to achieving the renewable energy targets at both county and provincial levels. Without that support, the driving force was very limited in three efforts: (i) to enable the grid connection of MLBGPs or centralized biogas plants, (ii) to establish advanced and stringent technological parameters for enhancing the conversion ratio of biogas generation capacity, and (iii) to diversify the scope of biogas use for both electricity and natural gas. This lack of technological know-how also resulted in the establishment in Heilongjiang of biogas power plants that could not operate in winter, when the outside temperature drops to –10 to –30 degrees Celsius, as the design of the biogas digesters failed to be resilient to extreme cold. Other issues such as a lack of staffing resources and frequent changes of personnel were apparent in Henan, where the PIO was still significantly understaffed during the project completion review.

48. Due diligence on project procurement should be improved to ensure that contract packaging, contracting methods, and standard bidding documents are defined to suit the needs and capacities of the EA and IAs, to avoid changes and noncompliance during implementation.

B. Recommendations

1. General

49. The use of biogas in rural areas of the PRC can deliver a circular economy model with high value addition to advance ecological well-being and contribute to global efforts in tackling climate change. To ensure the attainment of these ends, agriculture and livestock projects that incorporate biogas as renewable energy should consider the following lessons:

(i) A ministry with a strong commitment and binding political and policy targets should lead the project design and implementation.

(ii) Stringent technical parameters should be established for anaerobic digestion capacity, biogas power generation capacity (both electricity and natural gas), and grid connection (if applicable).

(iii) To hedge against external shocks and maintain robust cash flows, the selection of subprojects should focus on enterprises with diversified operations, such as livestock in combination with cold chain, crop or grain processing, or organic fertilizer purification.

(iv) The selection of subprojects should focus on the southern region of the PRC because of its stronger policy coordination and financial capacities and its warmer climatic conditions. Based on the successful implementation in the southern region, then select one or two central or northern provinces to follow the implementation experiences and adopt to the local circumstances.

(v) The special achievement by the Wannianxinxing subproject in Jiangxi Province, the only successful case of on-grid connection and sale of electricity to the grid as a private enterprise, should be thoroughly analyzed and its lessons disseminated as best practices.

2. Project Related

50. **Future monitoring.** The executing agency and the implementing agencies should monitor the outcome-level key indicators for Q42019– 2021 and report to ADB. The Shandong PIO should monitor any technical achievement the Lihai subproject can make for an alternative technological solution for biogas use, such as biogas to natural gas, and should help coordinate a gas purchase agreement between the enterprise and potential buyers. Any such solution could prove to be another business modality, which other industry players in the livestock or renewable industry could consider in supporting the development of rural clean energy.

51. **Covenants.** The loan covenants were monitored annually (Appendix 10). They state that “a subproject shall meet general quantitative feedstock requirements” related to pigs, broilers, beef cattle, and dairy cattle. This covenant should be changed or waived because of the many uncontrollable factors in the livestock industry, especially epidemics of diseases such as swine fever, bird flu, and mad cow disease. To be more rational and risk adverse, this covenant could instead state that “subprojects in each province shall on average meet the targets of” those feedstock requirements.

52. **Further action or follow-up**. The Jiangxi, Henan, and Shandong PIOs should continue to follow up with and offer intergovernmental coordination support for subproject owners that are concerned about obtaining the subsidies for the feed-in tariff. These enterprises include Taihua and Wannianxinxing in Jiangxi, Beixu in Henan, and Lihai in Shandong. It is important that the Jiangxi PIO follow up on the electricity sales and subsidy agreements for the Fengyuan, Likang, Xinglong and Lulin subproject enterprises in consultation with the local grid company, provincial Development and Reform Commission, and local energy bureau, so that more enterprises can follow the successful pathway of Wannianxinxing.

53. **Timing of the project performance evaluation report**. The project performance evaluation report may be prepared in 2022 or later, when the situation of the swine flu and corona virus disease (COVID-19) are under control in the PRC and the subproject enterprises have accumulated more feedstock for biogas production, so that the operations of MLBGPs and centralized biogas plants become more sustainable.

DESIGN AND MONITORING FRAMEWORK

Design Summary	Performance Indicators and Targets	Project Achievements
Impact Improved rural environmental management and access to biogas energy	By 2020, About 10,000 large-scale biogas plants on livestock farms are constructed and operated efficiently. Performance monitoring mechanism for biogas plants is adopted by the government. Business models of centralized biogas plant are replicated in other livestock farms or agro-enterprises.	By 2020, More than 10,000 large-scale biogas plants on livestock farms were constructed and operated efficiently. Performance monitoring mechanism for biogas plants was adopted by the government. Business models of centralized biogas plant were replicated in other livestock farms or agro-enterprises.
Outcome Improved efficiency of rural biomass renewable energy system and rural social benefits	By 2019, About 90% of the waste of subproject farms is collected and treated via the project biogas plants. About 55 million cubic meters[a] of biogas are produced per year for rural energy use. About 41,000 households, including 8,200 poor households, benefit from improved access to clean energy. About 27,000 farmers increase their incomes through expanded contract farming About 9,000 poor households benefit from the use of organic fertilizers and the sales of organic products Greenhouse gas emissions reduced by about 770,000 tons of carbon dioxide equivalent.[b]	By 2019, More than 90% of the waste of subproject farms was collected and treated via the project biogas plants. More than 100 million cubic meters of biogas were produced per year for rural energy use. About 41,000 households, including 9,200 poor households, benefited from improved access to clean energy. More than 27,000 farmers increased their incomes through expanded contract farming. (male/female ratio: 3.6:1.4; each household has about 4 people on average in the four provinces). More than 10,000 poor households benefited from the use of organic fertilizers and the sales of organic products. (male/female ration: 3:2; each household has about 4 people on average in the four provinces). Greenhouse gas emissions was reduced by about 1.72 million tons of carbon dioxide equivalent annually.
Outputs **Output 1:** Sustainable development and demonstration of commercial practices of MLBGPs	8 MLBGPs constructed by 2012 52 MLBGPs constructed by 2015 69 MLBGPs constructed by 2018 69 MLBGPs perform to technical standards and fully monitored by 2018 Up to 10 centralized biogas plants operated effectively by 2018	A total of 65 MLBGPs were constructed by 2018. 65 MLBGPs performed to technical stands and fully monitored by2018. 6 centralized biogas plants operated effectively by 2018.

Design Summary	Performance Indicators and Targets	Project Achievements
	About 80% of energy source of each livestock farm or agro-enterprise is from the biogas plant by 2018 Methane capture device worked about 95% of time when it was required in plants equipped with the device by 2017. Business models for centralized biogas plants are established by 2018.	More than 90% of energy source of each livestock farm or agro-enterprise was from the biogas plant by 2018. 62 methane capture devices were installed and worked about 95% of time when in operations by 2017. Business models for centralized biogas plants were established by 2018.
Output 2: Effective utilization of biogas sludge in eco-farming	A handbook on eco-farming and application of bio-fertilizers for agricultural production is developed by 2013. About 85% of biogas plants supply sludge to nearby farms as organic fertilizer for fruit, vegetable, and crop production by 2017. Farmers using biogas sludge as fertilizer reduce the use of chemical fertilizers by about 50% by 2017.	The handbook on eco-farming and application of bio-fertilizers for agricultural production was completed of development by 2013. 61 out of the 65 MLBGPs (94%) supplied sludge to nearby farms as organic fertilizer for fruit, vegetable, and crop production by 2017. All the MLBGPs (100%) supplied sludge to nearby farms by 2018. Farmers using biogas sludge as fertilizer reduced the use of chemical fertilizers for 190,000 tons, more than 50% annually.
Output 3: Capacity development for improved sector performance	A handbook on operation and maintenance of MLBGPs is developed by 2013. Guidelines on the establishment of centralized biogas plants are finalized by 2013. Four provincial technical service centers supported biogas plants as required by 2018. About 320 technicians were trained in the operation and maintenance of biogas plants by 2012. A performance monitoring system for the design and operation of MLBGPs is prepared by 2014. Business models for centralized biogas plants were established by 2018.	The handbook on operation and maintenance of MLGBPs was developed in 2018. Guidelines on the establishment of centralized biogas plants were finalized by 2014. Four provincial technical service centers supported biogas plants were established by 2015. More than 320 technicians were trained in the operation and maintenance of biogas plants by 2016. The performance monitoring system for the design and operation of MLBGPs was prepared by 2014. Business models for centralized biogas plants were established by 2017.

Design Summary	Performance Indicators and Targets	Project Achievements
Output 4:		
Project implementation support	One PMO with five staff and four PIOs with 7–10 staff are established in 2010 and are operational during project implementation.	PMO with five staff and four PIOs with seven staff were established in 2010 and operational during project implementation.
	Adequate budgetary resources are allocated annually.	Domestic funds were provided according to the project implementation progress.
	Project performance management system is set up by 2011 and updated yearly.	The project performance management system was set up in 2012 and updated yearly.
	Subprojects are prepared, reviewed, and approved in line with the review process.	Subprojects were prepared, reviewed, and approved in line with the review process.

[a] Original performance indicator was about 77 million cubic meters. This was reduced to about 55 million cubic meters (please see the reason on the adjustment in para 36).

[b] Original performance target was about 1 million tons of carbon dioxide equivalent. This was reduced to about 770,000 tons of carbon dioxide equivalent (please see the reason on the adjustment in para 36).

Source: Asian Development Bank and the Project Management Office.

PROJECT COST AT APPRAISAL AND ACTUAL

($ million)

Item	At Appraisal			At Completion		
	Foreign Exchange	Local Currency	Total Cost	Foreign Exchange	Local Currency	Total Cost
A. Investment Costs						
1. Civil Works						
a. Civil Works for Biodigesters	10.0	27.9	37.9	22.3	5.6	27.9
b. Civil Works for Eco-farming	1.5	4.5	6.0	4.3	1.1	5.4
Subtotal (1)	**11.5**	**32.4**	**43.9**	**26.6**	**6.7**	**33.3**
2. Equipment and Materials						
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. Muti-Donor CEF[a]-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
Subtotal (2b)	0.9	2.0	2.8	1.2	0.0	1.2
Subtotal (2)	**28.2**	**34.9**	**63.1**	**22.4**	**0.0**	**22.4**
3.GEF-Supported Centralized Biogas Plants	**2.6**	**4.0**	**6.6**	**4.2**	**4.2**	**8.4**
4. Vehicles	**0.8**	**1.0**	**1.9**	**0.1**	**0.0**	**0.1**
5. Capacity Development						
a. GEF[b]-Supported Capacity Development						
i. Workshops	0.1	0.9	1.0	0.5	0.0	0.5
ii. International Study Tours	0.1	0.2	0.3	0.0	0.0	0.0
Subtotal (5a)	0.2	1.1	1.3	0.5	0.0	0.5
b. GTZ-Supported Capacity Development						
i. Training	0.0	0.4	0.4	0.0	0.0	0.0
ii. Local Study Tours	0.0	0.2	0.2	0.0	0.0	0.0
iii. International Study Tours	0.0	0.1	0.1	0.0	0.0	0.0
Subtotal (5b)	0.0	0.7	0.7	0.0	0.0	0.0
c. Muti-Donor CEF-Supported Capacity Development	0.5	0.7	1.2	0.1	0.0	0.1
Subtotal (5)	**0.8**	**2.4**	**3.2**	**0.6**	**0.0**	**0.6**
6. Consulting Services						
a. GEF-Supported Consulting Services						
i. International Consultant	0.3	0.3	0.6	0.0	0.0	0.0
ii. National Consultants	0.0	0.6	0.6	1.3	0.0	1.3
Subtotal (6a)	**0.3**	**0.9**	**1.2**	**1.3**	**0.0**	**1.3**

Item	At Appraisal			At Completion		
	Foreign Exchange	Local Currency	Total Cost	Foreign Exchange	Local Currency	Total Cost
b. GTZ-Supported Consulting Services						
i. International Consultant	2.5	0.3	2.8	0.0	0.0	0.0
ii. National Consultants	0.0	1.3	1.3	0.0	0.0	0.0
Subtotal (6b)	2.5	1.6	4.1	0.0	0.0	0.0
c. Muti-Donor CEF-Supported Consulting Services	0.0	0.0	0.0	0.4	0.0	0.4
Subtotal (6)	**2.8**	**2.5**	**5.3**	**1.7**	**0.0**	**1.7**
7. Survey, Design and Supervision	**1.7**	**7.5**	**9.2**	**0.0**	**15.6**	**15.6**
8. Survey, Design and Supervision (Centralized Biogas Plants, GEF)	**0.1**	**0.2**	**0.3**	**0.0**	**0.0**	**0.0**
Total Base Costs	**48.6**	**84.8**	**133.4**	**55.5**	**26.5**	**82.0**
Contingencies	**5.0**	**6.1**	**11.1**	**0.0**	**4.4**	**4.4**
Subtotal (A)	**53.6**	**91.0**	**144.5**	**55.5**	**30.9**	**86.4**
B. Financing Charges during Implementation	**8.0**	**0.0**	**8.0**	**2.3**	**0.0**	**2.3**
Total Project Cost (A+B)	**61.5**	**91.0**	**152.5**	**57.8**	**30.9**	**88.7**

Note: Numbers may not sum precisely because of rounding.

[a] Clean Energy Financing Partnership Facility. Financing partners: the governments of Australia, Norway, Spain, Sweden, and the United Kingdom. Administered by the Asian Development Bank.

