

**Validation Report**  
August 2021

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

Reference number: PVR-777  
Project number: 40682-013  
Loan number: 2632  
Grant numbers: 0202 and 0203

Independent  
Evaluation  ADB

*Raising development impact through evaluation*

## ABBREVIATIONS

ADB	–	Asian Development Bank
CBP	–	centralized biogas plant
CEF	–	Clean Energy Fund
CO <sub>2</sub>	–	carbon dioxide
CPS	–	country partnership strategy
DMF	–	design and monitoring framework
EIRR	–	economic internal rate of return
FIRR	–	financial internal rate of return
GEF	–	Global Environment Facility
GHG	–	greenhouse gas
GTZ	–	German Corporation for Technical Cooperation
m <sup>3</sup>	–	cubic meters
MLBGPs	–	medium- and large-scale biogas plants
O&M	–	operation and maintenance
PCR	–	project completion report
PIO	–	project implementation office
PMO	–	project management office
PPMS	–	project performance management system
PRC	–	People's Republic of China
RRP	–	report and recommendation of the President
WACC	–	weighted average cost of capital

## NOTE

In this report, "\$" refers to United States dollars.

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## PROJECT BASIC DATA

<b>Project number</b>	40682-013	<b>PCR circulation date</b>	4 Dec 2020	
<b>Loan and grant numbers</b>	2632, 0202, and 0203	<b>PCR validation date</b>	Aug 2021	
<b>Program name</b>	<b>Integrated Renewable Biomass Energy Development Sector Project</b>			
<b>Sectors and subsectors</b>	Energy Agriculture, natural resources, and rural development	Renewable energy generation – biomass and waste Agro-industry, marketing, and trade		
<b>Strategic agendas</b>	Environment sustainable growth Inclusive economic growth			
<b>Safeguard categories</b>	Environment		B	
	Involuntary resettlement		C	
	Indigenous peoples		C	
<b>Country</b>	People's Republic of China	<b>Approved (\$ million)</b>	<b>Actual (\$ million)</b>	
<b>ADB financing (\$ million)</b>	<b>ADF:</b> 0.00	<b>Total project costs<sup>a</sup></b>	152.48	88.85
	<b>OCR:</b> 66.08	<b>Loan 2632</b>	66.08	50.21
		<b>Borrower</b>	10.70	4.40
		<b>Beneficiaries</b>	58.90	26.50
		<b>Others: GTZ<sup>b</sup></b>	4.60	0.0
<b>Cofinancier</b>	CEF–CEFPF and GEF	<b>Total cofinancing</b>		
		0202	3.00	1.57
		0203	9.20	6.17
<b>Approval date</b>	16 Apr 2010	<b>Effectiveness dates</b>		
		2632	15 Sep 2010	15 Oct 2010
		0202/0203	28 Sep 2010	27 Oct 2010
<b>Signing dates</b>	2632 0202/0203	<b>Project completion dates</b>	31 Dec 2015	30 Jun 2018
		<b>Financial closing dates</b>		
			2632	—
		0202/0203	—	01 Sep 2020
<b>Project officers</b>	J. Masic L. Wang	<b>Location</b>	<b>From</b>	<b>To</b>
		PRCM PRCM	Jul 2010 Jan 2013	Dec 2012 Sep 2020
<b>IED review Director</b>	N. Subramaniam, IESP <sup>c</sup>			

ADB = Asian Development Bank, ADF = Asian Development Fund, CEF–CEFPF = Clean Energy Fund under the Clean Energy Financing Partnership Facility, GEF = Global Environment Facility, GTZ = German Technical Cooperation, IED = Independent Evaluation Department, IESP = Sector and Project Division, OCR = ordinary capital resources, PCR = project completion report, PRCM = People's Republic of China Resident Mission.

<sup>a</sup> Numbers may not sum precisely because of rounding.

<sup>b</sup> The project completion report indicated that actual figure from GTZ is not available.

<sup>c</sup> Team members: B. Nguyen (quality reviewer), F. De Guzman (Senior Evaluation Officer), P. Choynowski, D. Corderi, and T. Hanson (consultants).

## I. PROJECT DESCRIPTION

### A. Rationale

1. The livestock industry in the People's Republic of China (PRC) had developed rapidly due to the growing demand for dairy and meat products. However, this rapid expansion led to environmental degradation associated with waste generation. Agro-enterprises, such as ethanol production, vegetable processing, and livestock slaughter also became important sources of biomass wastes and pollution problems. The wastes produced from the livestock farms and agro-enterprises contained high pollutant concentrations, such as chemical oxygen demand, biochemical oxygen demand, ammonia nitrogen, and phosphorous, which were often disposed without treatment. According to the report and recommendation of the President (RRP), the rural pollution's economic loss was estimated at about 1% of the PRC's gross domestic product.<sup>1</sup> Livestock wastes also released greenhouse gases (GHGs) that contributed to global warming.