[b] Financed on a grant basis by the Global Environment Facility and administered by the Asian Development Bank.

Source: Asian Development Bank and the Project Management Office.

PROJECT COST BY FINANCIER

Table A3.1: Project Cost at Appraisal by Financier

($ million)

Item	ADB		Government		GEF		GTZ		Multi-Donor CEF under CEFPF		Livestock Farms and Agro-enterprises		Total
	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount
A. Investment Costs													
1 Civil Works													
a. Civil Works for Biodigesters	19.2	50.7	5.4	14.2	0.0	0.0	0.0	0.0	0.0	0.0	13.3	35.1	37.9
b. Civil Works for Eco-farming	3.7	61.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	38.3	6.0
Subtotal (1)	**22.9**	**52.2**	**5.4**	**12.2**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**15.6**	**35.6**	**43.9**
2 Equipment and Materials													
a. Goods and Materials	33.9	56.2	3.4	5.7	0.0	0.0	0.0	0.0	0.0	0.0	23.0	38.1	60.3
b. Equipment													
i. Government-Supported Equipment	0.0	0.0	1.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
ii. Multi-Donor CEF[a]-Supported Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	100.0	0.0	0.0	1.8
Equipment	0.0	0.0	1.0	35.7	0.0	0.0	0.0	0.0	1.8	64.3	0.0	0.0	2.8
Subtotal (2)	**33.9**	**53.7**	**4.4**	**7.0**	**0.0**	**0.0**	**0.0**	**0.0**	**1.8**	**2.9**	**23.0**	**36.4**	**63.1**
3 GEF[b]-Supported Centralized Biogas Plants	**0.0**	**0.0**	**0.0**	**0.0**	**6.6**	**100.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**6.6**
4 Vehicles	**1.4**	**73.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.5**	**27.0**	**1.9**
5 Capacity Development													
a. GEF-Supported Capacity Development													
i. Workshops	0.0	0.0	0.0	0.0	1.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0

Item	ADB		Government		GEF		GTZ		Multi-Donor CEF under CEFPF		Livestock Farms and Agro-enterprises		Total
	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount
ii. International Study Tours	0.0	0.0	0.0	0.0	0.3	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
Subtotal (5a)	0.0	0.0	0.0	0.0	1.3	100.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3
b. GTZ-Supported Capacity Development													
i. Training	0.0	0.0	0.1	25.0	0.0	0.0	0.3	75.0	0.0	0.0	0.0	0.0	0.4
ii. Local Study Tours	0.0	0.0	0.0	0.0	0.0	0.0	0.2	100.0	0.0	0.0	0.0	0.0	0.2
iii. International Study Tours	0.0	0.0	0.0	0.0	0.0	0.0	0.1	100.0	0.0	0.0	0.0	0.0	0.1
Subtotal (5b)	0.0	0.0	0.1	14.3	0.0	0.0	0.6	85.7	0.0	0.0	0.0	0.0	0.7
c. Multi-Donor CEF-Supported Capacity Development	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	100.0	0.0	0.0	1.2
Subtotal (5)	**0.0**	**0.0**	**0.1**	**3.1**	**1.3**	**40.6**	**0.6**	**18.8**	**1.2**	**37.5**	**0.0**	**0.0**	**3.2**
6 Consulting Services													
a. GEF-Supported Consulting Services													
i. International Consultants	0.0	0.0	0.0	0.0	0.6	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6
ii. National Consultants	0.0	0.0	0.2	33.3	0.4	66.7	0.0	0.0	0.0	0.0	0.0	0.0	0.6
Subtoal (6a)	0.0	0.0	0.2	16.7	1.0	83.3	0.0	0.0	0.0	0.0	0.0	0.0	1.2
b. GTZ-Supported Consulting Services													
i. International Consultants	0.0	0.0	0.0	0.0	0.0	0.0	2.8	100.0	0.0	0.0	0.0	0.0	2.8
ii. National Consultants	0.0	0.0	0.1	7.7	0.0	0.0	1.2	92.3	0.0	0.0	0.0	0.0	1.3
Subtoal (6b)	0.0	0.0	0.1	2.4	0.0	0.0	4.0	97.6	0.0	0.0	0.0	0.0	4.1
c. Multi-Donor CEF-Supported Consulting Services	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Item	ADB		Government		GEF		GTZ		Multi-Donor CEF under CEFPF		Livestock Farms and Agro-enterprises		Total
	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount
Subtotal (6)	0.0	0.0	0.3	5.7	1.0	18.9	4.0	75.5	0.0	0.0	0.0	0.0	5.3
7 Survey, Design, and Supervision	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.2	100.0	9.2
8 Survey, Design, and Supervision (Centralized Biogas Plants, GEF)	0.0	0.0	0.0	0.0	0.3	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
Subtotal Base Costs (1+2+3+4+5+6+7+8)	58.1	43.6	10.2	7.6	9.2	6.9	4.6	3.4	3.0	2.2	48.3	36.2	133.4
Contingencies	0.0	0.0	0.5	4.5	0.0	0.0	0.0	0.0	0.0	0.0	10.6	95.5	11.1
Subtotal A	58.1	40.2	10.7	7.4	9.2	6.4	4.6	3.2	3.0	2.1	58.9	40.8	144.5
B. Financing Charges during implementation	8.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.0
Total Project Costs (A+B)	66.1	43.3	10.7	7.0	9.2	6.0	4.6	3.0	3.0	2.0	58.9	38.6	152.5

Note: Numbers may not sum precisely because of rounding.

[a] Clean Energy Financing Partnership Facility. Financing partners: the governments of Australia, Norway, Spain, Sweden, and the United Kingdom. Administered by the Asian Development Bank.

[b] Financed on a grant basis by the Global Environment Facility and administered by the Asian Development Bank.

Sources: Asian Development Bank

Table A3.2: Project Cost at Completion by Financier

($ million)

Item	ADB		Government		GEF[a]		GTZ		Multi-Donor CEF[b] under CEFPF		Livestock Farms and Agro-enterprises		Total
	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount
A. Investment Costs													
1 Civil Works													
a. Civil Works for Biodigesters	22.3	80.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.6	20.0	27.9
b. Civil Works for Eco-farming	4.3	80.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	20.0	5.3
Subtotal (1)	**26.6**	**80.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**6.7**	**20.0**	**33.3**
2 Equipment and Materials													
a. Goods and Materials	21.2	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.2
b. Equipment													
i. Government-Supported Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ii. Multi-Donor CEF-Supported Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	100.0	0.0	0.0	1.0
iii.GEF-Supported Equipment	0.0	0.0	0.0	0.0	0.2	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	100.0	0.0	0.0	1.0
Subtotal (2)	**21.2**	**94.7**	**0.0**	**0.0**	**0.2**	**0.8**	**0.0**	**0.0**	**1.0**	**4.5**	**0.0**	**0.0**	**22.4**
3 GEF-Supported Centralized Biogas Plants	**0.0**	**0.0**	**0.0**	**0.0**	**4.2**	**50.0**	**0.0**	**0.0**	**0.0**	**0.0**	**4.2**	**50.0**	**8.4**
4 Vehicles	**0.1**	**100.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.1**
5 Capacity Development													
a. GEF-Supported Capacity Development													
i. Workshops	0.0	0.0	0.0	0.0	0.5	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
ii. International Study Tours	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal (5a)	0.0	0.0	0.0	0.0	0.5	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5

Item	ADB		Government		GEF[a]		GTZ		Multi-Donor CEF[b] under CEFPF		Livestock Farms and Agro-enterprises		Total
	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount
b. GTZ-Supported Capacity Development													
i. Training	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ii. Local Study Tours	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
iii. International Study Tours	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal (5b)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
c. Multi-Donor CEF-Supported Capacity Development	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	100.0	0.0	0.0	0.1
Subtotal (5)	**0.0**	**0.0**	**0.0**	**0.0**	**0.5**	**88.1**	**0.0**	**0.0**	**0.1**	**11.9**	**0.0**	**0.0**	**0.6**
6 Consulting Services													
a. GEF-Supported Consulting Services													
i. International Consultants	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ii. National Consultants	0.0	0.0	0.0	0.0	1.3	100.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3
Subtoal (6a)	0.0	0.0	0.0	0.0	1.3	100.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3
b. GTZ-Supported Consulting Services													
i. International Consultants	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ii. National Consultants	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtoal (6b)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
c. Multi-Donor CEF-Supported Consulting Services	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	100.0	0.0	0.0	0.4
Subtotal (6)	**0.0**	**0.0**	**0.0**	**0.0**	**1.3**	**74.9**	**0.0**	**0.0**	**0.4**	**25.1**	**0.0**	**0.0**	**1.7**
7 Survey, Design, and Supervision	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**15.6**	**100.0**	**15.6**

Item	ADB		Government		GEF[a]		GTZ		Multi-Donor CEF[b] under CEFPF		Livestock Farms and Agro-enterprises		Total
	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount
8 Survey, Design, and Supervision (Centralized Biogas Plants, GEF)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal Base Costs (1+2+3+4+5+6+7+8)	47.9	58.4	0.0	0.0	6.2	7.5	0.0	0.0	1.5	1.8	26.5	32.3	82.0
Contingencies	0.0	0.0	4.4	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.4
Subtotal A	47.9	55.4	4.4	5.1	6.2	7.1	0.0	0.0	1.5	1.7	26.5	30.6	86.4
B. Financing Charges during implementation	2.3	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
Total Project Costs (A+B)	50.2	56.6	4.4	5.0	6.2	7.0	0.0	0.0	1.5	1.7	26.5	29.8	88.7

Note: Numbers may not sum precisely because of rounding.

[a] Financed on a grant basis by the Global Environment Facility and administered by the Asian Development Bank.

[b] Clean Energy Financing Partnership Facility. Financing partners: the governments of Australia, Norway, Spain, Sweden, and the United Kingdom. Administered by the Asian Development Bank.

Sources: Asian Development Bank and the Project Management Office.

DISBURSEMENT OF ADB LOAN AND GRANT PROCEEDS

Table A4.1: Annual and Cumulative Disbursement of ADB Loan Proceeds[a]

	Annual Disbursement		Cumulative Disbursement	
Year	Amount ($ million)	% of Total	Amount ($ million)	% of Total
2010	0.0	0.0	0.0	0.0
2011	4.2	8.3	4.2	8.3
2012	2.7	5.3	6.8	13.6
2013	5.1	10.1	11.9	23.8
2014	8.1	16.1	20.0	39.8
2015	7.6	15.2	27.6	55.0
2016	7.8	15.6	35.5	70.7
2017	6.4	12.8	41.9	83.5
2018	7.7	15.4	49.7	98.9
2019	0.5	1.1	50.2	100.0
2020	0.0	0.0	50.2	100.0
Total	**50.2**	**100.0**	**50.2**	**100.0**

ADB = Asian Development Bank.
[a] Includes disbursements to imprest accounts.
Note: Numbers may not sum precisely because of rounding.

Table A4.2: Annual and Cumulative Disbursement of CEFPF Grant Proceeds[a]

	Annual Disbursement		Cumulative Disbursement	
Year	Amount ($ 000')	% of Total	Amount ($ 000')	% of Total
2010	0.0	0.0	0.0	0.0
2011	0.0	2.7	0.0	2.7
2012	0.3	17.4	0.3	20.2
2013	0.0	0.0	0.3	20.2
2014	0.3	22.2	0.7	42.4
2015	0.2	12.3	0.9	54.7
2016	0.1	7.3	1.0	62.0
2017	0.1	8.6	1.1	70.6
2018	0.2	14.4	1.3	85.0
2019	0.2	15.9	1.6	100.8
2020	(0.0)	(0.8)	1.6	100.0
Total	**1.6**	**100.0**	**1.6**	**100.0**

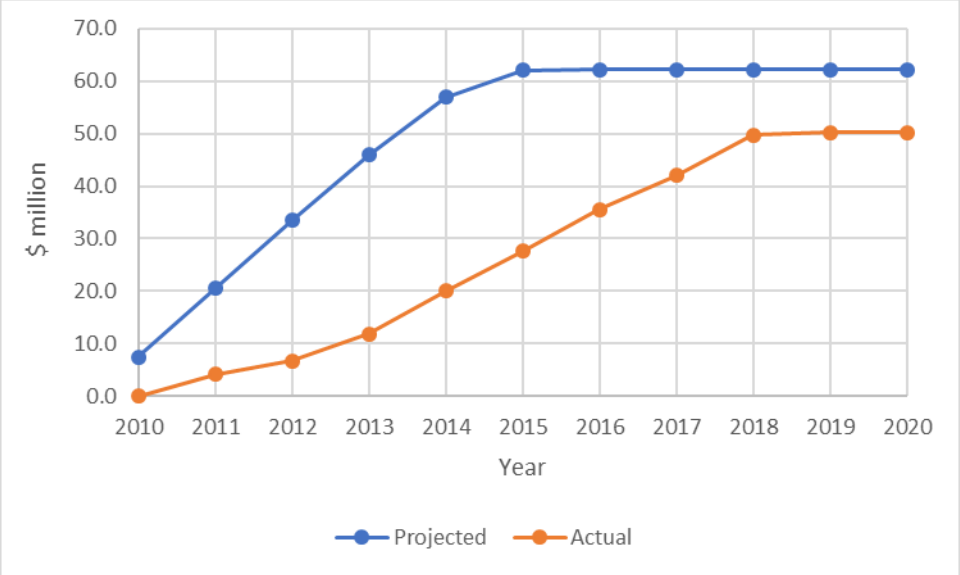
CEFPF = Clean Energy Financing Partnership Facility
[a] Includes disbursements to imprest accounts.
Note: Numbers may not sum precisely because of rounding.

Table A4.3: Annual and Cumulative Disbursement of GEF Grant Proceeds[a]

	Annual Disbursement		Cumulative Disbursement	
Year	Amount ($ million)	% of Total	Amount ($ million)	% of Total
2010	0.0	0.0	0.0	0.0
2011	0.1	2.3	0.1	2.3
2012	0.9	15.4	1.1	17.7
2013	0.1	1.9	1.2	19.6
2014	0.2	3.6	1.4	23.2
2015	0.4	6.1	1.8	29.3
2016	0.3	5.7	2.2	35.0
2017	0.8	12.6	2.9	47.6
2018	1.5	24.3	4.4	71.9
2019	1.8	29.1	6.2	101.0
2020	(0.1)	(1.0)	6.2	100.0
Total	**6.2**	**100.0**	**6.2**	**100.0**

GEF = Global Environment Facility.
Note: Numbers may not sum precisely because of rounding.
[a] Includes disbursements to imprest accounts.
Source: Asian Development Bank.

Figure A4.1: Projection and Cumulative Disbursement of ADB Loan Proceeds



CONTRACT AWARDS OF ADB LOAN AND GRANT PROCEEDS

Table A5.1: Annual and Cumulative Contract Awards of ADB Loan Proceeds

	Annual Contract Awards		Cumulative Contract Awards	
Year	Amount ($ million)	% of Total	Amount ($ million)	% of Total
2010	0.0	0.0	0.0	0.0
2011	2.7	5.7	2.7	5.7
2012	10.4	21.7	13.1	27.4
2013	11.9	25.0	25.1	52.4
2014	3.0	6.3	28.1	58.6
2015	4.1	8.5	32.1	67.1
2016	0.7	1.4	32.8	68.5
2017	13.0	27.2	45.8	95.6
2018	9.9	20.7	55.7	116.3
2019	0.0	0.0	55.7	116.3
2020	(7.8)	(16.3)	47.9	100.0
Total	**47.9**	**100.0**	**47.9**	**100.0**

ADB = Asian Development Bank.
Note: Numbers may not sum precisely because of rounding.

Table A5.2: Annual and Cumulative Contract Awards of CEFPF Grant Proceeds

	Annual Contract Awards		Cumulative Contract Awards	
Year	Amount ($ million)	% of Total	Amount ($ million)	% of Total
2010	0.0	0.0	0.0	0.0
2011	0.4	24.7	0.4	24.7
2012	0.0	0.0	0.4	24.7
2013	0.3	18.1	0.7	42.8
2014	0.8	51.9	1.5	94.7
2015	0.5	30.2	2.0	124.9
2016	0.1	4.6	2.0	129.5
2017	0.0	0.0	2.0	129.5
2018	0.2	15.7	2.3	145.2
2019	0.0	2.7	2.3	147.9
2020	(0.8)	(47.9)	1.6	100.0
Total	**1.6**	**100.0**	**1.6**	**100.0**

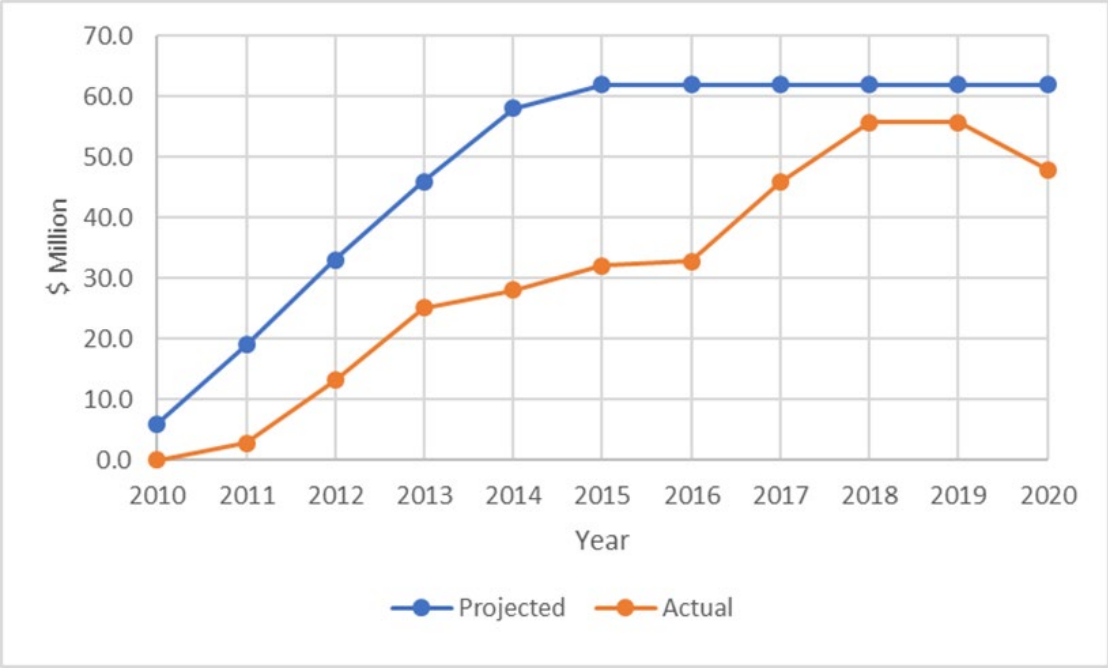
CEFPF = Clean Energy Financing Partnership Facility.
Note: Numbers may not sum precisely because of rounding.

Table A5.3: Annual and Cumulative Contract Awards of GEF Grant Proceeds

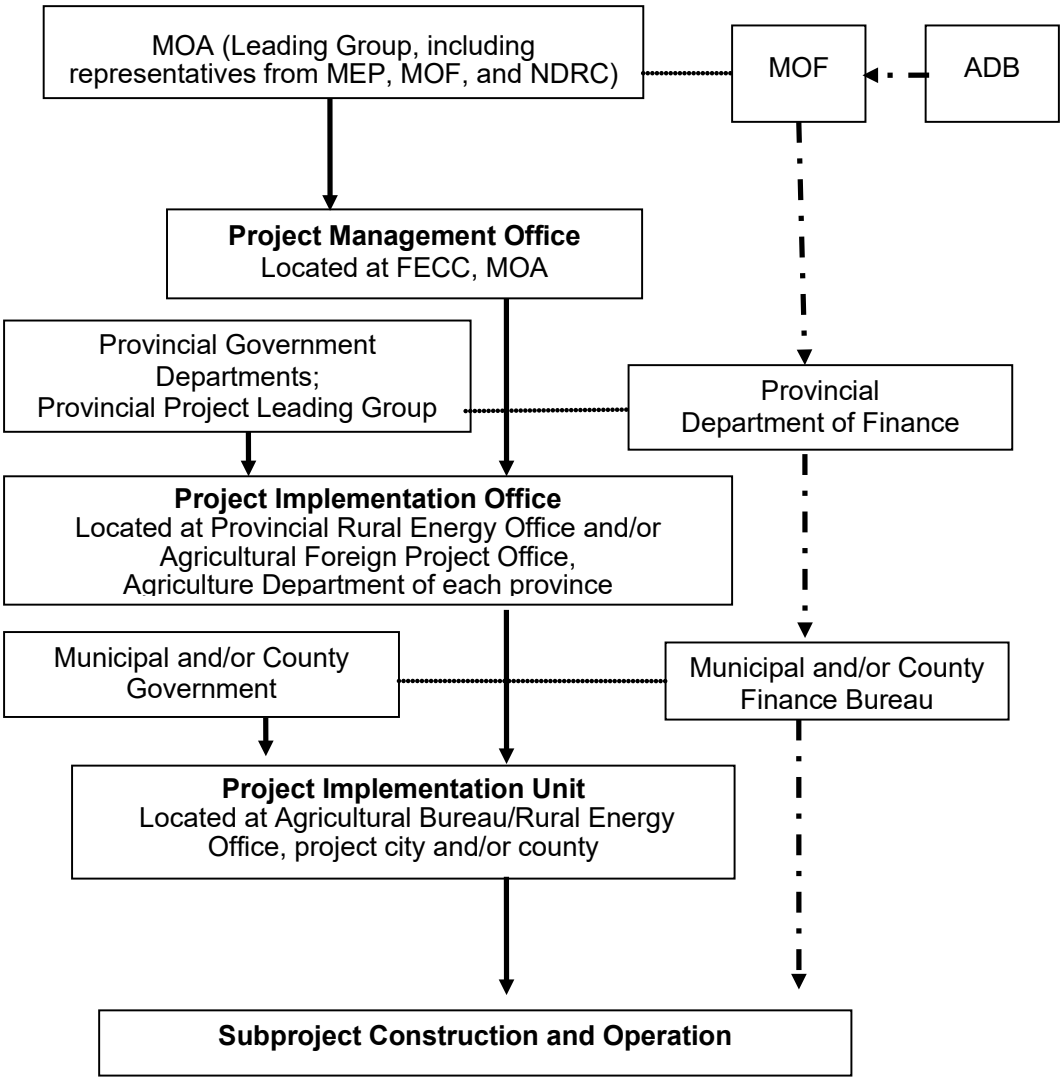
	Annual Contract Awards		Cumulative Contract Awards	
Year	Amount ($ million)	% of Total	Amount ($ million)	% of Total
2010	0.0	0.0	0.0	0.0
2011	0.9	14.0	0.9	14.0
2012	0.1	1.9	1.0	15.9
2013	0.9	14.6	1.9	30.5
2014	0.5	8.0	2.4	38.6
2015	1.0	15.4	3.3	54.0
2016	0.7	11.4	4.0	65.4
2017	0.7	11.6	4.8	77.0
2018	3.2	52.0	8.0	129.0
2019	0.3	5.1	8.3	134.1
2020	(2.1)	(34.1)	6.2	100.0
Total	**6.2**	**100.0**	**6.2**	**100.0**

GEF = Global Environment Facility.
Note: Numbers may not sum precisely because of rounding.
Source: Asian Development Bank.

Figure A5.1: Projection and Cumulative Contract Awards of ADB Loan Proceeds

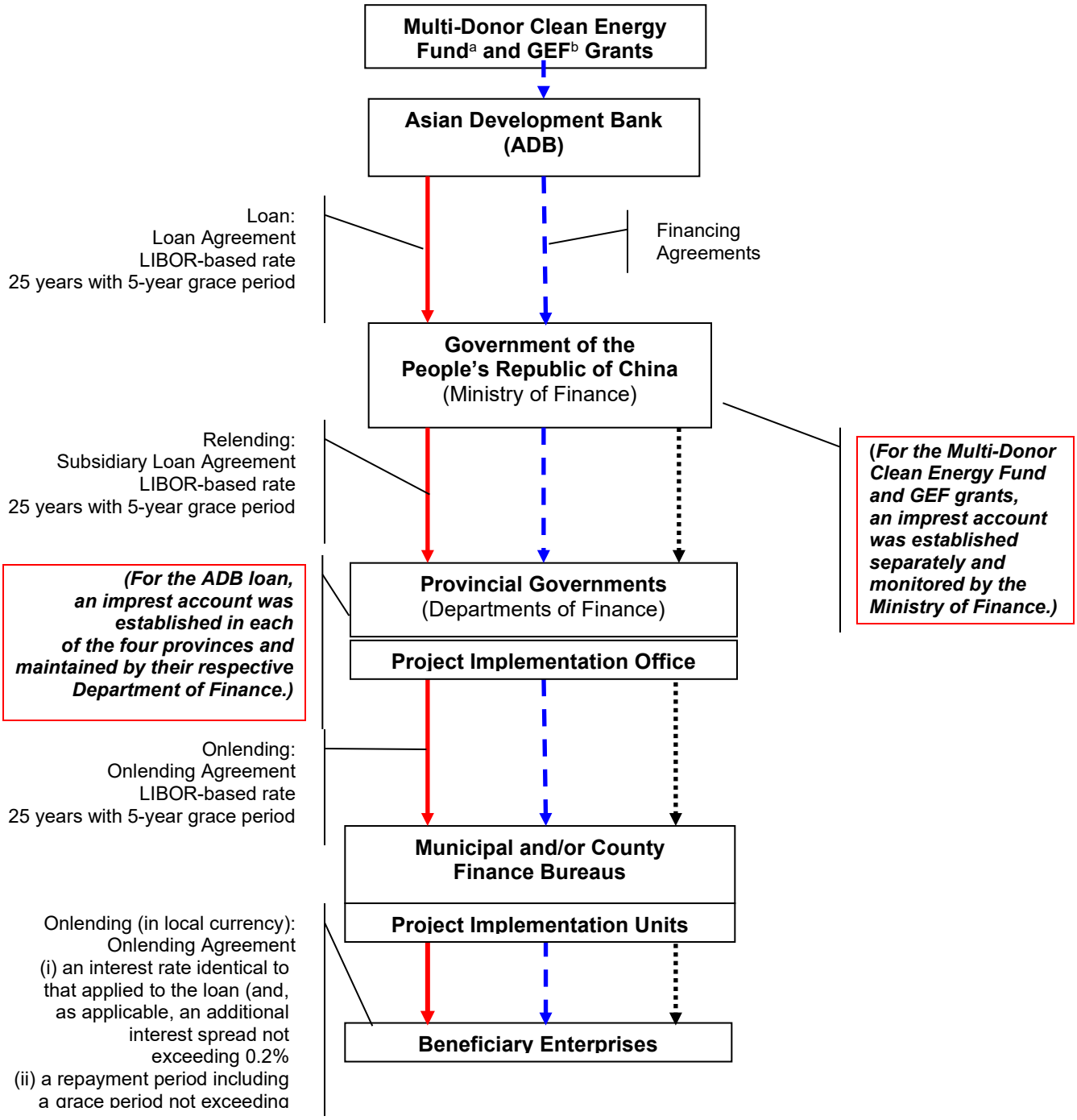


PROJECT IMPLEMENTATION ARRANGEMENT



ADB = Asian Development Bank, FECC = Foreign Economic Cooperation Center, MOA = Ministry of Agriculture, MEP = Ministry of Environment Protection, MOF = Ministry of Finance, NDRC = National Development Reform Commission

FUNDS FLOW



ADB = Asian Development Bank, GEF = Global Environment Facility, LIBOR = London interbank offered rate.