2. The rich organic wastes from the livestock farms can be converted to methane through anaerobic digestion, which can be used to generate electricity to power livestock farms and neighboring households. Sludge produced from the biogas plants can be used as bio-fertilizer to replace chemical fertilizers. It was estimated that anaerobic digestion can remove as high as 90% of pollutants.<sup>2</sup> The livestock densities in these areas were about triple the national average. Thus, the pollution problems from livestock farms and agro-enterprises were severe.

3. The Integrated Renewable Biomass Energy Development Sector Project (the project) was formulated and approved in April 2010 to improve the biogas subsector's performance through having an integrated renewable biomass energy system in the poor rural areas of the participating provinces of Heilongjiang, Henan, Jiangxi, and Shandong. The project's main components were (i) constructing 118 medium- and large-scale biogas plants (MLBGPs) for livestock farms and agro-enterprises; (ii) connecting 25 biogas plants to local power grids; (iii) pilot-testing and establishing business models for 10 centralized biogas plants (CBPs); (iv) financing the purchase of (a) blending and mixing machines to produce bio-fertilizers from the sludge of MLBGPs, (b) vehicles and equipment to transport and distribute the bio-fertilizers, and (c) seeds, seedlings, and other materials for farm production; (v) consulting services to strengthen the capacity of extension service centers and advisory assistance to the operation of biogas plants; and (vi) technical support for project implementation. The project was financed through the sector lending modality as the government satisfied the eligibility criteria of Asian Development Bank's (ADB) policy for sector lending. It included a well-formulated sector policy and strategic framework on biomass energy development and sector institutions in central and provincial governments.

### B. Expected Impact, Outcome, and Outputs

4. The project's envisaged impact was improved rural environmental management and access to biogas energy. Its expected outcome was improved efficiency of the rural biomass renewable energy system and rural social benefits. The project's planned outputs were (i) MLBGPs' sustainable development and demonstration of commercial practices, (ii) effective utilization of biogas sludge in eco-farming, (iii) capacity development for improved sector performance, and (iv) project implementation support.

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<sup>1</sup> ADB. 2010. *Report and Recommendation of the President to the Board of Directors: Proposed Loan and Administration of Grants to the People's Republic of China for the Integrated Renewable Biomass Energy Development Sector Project*. Manila.

<sup>2</sup> Zhang Cong. 2002. Environmental Impact Assessment of Biogas Engineering in Large and Medium-Sized Pig Farms –A Case Study from Wuwen Village in Hubei Province. *Agro-Environmental Protection*. 21(1). pp. 33–36.

5. There were four minor changes in scope during implementation. First, procurement methods were changed from quality and cost-based selection to international competitive shopping and national competitive bidding to direct contracting in March 2014. Second, the ceiling for advances to the imprest account in Henan Province was increased to \$5.0 million from \$2.2 million in October 2015. Third, two original key performance targets for outcomes were modified: (i) the annual production for rural energy use was reduced from “about 70 million cubic meters (m<sup>3</sup>)” of biogas to “about 55 million m<sup>3</sup>,” and (ii) GHGs’ target was changed from 1 million tons of carbon dioxide (CO<sub>2</sub>) equivalent to 770,000 tons. Fourth, the target of 118 MLBGP’s performing to technical standards by 2014 was changed to 69 MLBGP’s by 2018 in August 2017.

### C. Provision of Inputs

6. The project completion report (PCR) indicated that the project was approved in April 2010 and became effective in October 2010.<sup>3</sup> The loan agreement stated that the loan closing date was in June 2016, while it actually closed in December 2018, 2.5 years later. Removal and subsequent replacement of subprojects and slower-than-anticipated completion of MLBGP’s and CBP’s delayed the project. The loan financially closed in January 2020, while the grants financially closed in September 2020.

7. The total project cost at appraisal was estimated at \$152.54 million equivalent, including taxes and duties, contingencies and interest, and other charges during construction. The foreign exchange cost was estimated at \$61.59 million (60%), and the local currency cost was estimated at \$90.95 million equivalent (40%). ADB was to provide a \$66.08 million loan from its ordinary capital resources, representing 44% of the total project cost. The PRC was the borrower and was to pass on the loan’s proceeds to the four participating provinces on the same terms and conditions as the ADB loan plus an additional 0.2% interest rate. In addition to the ADB loan, the Global Environment Facility (GEF) was to provide a \$9.2 million grant, the multi-donor Clean Energy Fund (CEF) under the Clean Energy Financing Partnership Facility was to provide a \$3.0 million grant equivalent, and the German Technical Cooperation (GTZ) was to provide a \$4.6 million grant.