[a] Contributors: the governments of Australia, Norway, Spain, and Sweden. Administered by ADB.

[b] Multi-Donor Clean Energy Fund and GEF funds will be administered by ADB. Withdrawal applications were submitted to ADB for processing and payment.

FINANCIAL AND ECONOMIC REEVALUATION

A. SCOPE OF REEVALUATION

1. The project developed anaerobic digesters as a cost-effective way of treating livestock manure in large and medium-sized livestock farms as well as the waste of agro- enterprises to reduce rural point and nonpoint source pollution problems and mitigate rural energy gaps. Through reusing the effluent from the biogas plants, the project integrated eco-farming to realize a recycling economy with increased biogas use and improvement of rural livelihoods. The project comprised the four outputs: output 1—sustainable development and demonstration for commercial practices of medium-and large-scale Biogas Plants (MLBGPs); output 2—effective utilization of biogas sludge in eco-farming; output 3—capacity development for improved sector performance; and output 4—project implementation support. The investment components concerned outputs (i) and (ii) and they were implemented in four provinces (Heilongjiang, Henan, Jiangxi and Shandong) which integrated biogas utilization, grid connection, and eco-farming on subproject basis. A total of 65 MLBGPs under the loan were constructed.

2. At appraisal 10 core subprojects were selected for financial and economic evaluation. Among them, two out of the six the provinces, Shanxi and Jiangsu provinces withdrew, so were their two core subprojects. In the remaining selected 8 core subprojects at appraisal, 6 subprojects withdrew from the project, and 1 subproject bankrupted during project operations. Given the number and changes of subprojects, the reevaluation was undertaken on representative subprojects, which were selected following criteria of (i) biogas has been utilized for electricity generation and sales to the grid, (ii) biogas has been utilized for gas production for heating or sales, (iii) recycled economy was achieved at economy of scale through eco-farming with additional value, and (iv) all livestock types that the MLBGPs were built on are covered.

B. METHODOLOGY AND ASSUMPTIONS

3. The methodology and assumptions for financial reevaluation were based on the models used at appraisal and followed by feasibility study reports, with updates of actual performance information for initial operational period up to 2019 and the latest unit values provided by subproject enterprises to reevaluate the financial internal rate of return (FIRR) at completion. The financial reevaluation was conducted for each representative subprojects in the following steps: (i) estimation of cash flow over project life, (ii) estimation of the weighted average costs of capital (WACC), (iii) estimation of the FIRRs, (iv) assessment of the project financial viability based on the FIRR and WACC, and (v) sensitivity analysis. Data used in the analysis were derived from the executing agency's (EA) completion reports and field studies undertaken during the project completion review.

4. The main physical outputs of the MLBGPs are (i) energy in the form of biogas or electricity generated from biogas, and (ii) organic fertilizer comprising the effluent from anaerobic digestion as either liquid sludge or dehydrated solid residue. The main use of biogas in MLBGPs under the project is to convert the biogas into electricity for its own use, or delivered to local grid and consumed by villagers, livestock farms, and township enterprises, or to the public power grid. The electricity price in project areas ranged from CNY0.41 to CNY0.80 per kilowatt-hour. Different from the original expectation, the subsidy revenue on electricity generated by biogas has been gradually phased out therefore not considered in the reevaluation.

5. The other way to use biogas is for rural households cooking/heating, for which 1.0 cubic meter (m^3) of biogas can substitute 0.5 kilograms of liquefied petroleum gas, which sells in the

local market for CNY2.50–CNY3.00 per m^3, indicating a willingness to pay of about CNY1.50 per m^3. Over the implementation period, with stricter restriction on the use of coal, wood, or other plant material as rural household fuel, the willingness to for rural households to use biogas has grown, making this way of utilization of biogas a promising option.

6. Organic fertilizers and biogas slurry are used to produce green and organic agricultural products. The eco-farming practices and recycled economy facilities are often built as an integrated part of the MLBGPs. Solid organic fertilizers are also sold to farmers or ago-enterprises at varied prices in the range of CNY100-630 per ton. Slurry is provided to nearby farmers usually for free. The use of solid and liquid organic fertilizers generated significant benefit due to market price premium of organic agriculture products and cost savings resulted from reduced use of chemical fertilizers and increased land fertility.

7. Benefits from reduction of greenhouse gas (GHG) emissions were assessed in terms of the Clean Development Mechanism (CDM), with their value followed the domestic market price of certified emission reductions (CERs) at CNY68 or $10 per ton, [1] which is only included in the economic reevaluation as a proxy of economic value of environmental benefits. For the financial evaluation, the value of CERs is not included as no subproject has achieved such revenue by the time of completion.

8. The project period was assumed to be 25 years. Each subproject is assumed to have a life of 20 years following completion of the implementation, with a major replacement of equipment during year 11. Replacement of other equipment with a shorter life is included in the operation and maintenance costs. No residual value is assumed. Production of biogas and generation of electricity, as well as organic fertilizer and biogas slurry for initial operational period up to 2019 were based on the actual information provided by respective enterprises. Some enterprises had been severely affected by the breakout of swine fever over 2018-2019. A gradual buildup of utilization of the design capacity was assumed, with the full operation of the biogas plants expected during 2020-2021.

C. SUBPROJECT FINANCIAL REEVALUATION

9. **Financial costs.** Subproject capital costs were obtained from the EA's project completion report and reports of individual subprojects, which included the cost for civil works, equipment, and the cost for survey, design, and supervision. The costs of operation and maintenance were based on the actual performance of initial operation. Major equipment replacement is anticipated in year 11 of operation estimated at 40% of project capital cost.

10. **Financial benefits.** The main financial benefits of the subprojects are (i) revenues and cost savings through using recovered gas (predominantly methane) from the anaerobic digesters as fuel gas or converted into electricity for direct use by the livestock farms, or sale to local consumers through a special purpose grid or the public grid; (ii) recovered effluent from anaerobic digestion that are used directly or for sale as an organic fertilizer; and (iii) net revenue increase from farm products resulted from utilization of biogas sludge for eco-farming practices. The reduced GHG emissions that can be sold as CERs were not included in the financial benefits because no such CER transaction has successfully achieved during implementation. There were also financial benefits in terms of pollution levy reductions and reduced wastewater treatment

[1] This value is conservative as compared with the global social cost of carbon at a unit value of $36.30 per ton of carbon dioxide or its equivalent in 2016 prices, to be increased by 2% annually in real terms, which was suggested in ADB *Guidelines for the Economic Analysis of Projects (2017)*.

costs, these were however not considered in the financial benefits to be conservative. Compared with the appraisal estimates, the inclusion of revenue increase due to eco-farming and exclusion of CER revenues in the financial benefits are the main difference.

11. **Weighted Average Cost of Capital.** The weighted average cost of capital (WACC) was calculated for each representative subproject based on the actual composition of financing sources during the implementation. The results ranged from 2.1% to 3.7%, while the WACC for the overall project was 2.68%, against 5.2% estimated at appraisal. The WACC at the completion was lower than those estimated at appraisal mainly because of the lower interest rate of the ADB loan prevailing at the completion (10-years LIBOR-based swap rate plus 0.6% spread) and its higher proportion.

12. **Financial internal rate of return.** The FIRR results of the representative subprojects along with their key parameters and respective WACC are summarized in Table A8.1. The FIRRs of the representative subprojects ranged from 1.1% to 17.1% at project completion in comparison with the estimated range of 6% to 11.9% at appraisal, indicating some of the subprojects' financial returns were at the lower end of threshold, whilst some other subprojects registered higher financial returns. Except one subproject, Lihai subproject in Shandong, all other representative subprojects have FIRR exceeding respective WACC indicating their financial viability. The unviable Lihai subproject was affected by the high cost of electricity generation using waste of ducks. Those viable performing subprojects benefited from the large scale of vegetable planation under the eco-farming program. It should be recognized that the benefits obtained from eco-farming program is a significant contribution to the financial viability of MLBGPs, which mitigated the impact of elimination of subsidies for renewable energy feed-in-tariff. Scale of livestock waste residual utilization or capacity of collection of these wastes also played a critical role for eco-farming leading to the results.

Table A8.1: Financial Indicators by Representative Subprojects

Province	Subproject	Livestock Capacity			Facility Unitization by Completion	Full Operation Expected	WACC	FIRR	NPV at WACC (CNY million)
		Cow	Pig	Duck					
Shangdong	Wandefu	3,000			68%	2022	3.4%	9.1%	6.7
Shandong	Taiyu		70,000		80%	2020	3.3%	17.1%	86.0
Shandong	Lihai			3,000,000	90%	2020	3.1%	1.1%	-
Jiangxi	Lulin		4,200		*	2021	2.1%	4.7%	5.9
Jiangxi	Wannianxinxing		25,000		95%	2020	3.7%	10.0%	7.8
Henan	Beixu		200,000		100%	2019	2.4%	10.3%	61.3
Heilongjiang	Anxiong		7,000		*	2021	2.4%	6.4%	1.6

CNY = yuan, FIRR = financial internal rate of return; WACC = weighted average cost of capital, NPV = financial net present value, * refers to operation affected by swine fever in 2019.
Sources: Asian Development Bank and executing agency estimates.

13. Shandong Lihai subproject registered an FIRR lower than its WACC indicating lack of financial viability. This was particularly due to the high cost (CNY0.85 per kilowatt hour) of electricity generation using waste of ducks, the enterprise therefore is exploring options of delivering compressed gas for household/enterprise use. Shandong Taiyu subproject and Henan Beixu subprojects benefited from the large scale of vegetable planation under the eco-farming program. It should be recognized that the benefits obtained from eco-farming program is a significant contribution to the financial viability of MLBGPs, given the high cost for biogas-to-electricity generation and lack of subsidies for renewable energy feed-in-tariff. Scale of livestock or capacity of collection of agriculture waste also played a critical role in the results as indicated by the case of Shandong Taiyu, Jiangxi Wannianxinxing, and Henan Beixu subprojects. Cashflows of the representative subprojects for FIRR calculation are provided in Table A8.2.

Table A8.2: Financial Internal Rate of Return of Representative Subprojects
(CNY10,000)