8. At project completion, the total project cost was \$88.64 million.<sup>4</sup> ADB administered the loan and two grants, totaling \$57.75 million in foreign exchange (65%). Domestic financing was equivalent to \$30.89 million in local currency (35%). The PCR indicated that the cost underruns were mainly due to a lower amount of civil works and goods needed for constructing the MLBGP’s and CBP’s. Heilongjiang, Henan, and Jiangxi provinces requested to cancel the \$6.02 million from the ADB loan in August 2017 due to worsening market conditions for the livestock industry, which led to a high number of bankrupt subproject enterprises. The PCR also indicated that the last round of cancellation was at loan closing in January 2020 for \$9.85 million due to underspending on civil works and goods and an economic downturn. The total amount cancelled was about 24% of the approved ADB loan.

9. The project management office (PMO) was to engage an international consultant to support detailed design and supervise activities. Selected project implementation offices (PIOs) were to engage individual consultants to carry out activities under the CEF. These consultants were to review the installation of high-temperature flares, conduct a survey on MLBGP’s’

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<sup>3</sup> ADB. 2020. Completion Report: *Integrated Renewable Biomass Energy Development Sector Project in the People’s Republic of China*. Manila.

<sup>4</sup> The project’s implementation cost from the GTZ was not available so the project cost at completion did not include GTZ’s expenditure.

performances in participating provinces, and develop and implement a performance monitoring mechanism for MLBGPs. The PMO and PIOs were to engage firms to support the GEF-funded activities. The consultants were to assist in capacity development and project management for the design, construction, and operation of the CBPs and specialized studies. GTZ was to finance and recruit consultants to assist in project implementation management, subproject construction supervision, and capacity development of MLBGPs' design and operation.

10. Under the CEF 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. Under the GEF grant, one consulting firm and seven individual consultants were recruited. The PMO did not engage an international consultant to support detailed design and supervise activities. The PCR provided no information on person-months of consulting services.

11. The project was categorized B at appraisal for environment, while involuntary resettlement and indigenous peoples had no categorizations. Initial environmental examinations were prepared for five core subprojects. The adverse environmental impacts were insignificant and only minor construction and operational impacts were expected. No land acquisition or resettlement was required since all subprojects were to take place within the existing agro-enterprises-owned land. No subproject was located in a minority autonomous area and no ethnic minorities were identified at the subproject sites. The project had no gender action plan.

#### **D. Implementation Arrangements**

12. As envisioned at appraisal, the Ministry of Agriculture and Rural Affairs was the executing agency and the agriculture departments of the four participating provinces were the implementing agencies. A PMO was established in the ministry for overall project management, coordination, training, recruitment of consultants, and other implementation and monitoring activities, and the ministry's Foreign Economic Cooperation Center provided support. Each PIO was located in the respective provincial agriculture department and was to conduct 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. Each implementing agency was to supervise the respective PIO and the finance departments in the designated municipalities, districts, or counties that were responsible in the selection and approval of subloan applications. There was no attached advisory technical assistance to the project.

13. The loan, project, and grant agreements had 44 covenants, of which 42 were complied with and 2 were partly complied with. For the two partly complied with covenants, the subborrower was to cover 40% of the proposed subproject's total investment from sources other than the subloan, of which at least 15% of the total investment was to be the subborrower's equity investment. The subborrower raised only 35% of the financing. The borrower also could not meet the sales requirement of 3,000 pigs per subproject due to swine flu, restrictions on land for pig farming, and subproject dropouts and bankruptcies. However, annual sales averaged above 10,000 per subproject in Henan, Jiangxi, and Shandong provinces.<sup>5</sup>

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<sup>5</sup> The text in the PCR (para. 29) and Appendix 10 were inconsistent in their assessment of compliance with the covenant in Project Agreement, Schedule, para. 19.