Year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Jiangxi Lulin																						
Revenue						608.37	391.10	869.10	869.10	869.10	869.10	869.10	869.10	869.10	869.10	869.10	869.10	869.10	869.10	869.10	869.10	869.10
Capital Expense			350.64	631.14	322.58	56.10	42.08									561.02						
O&M Costs						418.74	282.14	655.79	687.52	720.83	720.83	720.83	720.83	720.83	720.83	720.83	720.83	720.83	720.83	720.83	720.83	720.83
Net Cashflow			(350.64)	(631.14)	(322.58)	133.53	66.88	213.31	181.58	148.27	148.27	148.27	148.27	148.27	148.27	(412.75)	148.27	148.27	148.27	148.27	148.27	148.27
Jiangxi Wannianxinxing																						
Revenues					332.22	1,129.56	1,262.45	1,328.90	1,328.90	1,328.90	1,328.90	1,328.90	1,328.90	1,328.90	1,328.90	1,328.90	1,328.90	1,328.90	1,328.90	1,328.90	1,328.90	1,328.90
Capital Expenses				246.93	740.78										395.08							
O&M Costs					751.29	853.56	1,000.58	1,104.00	1,158.09	1,158.09	1,158.09	1,158.09	1,158.09	1,158.09	1,158.09	1,158.09	1,158.09	1,158.09	1,158.09	1,158.09	1,158.09	1,158.09
Net Cashflow				(246.93)	(1,159.85)	276.00	261.87	224.89	170.81	170.81	170.81	170.81	170.81	170.81	(224.27)	170.81	170.81	170.81	170.81	170.81	170.81	170.81
Shandong Wandefu																						
Revenues	56.46	84.69	112.92	112.92	112.92	169.38	225.84	282.30	322.95	333.60	333.60	333.60	333.60	333.60	333.60	333.60	333.60	333.60	333.60	333.60	333.60	333.60
Capital Expenses	303.70	261.14	81.54	96.30			919.60											664.91				
O&M Costs	21.14	31.71	42.28	42.28	42.28	63.42	84.56	105.70	109.16	113.26	113.26	113.26	113.26	113.26	113.26	113.26	113.26	113.26	113.26	113.26	113.26	113.26
Net Cashflow	(268.38)	(208.17)	(10.90)	(25.66)	70.64	105.96	(778.32)	176.60	213.79	220.34	220.34	220.34	220.34	220.34	220.34	220.34	220.34	(444.58)	220.34	220.34	220.34	220.34
Shangdong Taiyu																						
Revenues				600.00	600.00	1,698.28	2,037.94	3,396.56	3,396.56	3,396.56	3,396.56	3,396.56	3,396.56	3,396.56	3,396.56	3,396.56	3,396.56	3,396.56	3,396.56	3,396.56	3,396.56	3,396.56
Capital Expenses	80.28	241.80	807.92			406.27	4,688.15											2,489.77				
O&M Costs				487.05	487.05	1,623.49	1,948.18	3,246.97	1,768.22	1,768.22	1,768.22	1,768.22	1,768.22	1,768.22	1,768.22	1,768.22	1,768.22	1,768.22	1,768.22	1,768.22	1,768.22	1,768.22
Net Cashflow	(80.28)	(241.80)	(807.92)	112.95	112.95	(331.48)	(4,598.40)	149.59	1,628.34	1,628.34	1,628.34	1,628.34	1,628.34	1,628.34	1,628.34	1,628.34	1,628.34	(861.43)	1,628.34	1,628.34	1,628.34	1,628.34
Shangdong Lihai																						
Revenues							481.80	481.80	481.80	481.80	481.80	481.80	481.80	481.80	481.80	481.80	481.80	481.80	481.80	481.80	481.80	481.80
Capital Expenses			1,220.62			743.96												785.83				
O&M Costs							297.00	297.00	297.00	297.00	297.00	297.00	297.00	297.00	297.00	297.00	297.00	297.00	297.00	297.00	297.00	297.00
Net Cashflow	-	-	(1,220.62)	-	-	(743.96)	184.80	184.80	184.80	184.80	184.80	184.80	184.80	184.80	184.80	184.80	184.80	(601.03)	184.80	184.80	184.80	184.80
Henan Beixu																						
Revenues					2,799.06	4,198.59	4,665.10	4,665.10	4,665.10	4,665.10	4,665.10	4,665.10	4,665.10	4,665.10	4,665.10	4,665.10	4,665.10	4,665.10	4,665.10	4,665.10	4,665.10	4,665.10
Capital Expenses				2,550.00	2,550.00	2,550.00									3,060.00							
O&M Costs					2,167.37	3,251.06	3,612.29	3,612.29	3,612.29	3,612.29	3,612.29	3,612.29	3,612.29	3,612.29	3,612.29	3,612.29	3,612.29	3,612.29	3,612.29	3,612.29	3,612.29	3,612.29
Net Cashflow				(2,550.00)	(1,918.31)	(1,602.47)	1,052.81	1,052.81	1,052.81	1,052.81	1,052.81	1,052.81	1,052.81	1,052.81	(2,007.19)	1,052.81	1,052.81	1,052.81	1,052.81	1,052.81	1,052.81	1,052.81
Heilongjiang Anxiong	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	
Revenues		86.40	86.40	86.40	86.40	86.40	86.40	86.40	-	-	43.20	86.40	86.40	86.40	86.40	86.40	86.40	86.40	86.40	86.40	86.40	
Capital Expenses	419.29													167.72								
O&M Costs		30.61	30.61	30.61	30.61	30.61	30.61	30.61	30.61	30.61	30.61	30.61	30.61	30.61	30.61	30.61	30.61	30.61	30.61	30.61	30.61	
Net Cashflow	(419.29)	55.79	55.79	55.79	55.79	55.79	55.79	55.79	(30.61)	(30.61)	12.59	55.79	55.79	(111.93)	55.79	55.79	55.79	55.79	55.79	55.79	55.79	

Sources: Asian Development Bank and executing agency estimates.

D. ECONOMIC REEVALUATION

14. The economic reevaluation was conducted for each representative subprojects in the following steps: (i) estimation of net economic benefit flow, (ii) estimation of the EIRR, (iii) comparison of the EIRRs with the economic cost of capital, (iv) comparison of the EIRR at completion with the EIRR at appraisal, and (v) sensitivity analysis. Economic analysis was based on an opportunity cost of capital of 12% following the value adopted at appraisal, although ADB's prevailing minimum required EIRR at completion is 9%. The economic analysis was conducted following the *Guidelines for the Economic Analysis of Projects of the Asian Development Bank (2017)*.

15. **Economic costs.** The financial capital costs of the subprojects were converted into economic values by deducting the cost of taxes and adjusting the tradable costs by applying the shadow exchange rate factor of 1.023 for period of 2011-2015 issued by Economic Research and Regional Cooperation Department of ADB. The opportunity cost of surplus labor is estimated as 0.70 of the prevailing wage rate, and the opportunity cost of scarce labor for skilled labor is estimated as 1.0. All traded outputs were valued at their market prices. This is the same approach followed at the appraisal.

16. **Economic benefits.** As identified at appraisal, the economic benefits of the project included (i) replacement of fossil fuel energy with renewable biomass energy in rural areas, (ii) reduction of global warming by collecting and using methane gas generated from the animal waste of livestock farms, and (iii) improved sustainability of the recycling economy by promotion of eco-farming systems and practices. The economic value of electricity is assumed to be the market price of electricity as reported by the beneficiary, following the approach adopted at

appraisal. The economic price for organic fertilizer reflects the saving in the use of chemical fertilizers and pesticides, together with the economic value of increased and improved crop output, for which the market price of the organic fertilizer sold under respective subprojects is used as a proxy of the willingness to pay (para 6). The economic benefit from Certified Emission Reductions (CERs), as the environmental benefits, is assumed to be received for the full subproject life (para 7).

17. **Economic internal rate of return.** The estimated economic internal rates of return (EIRRs) of the representative subprojects are shown in Table A8.3. The EIRRs of these subprojects range from 11.5% to 24.1%, the results are close to the appraisal estimates ranging from 12.2% to 23.6%. Except Jiangxi Lulin, all subprojects' EIRR are higher than the opportunity cost of capital, indicating their economic viability. Economic benefits of the representative subprojects for EIRR calculation are provided in Table A8.4.

Table A8.3: Economic Indicators by Representative Subproject

Province	Subproject	EIRR (%)	ENPV[a] (CNY million)
Shangdong	Wandefu	24.1%	5.64
Shandong	Taiyu	23.8%	29.95
Shandong	Lihai	12.9%	1.17
Jiangxi	Lulin	11.5%	-0.33
Jiangxi	Wannianxinxing	15.8%	2.40
Henan	Beixu	14.7%	8.95
Heilongjiang	Anxiong	15.2%	0.67

CNY = yuan, EIRR = economic internal rate of return, ENPV = economic net present value at discount rate of 12%.
Sources: Asian Development Bank and executing agency estimates.

Table A8.4: Economic Internal Rate of Return of Representative Subprojects

(CNY '000)

Year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Jiangxi LuLin												
Benefits						701.17	483.89	961.90	961.90	961.90	961.90	961.90
Capital Expenses			342.75	616.95	315.33	54.84	41.13					
O&M Costs						474.99	324.21	655.79	687.52	720.83	720.83	720.83
Net Benefits			(342.75)	(616.95)	(315.33)	171.34	118.55	306.11	274.38	241.07	241.07	241.07
Jiangxi Wannianxinxing												
Benefits					332.22	1,180.59	1,313.48	1,379.93	1,379.93	1,379.93	1,379.93	1,379.93
Capital Expenses				241.38	724.13							
O&M Costs					751.29	853.56	1,000.58	1,104.00	1,158.09	1,158.09	1,158.09	1,158.09
Net Benefits				(241.38)	(1,143.19)	327.03	312.90	275.92	221.84	221.84	221.84	221.84
Shandong Wandefu												
Benefits	88.46	132.68	176.91	176.91	176.91	265.37	353.82	442.28	442.28	442.28	442.28	442.28
Capital Expenses	296.87	255.27	79.71	94.13	-	-	898.93					
O&M Costs	21.14	31.71	42.28	42.28	42.28	63.42	84.56	105.70	109.16	113.26	113.26	113.26
Net Benefits	(229.55)	(154.30)	54.92	40.49	134.63	201.94	(629.67)	336.57	333.11	329.01	329.01	329.01
Shangdong Taiyu												
Benefits	-	-	-	600.00	600.00	1,698.28	2,037.94	3,920.20	3,920.20	3,920.20	3,920.20	3,920.20
Capital Expenses	78.48	236.36	789.76	-	-	397.14	4,582.75					
O&M Costs	-	-	-	487.05	487.05	1,623.49	1,948.18	3,246.97	1,768.22	1,768.22	1,768.22	1,768.22
Net Benefits	(78.48)	(236.36)	(789.76)	112.95	112.95	(322.34)	(4,492.99)	673.23	2,151.98	2,151.98	2,151.98	2,151.98
Shangdong Lihai												
Benefits							481.80	481.80	716.16	716.16	716.16	716.16
Capital Expenses			1,193.18			727.23						
O&M Costs							290.32	290.32	290.32	290.32	290.32	290.32
Net Benefits			(1,193.18)	-	-	(727.23)	191.48	191.48	425.84	425.84	425.84	425.84
Henan Beixu												
Benefits				-	2,799.06	4,198.59	4,767.63	4,767.63	4,767.63	4,767.63	4,767.63	4,767.63
Capital Expenses				2,492.67	2,492.67	2,492.67						
O&M Costs				-	2,118.65	3,177.97	3,531.08	3,531.08	3,531.08	3,531.08	3,531.08	3,531.08
Net Benefits				(2,492.67)	(1,812.25)	(1,472.05)	1,236.56	1,236.56	1,236.56	1,236.56	1,236.56	1,236.56
Heilongjiang Anxio	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Benefits		110.00	110.71	111.43	112.19	112.96	113.76	114.58	-	-	73.09	116.29
Capital Expenses	409.86											
O&M Costs		29.92	29.92	29.92	29.92	29.92	29.92	29.92	29.92	29.92	29.92	29.92
Net Benefits	(409.86)	80.08	80.78	81.51	82.26	83.04	83.83	84.66	(29.92)	(29.92)	43.17	86.37

Year	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Benefits	961.90	961.90	961.90	961.90	961.90	961.90	961.90	961.90	961.90	961.90
Capital Expenses				548.40						
O&M Costs	720.83	720.83	720.83	1,281.85	720.83	720.83	720.83	720.83	720.83	720.83
Net Benefits	241.07	241.07	241.07	(868.35)	241.07	241.07	241.07	241.07	241.07	241.07
Jiangxi Wannianxinxing										
Benefits	1,379.93	1,379.93	1,379.93	1,379.93	1,379.93	1,379.93	1,379.93	1,379.93	1,379.93	1,379.93
Capital Expenses			386.20							
O&M Costs	1,158.09	1,158.09	1,158.09	1,158.09	1,158.09	1,158.09	1,158.09	1,158.09	1,158.09	1,158.09
Net Benefits	221.84	221.84	(164.36)	221.84	221.84	221.84	221.84	221.84	221.84	221.84
Shandong Wandefu										
Benefits	442.28	442.28	442.28	442.28	442.28	442.28	442.28	442.28	442.28	442.28
Capital Expenses						649.96				
O&M Costs	113.26	113.26	113.26	113.26	113.26	113.26	113.26	113.26	113.26	113.26
Net Benefits	329.01	329.01	329.01	329.01	329.01	(320.95)	329.01	329.01	329.01	329.01
Shangdong Taiyu										
Benefits	3,920.20	3,920.20	3,920.20	3,920.20	3,920.20	3,920.20	3,920.20	3,920.20	3,920.20	3,920.20
Capital Expenses						2,433.79				
O&M Costs	1,768.22	1,768.22	1,768.22	1,768.22	1,768.22	1,768.22	1,768.22	1,768.22	1,768.22	1,768.22
Net Benefits	2,151.98	2,151.98	2,151.98	2,151.98	2,151.98	(281.81)	2,151.98	2,151.98	2,151.98	2,151.98
Shangdong Lihai										
Benefits	716.16	716.16	716.16	716.16	716.16	716.16	716.16	716.16	716.16	716.16
Capital Expenses						768.16				
O&M Costs	290.32	290.32	290.32	290.32	290.32	290.32	290.32	290.32	290.32	290.32
Net Benefits	425.84	425.84	425.84	425.84	425.84	(342.33)	425.84	425.84	425.84	425.84
Benefits	4,767.63	4,767.63	4,767.63	4,767.63	4,767.63	4,767.63	4,767.63	4,767.63	4,767.63	4,767.63
Capital Expenses			2,991.20							
O&M Costs	3,531.08	3,531.08	3,531.08	3,531.08	3,531.08	3,531.08	3,531.08	3,531.08	3,531.08	3,531.08
Net Benefits	1,236.56	1,236.56	(1,754.65)	1,236.56	1,236.56	1,236.56	1,236.56	1,236.56	1,236.56	1,236.56
Heilongjiang Anxiong	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	
Benefits	116.29	116.29	116.29	116.29	116.29	116.29	116.29	116.29	116.29	
Capital Expenses		163.95								
O&M Costs	29.92	29.92	29.92	29.92	29.92	29.92	29.92	29.92	29.92	
Net Benefits	86.37	(77.57)	86.37	86.37	86.37	86.37	86.37	86.37	86.37	

Sources: Asian Development Bank and executing agency estimates.

E. SENSITIVITY ANALYSIS

18. Sensitivity analyses have been undertaken for both the financial and economic analyses. The sensitivity tests assessed the impact of increased operation and maintenance costs and reduced benefits. From both the financial and economic perspectives, the results indicate that the subprojects are highly sensitive to cost increases, benefit decreases or reduction of operations. Less than 10% of negative changes would lead these subprojects to unacceptable situation. The impact of swine fever, high electricity generation cost, absence of CER revenues, and phasing-out of subsidies on electricity affected their robustness. Of the representative subprojects, only the Shandong Wandefu and Taiyu subprojects remain viable in the sensitivity analysis for both FIRR and EIRR. The results are provided in Table A8.5 and Table A8.6.

Table A8.5: Sensitivity Analysis on FIRR

Province	Subproject	Base Case	Revenue -10%	O&M Cost +10%	O&M Cost+10% Revenue -10%
Shangdong	Wandefu	9.1%	5.6%	7.9%	4.2%
Shandong	Taiyu	17.1%	11.3%	13.4%	7.4%

FIRR = financial internal rate of return, O&M = operation and maintenance cost
Sources: Asian Development Bank and executing agency estimates.

Table A8.6: Sensitivity Analysis on EIRR

Province	Subproject	Base Case	Benefit -10%	O&M Cost +10%	O&M Cost+10% Benefit -10%
Shangdong	Wandefu	24.1%	19.5%	23.0%	18.4%
Shandong	Taiyu	23.8%	18.1%	14.6%	14.6%
Shandong	Lihai	12.9%	10.4%	9.2%	9.2%
Jiangxi	Lulin	11.5%	3.1%	-	-
Jiangxi	Wannianxinxing	15.8%	0.5%	-	-
Henan	Beixu	14.7%	5.2%	-	-
Heilongjiang	Anxiong	15.2%	12.0%	11.0%	11.0%

EIRR = economic internal rate of return, O&M = operation and maintenance cost, = negative value.
Sources: Asian Development Bank and executing agency estimates.

F. FINANCIAL SUSTAINABILITY

19. Biogas plants are built in association with livestock farms. The difficulty experienced by livestock sector over the implementation period, particularly during 2017-2019, has been the key factor affecting the operations of the MLBGPs under the project. The economic downturn, breakout of swine fever, restriction on pig farming, and lack of biogas production for electricity generation constituted the external factors what went beyond the control of these enterprises. This has caused the attention of central and provincial governments. Various measures, including offering subsidies from the central government budget to large pig farms to support their facility construction, reduction of taxes and duties, introduction of preferable insurance coverage, are being taken to help the MLBGP enterprises to overcome the difficulties and restore operation.

20. Based on the lessons of the project, measures that MLBGPs can take to enhance their financial sustainability would include:

(i) Instead of electricity generation using biogas, delivering compressed gas for rural households cooking/heating or enterprise use is a promising option particularly in the situation of high electricity generation cost and absence of subsidy to electricity generated by biogas.
(ii) Eco-farming component has demonstrated significant contribution to the financial viability of MLBGPs, expansion of this component wherever feasible would be helpful.
(iii) Scale of agriculture waste to be collected and treated plays a critical role in the operation results, MLBGPs need to expand the coverage of livestock and agriculture waste collection to sustain operation.

21. On the government side, Heilongjiang, Henan, Jiangxi and Shandong provinces should continue to monitor the enterprises under by the project to ensure the debt repayment accountability.

ENVIRONMENT PROTECTION

A. Introduction

1. The sector loan project covers four provinces that include Heilongjiang, Henan, Jiangxi and Shandong. It includes a total of 53 subprojects sites, of which the total capacity of the farms and agro-processing operations are: 397,059 hogs, 7,100 dairy cows, 17,000 beef cattle, 200,000 chickens, 3,000,000 ducks, and 1,846,120 tons of agro-processing wastes. The total biogas generation capacity and fertilizer generation capacity are 126,41 million cubic meters (m^3) and 1.15 million tons per annum, respectively. The use of biogas slurry and organic fertilizers for eco-faming has reduced the use of fertilizers by 11,902.17 tons per year and facilitated the ecological agriculture areas expansion to 10,554.07 ha. All the subproject facilities were put into operation by the end of 2018.

Table A9.1: Summary of Subprojects by Province

Item		Heilongjiang	Henan	Jiangxi	Shandong	Total
No. of Subprojects		2	6	35	10	53
Waste Treatment (million t/a)		0.027	0.35	0.70	0.78	1.542
Biogas Production (million m^3)		0.037	5.54	60.75	59.75	126.077
Electric Power Generation (million kWh/a)		0.38	2.68	4.62	10.05	17.73
Organic Fertilizers for Eco- farming (million tons peryr)		0.03	0.04	0.48	0.60	1.15
Pig	No. of Farms	7	30	47	6	90
	No. of Pigs	17,000	122,099	187,960	70,000	397,059
Diary	No. of Farms	4	6	1	4	15
	No. of Cows	0	0	0	7,100	7,100
Cattle	No. of Farms	2	1	0	4	7
	No. of Cattle	0	0	0	17,000	17,000
Chicken	No. of Farms	0	5	1	1	7
	No. of Chickens	0	0	200,000	0	200,000
Duck	No. of Farms	0	0	0	9	9
	No. of Ducks	0	0	0	3,000,000	3,000,000
No of Agro-processing Operations		3	0	2	6	11

kWh/a = kilowatt-hour, m^3 = cubic meter, t/a = ton/age
Source: Project Management Office.

2. Based on ADB's *Environment Policy (2002)* and *Environment Assessment Guidelines (2003)*, the project is classified as environment category B. The initial environmental examination (IEE) of the six core subprojects were reviewed by the Asian Development Bank (ADB), and a summary IEE was prepared and disclosed on the ADB project website in December 2008. The summary IEE includes an environmental assessment and management framework (EAMF) to ensure ADB's environment requirements met for subsequent subprojects.

3. **Due diligence on non-core subprojects.** The list of environmental criteria for subproject selection in the EAMF was used as guidelines for screening and selection throughout non-core subprojects' preparation. [1] During implementation, the preparation and approvals of the domestic environmental impact assessment (EIA) for the subsequent non-core subprojects were completed in accordance with the People's Republic of China's (PRC) laws and regulations. ADB approved a total of 24 subproject IEEs, including 1 in Heilongjiang, 2 in Henan, 11 in Jiangxi and 10 in Shandong during May 2009 to June 2018.

[1] Includes the following: (i) regulatory restrictions, (ii) safe distance from sensitive objects, (iii) sensitivity of local environment, (iv) carrying capacity of local farmland, and (v) environmental commitment of the enterprise.

4. At project completion, in line with domestic legislations, a total of 45 subprojects (2 in Heilongjiang, 2 in Henan, 35 in Jiangxi and 6 in Shandong) passed domestic environment completion acceptance audit by August 2019. The acceptance audit for the remaining subprojects was completed by 30 June 2020.

B. Environmental Management and Monitoring

5. The Ministry of Agriculture (MOA), the executing agency (EA), was overall responsible for the implementation of environmental management plan (EMP) and for effective management of activities specified in the EMP. The four provincial project implementation offices (PIO) and implementing agencies (IA) were responsible for relevant requirements of EMP to be part of design drawings and bidding documents, for the supervision of implementation of mitigation measures during construction and operation, and for coordination of external environment monitoring. Contractors, under the guidance of construction supervision companies, were responsible for the implementation of mitigation measures specified in the EMP during the construction period. The IAs or the operators were responsible for the implementation of mitigation measures during the operation. Within IAs or the operators, their safety and environment protection sections recruited environmental staff; and they were responsible for ensuring implementation of the mitigation measures in the EMP and coordination for environment completion acceptance audit and monitoring. Each IA signed the contract with local environment monitoring center as external environment monitoring agency from 2014. Six EMRs, covering period through 2015-2018, were submitted and disclosed on ADB project website.[2]

6. At appraisal, the ADB Summary Initial Environmental Examination (SIEE) and the Environment assessment and Review Framework estimated that the total inputs for environmental staffing requirements were 1,867 months, while the estimated budget for EIA institutes, environmental protection institutes and environmental capacity building and monitoring as part of the implementation consultancy would be $0.5 million, $0.25 million and $0.12 million, respectively.

C. Environment Mitigation Measures Implementation

7. Multiple candidate sites were identified and analyzed for each of the non-core subproject. The following factors were considered for the site selection: (i) occupation of less land; (ii) safe and sanitary distance to sensitive areas, including residences and residential areas, schools, hospitals, and business and office districts; (iii) avoidance of runoff to surface water; (iv) avoidance of penetration of leachate to groundwater aquifers; and (v) adequate farmland for use of biogas residues to minimize non-point source pollution.

8. The mitigation measures were implemented from the stage of project technical design, construction, and operation. In conclusion, the project had less impact on the surrounding environment. Only minor construction and operational impacts were brought by the project, but these were mitigated to acceptable levels by applying adequate construction and operation management practices. There were no significant/unanticipated adverse effects/risks to the environment.

9. **Construction period.** For all subprojects, the construction of biogas digesters and

[2] Including four consolidated annual environmental monitoring reports (EMR) during 2015-2018, and two EMRs respectively covering January- September 2017 and January-June 2018.

associated facilities and infrastructure involved removal of vegetation and excavation. The excavated earth was re-used for road building and landscaping, without external disposal. Water and soil retaining weirs were used to avoid soil erosion. Measures such as water spraying and truck covers were adopted so as to suppress the generation of dust. In view of the relatively long distance from sensitive areas and with the use of low-noise machinery, the noise nuisance was minimal. Solid wastes from construction activities were collected by local sanitation bureaus for disposal in landfill sites. The wastewater from construction activities and from construction workers containing no toxic substances was re-used for site spraying and landscaping. The environmental impacts during construction were assessed as temporary at local level, which were verified by the monitoring results in the environmental monitoring reports (EMR).

10. **Operational period.** During operation, the EMP was properly implemented. All the environmental protection facilities were constructed and were operating efficiently. The monitoring results show that the project did not have adverse impact on air and water qualify in and around the project areas and that all the environmental pollution emissions complied with relevant standards, with the exception of the particulate matter less than 10 micrometers in diameter (PM_{10}) in the surrounding areas and the noise level at the project's boundary during the operation but mitigation measures were implanted to alleviate the issues. The mitigation measures for the environmental impacts were fully implemented, such as the use of the tank truck for manure transportation, the noise-absorption materials and containers for installation of the generator sets, proper package and treatment of the solid wastes. In addition, environment, health, and safety (EHS) was seriously considered in supervising the biogas equipment operation safely. The required environmental supervisors were assigned to conduct daily safety check and monitoring. More effective measures were taken to eliminate or reduce the generation of the malodorous gas, which was produced in the animal manure collection as well as in the process of systematic disposal of the waste.

11. The major adverse environmental impacts during the operation phase include the below. (i) **Odor:** the biogas digesters were built adjacent to the livestock and agro-processing operations, and as such the transportation of livestock manure and agro-processing wastes were confined within the farms and plants. Sealed and covered vehicles were used to prevent leakage during transportation. The livestock manure and agro-processing wastes were dumped directly into the biogas digesters; and no storage was necessary. The anaerobic digestion process removed over 90% of the odor. The field application of the biogas residues was scheduled to avoid windy days, such that the odor was not blown too far. (ii) **Water Pollution:** there was adequate farmland in the subproject areas, so the application rate did not exceed the recommended 25 to 50 tons per hectare per annum. In the meantime, the application of biogas slurry and solids in the field took consideration of weather conditions and crop growth status. It was scheduled to avoid the rainstorm season. Moreover, burying instead of spreading also reduced the amount of surface runoff. The application areas are located also as far as possible to water bodies. (iii) **Noise:** in view of the long-distance sensitive areas (i.e. residential areas, schools, hospitals, etc.), the noise impacts on local communities were minimal. However, to mitigate potential noise impact to animals, low-noise equipment was selected, and insulation of power houses was adopted. (iv) **Safety and greenhouse gases (GHGs) Emissions**: the mitigation measures included (a) strictly obeying the Guideline on Operation, maintenance and safety of biogas systems for livestock and poultry farms (NY/T1221-2006) proclaimed by MOA; (b) developing and implementing operational safety procedures for biogas facilities; (c) providing safety training by biogas system safety experts to operational and management staff; (d) installing safety apparatus, including water sealing and constant pressure equipment; (e) providing fire prevention and extinguishing facilities; and (f) developing and implementing emergency procedures for leakage, fire and explosion, and conduct periodic drills. With the implementation of the above mitigation measures, the

impacts/risks were reduced into the minimum, while the operational monitoring results indicate compliance with national applicable standards in the EMRs.

12. **Public Consultation and Grievance Redress Mechanism (GRM)**. The public consultation plan for the core subprojects at appraisal was developed as a template for the subsequent non-core subproject's public consultation. During implementation public awareness and public consultation activities regarding environmental aspect for all subprojects have been conducted. The feedback on the measures discussed above and satisfaction level to the environmental safeguards provided to affected persons were collected through interviews, questionnaires, and other methods. No environmental complaint or grievance was raised.

D. Environment Performance Indicators and Benefits

13. The project is expected to mainly achieve environmental benefits, reduction of water and air pollution, improvement of public health improvement, expansion of eco-farming, and reduction of GHG emissions. The project used the solid and liquid waste from the animal manure and agro-processing operations as feedstock totaling to 1.85 million tons per year, and this produced about 126.41 million m^3 per year of biogas through anaerobic fermentation technologies. Each year, about 13.68 million m^3 of the biogas was transmitted to the local village gas grids. Among which, 6.17 million m^3 was used for heating, and the remaining 106.56 million m^3 was used to generate 17.72 million kilowatt-hours of electric power. The subprojects also produced 1.51 million m^3 of liquid biogas slurry and 0.24 million tons of solid biogas residue, which were reused to produce 1.15 million tons organic fertilizer per year for eco-farming. The project is estimated to result in an estimated annual GHG emissions reduction of 1.72 million tons of carbon dioxide equivalent.[3]

E. Conclusions and Recommendations

14. Adequate environmental mitigation measures were adopted and the EMP was effectively implemented for all types of subprojects during the construction and operation periods to minimize the adverse environmental impacts to an acceptable level. Construction and operation environmental monitoring was carried out, and EMRs were submitted to ADB as agreed, detailing the progress made against the EMP. The environment monitoring results followed the applicable standards and there were no significant adverse effects to the environment. The actual performance of the environmental protection measures was pursuant to applicable environmental protection regulations and standards. The project had substantial positive environmental benefits in reducing environmental pollution from animal wastes and supporting circular economy and zero-waste approach for GHG emissions reduction. The project has a demonstration effect on the other similar renewable biogas energy development projects in four provinces or other provinces in PRC.

[3] The climate change benefits from this project can be estimated by calculating the GHG emissions on with-and-without-biogas-production scenarios. Without biogas production, the major GHG from a livestock farm is methane. According to the Evaluation and Reduction Methods for Methane Emissions from Animal Manure by Peng and Dong, the methane emission coefficient for pig, cow and chicken/duck manure in the temperate zone in Asian region with annual average temperature higher than 15℃ but lower than 25ºC are 3.48, 6.32 and 0.015 kilograms per head per year. The emission avoided from the coal saving is estimated based on the assumption that: (i) the heat value of standard coal is 29,307.60 terajoule/metric ton, (ii) carbon emission factor is 26.39 tons of carbon/terajoule, and (iii) carbon oxidation ratio is 80%. Thus, the total forgone emission from the with-biogas scenario in comparison to the without-biogas scenario will amount to an equivalence of 204,759.44 ton/age of CO_2.According to the Intergovernmental Panel on Climate Change (IPCC), one ton of Biochemical Oxygen Demand (BOD5) produced in wastewater will also generate 0.22 tons of methane (CH4) emission. Therefore, the wastewater treatment in the biomass processing will reduce 26,445.28 tons of CO_2 emission.

STATUS OF COMPLIANCE WITH LEGAL COVENANTS

Covenant	Reference in Legal Agreement	Status of Compliance
(a) The Borrower shall cause each Participating Province to carry out the Project with due diligence and efficiency and in conformity with sound administrative, financial, engineering, environmental, and bio-energy development practices. (b) In the carrying out of the Project and operation of the Project facilities, the Borrower shall perform, or cause to be performed, all obligations set forth in Schedule 5 to this Loan Agreement and the Schedule to the Project Agreement.	LA, Art. IV, Section 4.01	Complied. Compliance was confirmed in progress reports.
The Borrower shall make available to each Participating Province, promptly as needed and on terms and conditions acceptable to ADB, the funds, facilities, services, land and other resources which are required, in addition to the proceeds of the Loan, for the carrying out of the Project.	LA, Art. IV, Section 4.02	Complied. Compliance was confirmed in progress reports.
The Borrower shall ensure that the activities of its departments and agencies with respect to the carrying out of the Project and operation of the Project facilities are conducted and coordinated in accordance with sound administrative policies and procedures.	LA, Art. IV, Section 4.03	Complied. Compliance was confirmed in progress reports.
The Borrower shall take all action which shall be necessary on its part to enable the Participating Provinces to perform their obligations under the Project Agreement, and shall not take or permit any action which would interfere with the performance of such obligations.	LA, Art. IV, Section 4.04	Complied. Compliance was confirmed in progress reports.
(a) The Borrower shall cause each Participating Province to ensure, through the concerned county or municipality, that the Participating Enterprises exercise their rights under the Sub-Loan Agreements in such a manner as to protect the interests of the Borrower and ADB and to accomplish the purposes of the Loan. (b) No rights or obligations under a Sub-Loan Agreement shall be assigned, amended, abrogated or waived without the prior concurrence of ADB.	LA, Art. IV, Section 4.05	Complied. Compliance was confirmed in progress reports.
Implementation Arrangements MOA shall be the EA for the Project. The leading group that has been established and comprises senior officials from MOF, National Development Reform Commission, MOA's Department of Planning and Department of Science, Education, and Rural Environment, and FECC, shall provide policy guidance and support to project implementation. The PMO set up by MOA shall be responsible for overall project management, coordination, training, recruitment of consultants, and other implementation and monitoring activities. The PMO shall be headed by a director appointed by the Department of Science, Education, and Rural Environment of MOA, who will be responsible for overall guidance on project implementation, preparation of annual work plans, and policy coordination with relevant government agencies. FECC shall be responsible for day-to-day project management activities. The PMO shall be supported by four professional staff from existing FECC staff, who shall be employees all on full-time basis.	LA, Schedule 5, para. 1 PA, Schedule, para. 1	Complied. FECC took overall responsibility for project implementation and professional and full-time staff were in place as required.

Covenant	Reference in Legal Agreement	Status of Compliance
The Departments of Agriculture of the four Participating Provinces shall be the IAs. The provincial leading group set up in each of the Participating Provinces, comprising senior officials from the departments of agriculture, finance, and audit shall provide guidance in project implementation. A PIO shall be set up based in either the Provincial Rural Energy Office or the Agricultural Foreign Capital Project Office within each provincial Department of Agriculture to manage and oversee the Project implementation activities. Each PIO shall be headed by a senior official from the IA as director and staffed with seven to ten trained and qualified technical, financial, and project management personnel.	LA, Schedule 5, para. 2 PA, Schedule, para. 2	Complied. The four PIOs were set up in Heilongjiang Provincial Rural Energy Office, Energy Station of Henan Department of Agriculture, Foreign Capital Utilization Office of Jiangxi Provincial Agricultural Department, and Technology Introduction Office of Shandong Provincial Department of Agriculture. All four PIOs were headed by a Director or Deputy Director level official and staffed with sufficient well trained and qualified staff to implement the project.
Each concerned Local Government shall set up a leading group and establish a PIU for field-level Project activities. The PIUs shall be located at the Bureau of Agriculture or other related agencies in the concerned Local Governments and supported by the bureaus of finance, livestock, renewable energy offices, poverty alleviation offices, and other relevant technical agencies of such concerned Local Governments. The PIUs shall work closely with the township governments and village committees; nongovernment organizations, such as women associations and research institutes; and universities.	LA, Schedule 5, para. 3 PA, Schedule, para. 3	Complied. The PIOs for all four participating provinces were established and functioned as required.
Counterpart Financing The Borrower shall cause the EA and IAs to ensure that (a) all domestic financing necessary for the Project be provided in a timely manner, and (b) additional counterpart financing be provided in the event of any shortfall of funds or cost overruns to complete the Project.	LA, Schedule 5, para. 4 PA, Schedule, para. 4	Complied. Counterpart funding was made available to ensure project completion.
(a) Each Participating Province shall carry out the Project with due diligence and efficiency, and in conformity with sound administrative, financial, engineering, environmental, and bio-energy development practices. (b) In the carrying out of the Project and operation of the Project facilities, each Participating Province shall perform all obligations set forth in the Loan Agreement to the extent that they are applicable to each Participating Province and all obligations set forth in the Schedule to this Project Agreement.	PA, Art. II, Section 2.01	Complied. All four participating province fully performed all obligations.
Each Participating Province shall make available, promptly as needed, the funds, facilities, services, equipment, land and other resources which are required, in addition to the proceeds of the Loan, for the carrying out of the Project.	PA, Art. II, Section 2.02	Complied. Funds, facilities, services, equipment, land, and other resources were provided as project progressed.
(a) In the carrying out of the Project, each Participating Province shall employ competent and qualified consultants and contractors, acceptable to ADB, to an extent and upon terms and conditions satisfactory to ADB.	PA, Art. II, Section 2.03	Complied. Consulting firms and individual consultants with the CEFPF and

Covenant	Reference in Legal Agreement	Status of Compliance
(b) Except as ADB may otherwise agree, all Goods, Works and consulting services to be financed out of the proceeds of the Loan shall be procured in accordance with the provisions of Schedule 4 to the Loan Agreement. ADB may refuse to finance a contract where Goods, Works or consulting services have not been procured under procedures substantially in accordance with those agreed between the Borrower and ADB or where the terms and conditions of the contract are not satisfactory to ADB.		GEF grants were recruited for a total of 281 person-months, supporting the EA and four IAs for project management and technical services. Recruitment of consulting services, procurement of goods and civil works were conducted in compliance with provisions of Schedule of the Loan Agreement.
Each Participating Province shall carry out the Project in accordance with plans, design standards, specifications, work schedules and construction methods acceptable to ADB. Each Participating Province shall furnish, or cause to be furnished, to ADB, promptly after their preparation, such plans, design standards, specifications and work schedules, and any material modifications subsequently made therein, in such detail as ADB shall reasonably request.	PA, Art. II, Section 2.04	Complied. The Project was carried out in accordance with ADB accepted plans, design standards, specifications, work schedules and construction methods.
(a) Each Participating Province shall cause the Participating Enterprises to take out and maintain with responsible insurers, or make other arrangements in line with the Borrower's regulations for, insurance of the Project facilities which are being and have been developed or constructed by the concerned Participating Enterprise to such extent and against such risks and in such amounts as shall be consistent with sound practice. (b) Without limiting the generality of the foregoing, each Participating Province undertakes to insure, or cause to be insured, the Goods to be imported for the Project and to be financed out of the proceeds of the Loan against hazards incident to the acquisition, transportation and delivery thereof to the place of use or installation, and for such insurance any indemnity shall be payable in a currency freely usable to replace or repair such Goods.	PA, Art. II, Section 2.05	Complied. Project facilities were properly insured in line with the Borrower's regulation.
Each Participating Province shall maintain, or cause to be maintained, records and accounts adequate to identify the Goods, Works and consulting services and other items of expenditure financed out of the proceeds of the Loan, to disclose the use thereof in the Project, to record the progress of the Project (including the cost thereof) and to reflect, in accordance with consistently maintained sound accounting principles, its operations and financial condition.	PA, Art. II, Section 2.06	Complied. Compliance was confirmed during review missions.
(a) ADB and the Participating Provinces shall cooperate fully to ensure that the purposes of the Loan will be accomplished. (b)The concerned Participating Province shall promptly inform ADB of any condition which interferes with, or threatens to interfere with, the progress of the Project, the performance of its obligations under this Project Agreement, or the accomplishment of the purposes of the Loan.	PA, Art. II, Section 2.07	Complied. Compliance was confirmed during review missions and in progress reports.

Covenant	Reference in Legal Agreement	Status of Compliance
(c)ADB and each Participating Province shall from time to time, at the request of either party, exchange views through their representatives with regard to any matters relating to the Project, the concerned Participating Province and the Loan.		
(a) Each Participating Province shall furnish to ADB all such reports and information as ADB shall reasonably request concerning (i) the Loan and the expenditure of the proceeds thereof; (ii) the Goods, Works and consulting services and other items of expenditure financed out of such proceeds; (iii) the Project; (iv) the administration, operations and financial condition of the Participating Province to the extent relevant to the Project; and (v) any other matters relating to the purposes of the Loan. (b)Without limiting the generality of the foregoing, the EA and each Participating Province shall furnish to ADB semi-annually reports on the execution of the Project and on the operation and management of the Project facilities. Such reports shall be submitted in such form and in such detail and within such a period as ADB shall reasonably request, and shall indicate, among other things, progress made and problems encountered during the six (6) months under review, steps taken or proposed to be taken to remedy these problems, and proposed program of activities and expected progress during the following six (6) months. (c)Promptly after physical completion of the Project, but in any event not later than three (3) months thereafter or such later date as ADB may agree for this purpose, each Participating Province shall prepare and furnish to ADB a report, in such form and in such detail as ADB shall reasonably request, on the execution and initial operation of the Project, including its cost, the performance by the participating Province of its obligations under this Project Agreement and the accomplishment of the purposes of the Loan.	PA, Art. II, Section 2.08	Complied. All semi-annual or annual progress reports were submitted on time. The EA submitted a consolidated PCR to ADB on time which was based on the PCRs prepared by four IAs.
(a) Each Participating Province shall (i) maintain separate accounts for the Project and for its overall operations; (ii) have such accounts and related financial statements (balance sheet, statement of income and expenses, and related statements) audited annually, in accordance with appropriate auditing standards consistently applied, by independent auditors whose qualifications, experience and terms of reference are acceptable to ADB; and (iii) furnish to ADB, promptly after their preparation but in any event not later than six (6) months after the close of the fiscal year to which they relate, certified copies of such audited accounts and financial statements and the report of the auditors relating thereto (including the auditors' opinion on the use of the Loan proceeds and compliance with the covenants of the Loan Agreement as well as on the use of the procedures for imprest account/statement of expenditures), all in the English language. Each Participating Province shall furnish to ADB such further information concerning such accounts and financial statements and the audit thereof as ADB shall from time to time reasonably request.	PA, Art. II, Section 2.09	Complied. All annual audited reports covering the loan, CEFPF and GEF grants were submitted on time as requested. Shandong Dadi and Tengzhou Kunda enterprises ceased operations while three completed projects failed to be put into use. The completed works and equipment procured under the two companies were abandoned. Shandong Dadi and Tengzhou Kunda could not provide the financial statements and/or had restricted audit scope, resulting in qualified opinion since fiscal year 2015-2019 and 2016-2019, respectively.

Covenant	Reference in Legal Agreement	Status of Compliance
(b) Each Participating Province shall enable ADB, upon ADB's request, to discuss the Participating Province's financial statements and its financial affairs, to the extent relevant to the Project, from time to time with the auditors appointed by the Participating Province pursuant to Section 2.09(a) hereabove, and shall authorize and require any representative of such auditors to participate in any such discussions requested by ADB, provided that any such discussion shall be conducted only in the presence of an authorized officer of the Participating Province unless the Participating Province shall otherwise agree.		
Each Participating Province shall permit and make necessary arrangements for ADB's representatives to review the Project, the Goods and Works financed out of the proceeds of the Loan, the plants, sites, properties and equipment under Subprojects, to the extent relevant to the Project, and any relevant records and documents.	PA, Art. II, Section 2.10	Complied. Each participating province facilitated ADB's representatives review as needed.
Except as ADB may otherwise agree, each Participating Province shall ensure that the Participating Enterprises shall not sell, lease or otherwise dispose of any of its assets which shall be required for the efficient carrying on of its operations or the disposal of which may prejudice its ability to perform satisfactorily any of its obligations under this Project Agreement.	PA, Art. II, Section 2.11	Complied. Each participating enterprise did not sell, lease, or otherwise dispose of its assets.
Except as ADB may otherwise agree, each Participating Province shall apply the proceeds of the Loan to the financing of expenditures on the Project in accordance with the provisions of the Loan Agreement and this Project Agreement, and shall ensure that all Goods, Works and consulting services financed out of such proceeds are used exclusively in the carrying out of the Project.	PA, Art. II, Section 2.12	Complied. Compliance is confirmed and ensured during the project review mission and day-to-day project administration.
Land Acquisition and Resettlement Each Participating Province shall ensure that (a) the Participating Enterprises shall have valid legal entitlement to the land on which development or construction of the Project facilities under the proposed Subproject will be carried out, (b) no land acquisition be required for such proposed Subproject, and (c) no resettlement be required for such proposed Subproject.	PA, Schedule, para. 5	Complied. The project is categorized as "C" and no land acquisition and resettlement issues were identified.
Environment Each Participating Province shall ensure that the Project facilities are constructed, maintained, and operated in strict conformity to (a) all applicable national and local government technical guidelines, environmental laws, regulations, and procedures; (b) ADB's Environmental Policy (2002) and guidelines; and (c) the environmental mitigation and monitoring measures set out in the respective environmental assessment reports. In case that any subproject is cited for a violation of any law, regulation, standard, or ordinance related to environmental protection within the reporting period, a certification from the environmental authorities concerned will be included in the reports showing that the defect has been corrected or a corrective action plan has been accepted or approved.	PA, Schedule, para. 6	Complied. Compliance is confirmed in the external environmental monitoring reports.

Covenant	Reference in Legal Agreement	Status of Compliance
Environmental Review of Non-Core Subprojects Each Participating Province shall ensure that environmental safeguard screening procedures of the Non-Core Subprojects be applied in compliance with the environment assessment and review procedure formulated for the Project, which requires adequate consultations and the establishment of an environmental management plan for each Subproject.	PA, Schedule, para. 7	Complied. IEEs for all non-core subprojects were disclosed and all environmental safeguards screening procedures were done prior to approval of non-core subprojects.
Project Performance Monitoring System Within 12 months of the Loan effective date, the EA and each Participating Province shall establish a PPMS with proper indicators to be monitored and their frequency, and a suitably-staffed PPMS unit within the PMO and PIOs. Each will monitor and evaluate project impacts and effects through the PPMS to ensure that the project facilities are managed effectively and the benefits are maximized. Each province will cause the concerned PIO to conduct routine results monitoring evaluations and socioeconomic surveys, and transmit the results to PMO, which will in turn consolidate and report the results to Ministry of Finance of the Borrower, Global Environment Facility, and ADB together with the semiannual progress reports.	PA, Schedule, para. 8	Complied. PPMS was established and status updated in the progress reports.
Subproject Review and Approval Procedure Each Participating Province shall supervise the concerned PIO and finance bureaus of the concerned Local Governments in the selection and approval of the Sub-loan applications in accordance with the subproject review and approval process.	PA, Schedule, para. 9	Complied. Selection and approval of the Sub-loan applications were made in accordance with the subproject review and approval process.
Each Participating Province shall ensure that due diligence be conducted prior to approval of the proposed Subprojects on the following aspects: (i) financial and economic viability, (ii) compliance of technical design with relevant standards, (iii) safeguard compliance, and (iv) procurement plan and other implementation arrangements for the Subprojects.	PA, Schedule, para. 10	Complied. Due diligence on requested aspects were done prior to approval of subprojects.
Each Participating Province shall submit to ADB the feasibility study report and IEE of the first Non-Core Subproject in the respective Participating Province for review and approval prior to the execution of the Sub-loan Agreements and implementation of the selected Subproject. Each Participating Province shall approve, without ADB's prior review, the remaining Non-Core Subprojects.	PA, Schedule, para.11	Complied. All necessary requirements were followed in implementing subsequent non-core subprojects.
Each Participating Province shall ensure that the necessary clearances be obtained prior to starting the bidding process of each Non-Core Subproject, including environmental safeguard clearance by the respective provincial, city, or county environmental protection bureaus. Each Participating Province shall ensure that the same level of environmental safeguard review as described in EARP of the SIEE be carried out; ensure that EARP comply with both the Borrower's and ADB's regulatory and policy requirements, with the more stringent requirements being followed should the Borrower's and ADB's requirements differ. Upon approval of the provincial	PA, Schedule, para. 12	Complied. Necessary clearances were obtained prior to starting the bidding process of each non-core subproject.

Covenant	Reference in Legal Agreement	Status of Compliance
EPBs, the environmental assessment reports shall be posted on the local government's website or billboard and provided to ADB for disclosure.		
Each Participating Province shall cause the concerned Local Governments to maintain the records of reviewing, selecting, and approving the Sub-loans for ADB's review. ADB shall have the right to refuse provision of funding for those Non-Core Subprojects which fail to meet the Sub-loan terms, Sub-Borrowers' and Subprojects' eligibility criteria, and national technical requirements, in which case the finance bureaus of the concerned Local Governments shall refund the proceeds of the Loan to ADB.	PA, Schedule, para. 13	Complied. Records were maintained for review by ADB.
Non-Core Subprojects Selection Criteria General Requirements The proposed Subproject shall focus on large-scale farming, livestock production, processing, and distribution; deal with waste from the farming and livestock enterprises or farmer cooperatives; and demonstrate a replicable integrated approach to environment-friendly waste treatment, biogas energy, and fertilizer utilization that benefits the rural population.	PA, Schedule, para. 14	Complied. New subprojects selected were compliant with required selection standards.
The application for the Sub-Loan shall be made on a voluntary basis and provide the complete set of legally required documentation for project review and approval as required in paragraphs 9 through 13 above.	PA, Schedule, para. 15	Complied. The application for subprojects were made on voluntary basis and required documents were provided.
The Subproject application shall also provide high-standard conditions for livestock production, product processing, and distribution; and prove the possession of management and technical capabilities.	PA, Schedule, para. 16	Complied. High-standard conditions were provided.
Financial Requirements The Participating Enterprises shall be registered at the Industry and Commerce Bureau, or the farmer cooperatives at the relevant department. The Participating Enterprises shall have a good reputation, have no loan default or commercial breach in the past, have a sound financial management system, and agree to take the responsibility to repay the Sub-Loan.	PA, Schedule, para. 17	Complied. The participating enterprises met the necessary financial requirements in the time of subprojects approval.
The Sub-Borrower shall be able to raise financing to cover 40% of the total investment for the proposed Subproject from sources other than the Sub-Loan, of which at least 15% of the total investment costs shall be the Sub-Borrower's equity investment.	PA, Schedule, para. 18	Partially complied. Domestic financing reached at about 35% Counterpart funding was provided in a timely manner in line with implementation progress.
Requirements for Feedstock A Subproject shall meet the following general quantitative feedstock requirements: (i) an annual sale of more than 3,000 pigs, 100,000 broilers, or (ii) 500 beef cattle; or (iii) an annual inventory of more than 50,000 layers or 200 dairy cattle. Other Subprojects such as poultry farms, agro-industrial waste or bio-organic municipal waste from 17,000 people, or a mixture of all these waste, shall be equivalent to this standard, which implies a production of at least 300 m3/day of biogas (60% methane [CH4]) for a	PA, Schedule, para. 19	Partially complied. Henan and Jiangxi have annual sale of pigs for over 10,000 and Shandong over 15,000 averaged at per subproject level. Shandong and Jiangxi have annual inventory of cattle for over 500 and 1,000, respectively, averaged at per subproject level. For poultry, Shandong is 5,000 m^3/day and

Covenant	Reference in Legal Agreement	Status of Compliance
medium- scale biogas plants; or 600 m3/day of biogas for large-scale biogas plants.		Jiangxi 300 m^3/day. It is not applicable for Henan of cattle or poultry.
Environmental Management Requirements None of the Subprojects shall infringe on natural reserves. The location of each Subproject shall comply with local land use plan.	PA, Schedule, para. 20	Complied. Compliance was confirmed in the progress report and external monitoring reports.
The Subprojects which are animal husbandry farm or agro-product processing enterprises shall demonstrate the possibility to utilize the biogas by-products, including bio-solids and slurry.	PA, Schedule, para. 21	Complied. The biogas by-products including bio-solids and slurry were utilized by some animal husbandry farms or agro-product processing enterprises through activities under eco-farming component.
All project emissions have to be controlled according to the Chinese environmental legislation.	PA, Schedule, para. 22	Complied. All project emissions were controlled according to the Chinese environmental legislation.
Socioeconomic Requirements Each Subproject shall enhance at least 300 indirect beneficiaries who will benefit through increased production, better living condition via fertilizer application, energy use, and proactive engagement of local farmers in the production activities.	PA, Schedule, para. 23	Complied. Over 9 million beneficiaries from the four participating provinces were benefitted from the project activities.
MOA shall be the EA, responsible for overall Project implementation. The Departments of Agriculture of the Participating Provinces shall be the IAs, responsible respectively for the activities to be undertaken in their provinces.	CEFPF & GEF GA, Schedule 4, para. 1	Complied. MOA as the EA was responsible for overall project implementation. The four IAs were responsible for the activities undertaken in their respective province.
The lead group set up by MOA and comprising senior officials from Ministry of Finance, National Development Reform Commission, MOA's departments of planning, science, education, and rural environment, and the FECC, shall provide policy guidance and support to Project implementation.	CEFPF & GEF GA, Schedule 4, para. 2	Complied. Lead group was established during inception of the project.
The PMO established in MOA shall be responsible for overall Project management, coordination, training, recruitment of consultants, and other implementation and monitoring activities. The PMO will be headed by a director appointed by the Department of Science, Education, and Rural Environment of MOA, who shall be responsible for overall guidance on project implementation, preparation of annual work plans, and policy coordination with relevant government agencies. FECC shall be responsible for day-to-day project management activities. The PMO will be supported by four professional staff from existing FECC staff. The PMO staff will be full-time employees.	CEFPF & GEF GA, Schedule 4, para. 3	Complied. The PMO established by MOA functioned effectively.
The provincial lead group set up by each IA and comprising senior officials from the departments of agriculture, finance, and audit shall provide guidance in Project implementation in each concerned Participating Province. The PIO set up by each IA shall be based in	CEFPF & GEF GA, Schedule 4, para. 4	Complied. Lead group for each participating province was established during

Covenant	Reference in Legal Agreement	Status of Compliance
either the Provincial Rural Energy Office or the Agricultural Foreign Capital Project Office within concerned provincial Department of Agriculture to manage and oversee the project implementation activities. Each PIO shall be headed by a senior official from the IA as director and staffed with seven to ten trained and qualified technical, financial, and project management personnel.		project inception and functioned effectively and efficiently.

ADB = Asian Development Bank, CEFPF = Clean Energy Financing Partnership Facility, EA = executing agency, EARP = environmental assessment and review procedure, EPB = environmental protection bureau, FECC = Foreign Economic Cooperation Center, GA = grant agreement, GEF = Global Environment Facility, IA = implementing agency, IEE = initial environmental examination, LA = loan agreement, MOA = Ministry of Agriculture, PA = project agreement, PIO = project implementing office, PIU = project implementing unit, PLG = project leading group, PMO = project management office, PPMS = project performance management system, SIEE = summary initial environmental examination