## II. EVALUATION OF PERFORMANCE AND RATINGS

### A. Relevance of Design and Formulation

14. The PCR rated the project relevant. The project was aligned with the government's priorities in promoting the "energy-ecological type" of biogas plants, the 2007 Medium- and Long-Term Development Plan for Renewable Energy, and the Circular Economy Promotion Law of 2009.<sup>6</sup> The project was consistent with ADB's core area of operation on climate change in its Strategy 2020.<sup>7</sup> The project also supported the government's commitment to the Kyoto Protocol in reducing GHG emissions; the Energy Development Plan in the Eleventh Five-Year Plan, 2006–2010; the National Rural Biogas Development Plan, 2006–2010; and the four participating provinces' rural energy development action plans.<sup>8</sup> The project was also in line with ADB's 2008–2010 country partnership strategy (CPS) for the PRC that aimed to improve rural environmental quality, increase access to energy, and reduce reliance on imported energy sources through the development and utilization of biomass renewable energy.<sup>9</sup>

15. The PCR indicated that project design could have been improved. The criteria for selecting livestock subprojects should have been designed more rigorously and specifically targeted key agribusiness players instead of small- and medium-sized livestock farmers to improve its relevance. Facilitating adoption of advanced technologies was another missed opportunity.<sup>10</sup> The PCR also noted that the design and monitoring framework (DMF) had design weaknesses. Quantifiable indicators should have been established for outputs 1 and 2 to measure the number of grid connections for MLBGPs and CBPs, and the level of the feed-in tariff and degree of energy conservation. Key performance indicators for output 4 merely supported routine project implementation and, therefore, had limited value as indicators. The PCR also suggested that a separate output should have been created to reflect synergy between outputs 1 and 2 and 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 eco-farming expansion.

16. The PCR indicated that the government satisfied the eligibility criteria of ADB's policy for sector lending and the project adopted a sector investment approach to strengthen the enforcement of the sector policy framework and institutional capacity. Minor changes in scope were made in 2015 and 2017 to expand eco-farming to generate better economic and financial returns to the subproject enterprises and enhance carbon absorption through eco-farming. This validation notes that some changes in the scope mainly reduced the number of biogas plants to be constructed. In principle, this should have affected the outcome performance targets and would warrant a major change in scope. Although the PCR documented a few design weaknesses, the project addressed the issue of agricultural waste and climate change and was consistent with the government's and ADB's priorities. On this basis, this validation assesses the project relevant.

<sup>6</sup> Government of the People's Republic of China. 2007. *Medium and Long-Term Development Plan for Renewable Energy in [the People's Republic of] China*. Beijing.

<sup>7</sup> ADB. 2008. *Strategy 2020: The Long-Term Strategic Framework of the Asian Development Bank, 2008–2020*. Manila.

<sup>8</sup> Government of the People's Republic of China, National Development and Reform Commission. 2007. *Eleventh Five-Year Plan on Energy Development*. Beijing; and Government of the People's Republic of China, Ministry of Agriculture. 2003. *National Rural Biogas Development Plan, 2006–2010*. Beijing.

<sup>9</sup> ADB. 2008. *Country Partnership Strategy: People's Republic of China, 2008–2010*. Manila.

<sup>10</sup> The published handbook, guidelines, and business models for MLBGPs or CBPs for output 3 lacked technical parameters to optimize the use of biogas as a renewable energy. No technical requirements existed for pilot-testing or adopting cutting-edge biogas technologies for scaling up heating and cooling and utility supply.

## **B. Effectiveness in Achieving Project Outcome and Outputs**

17. The PCR rated the project effective as it achieved the expected outcome of improved efficiency of rural biomass renewable energy systems and rural social benefits. All four outputs were substantially delivered. The achieved biogas production and GHG emission reduction were double the original approved outcome performance targets for 2019.

18. According to the PCR, all outcome targets were met. By 2019, more than 90% of the wastes of subproject farms were collected and treated (target was 90%). More than 100 million m<sup>3</sup> of biogas were produced per year for rural energy use (target was 55 million m<sup>3</sup>). The project met the target of about 41,000 households benefiting from improved access to clean energy. About 9,200 of these households were poor (target was 8,200). More than 27,000 farmers increased their incomes through expanded contract farming (target was 27,000). More than 10,000 poor households benefited from the use of organic fertilizers and the sales of organic products (target was 9,000). Finally, the project reduced GHG emissions by about 1.72 million tons of CO<sub>2</sub> equivalent annually (target was 770,000 tons).

19. For output 1—the sustainable development and demonstration of commercial practices of MLBGPs—65 MLBGPs were constructed by 2018 (target was 69), performing to technical stands and being fully monitored, as required. A total of 6 CBPs operated effectively by 2018 (target was 10). More than 90% of energy sources of each livestock farm or agro-enterprise were from the biogas plant by 2018 (target was 80%). A total of 62 methane capture devices were installed and worked about 95% of time by 2017, and business models for CBPs were established by 2018, meeting the expected targets set at appraisal.

20. For output 2—effective use of biogas sludge in eco-farming—a handbook on eco-farming and application of bio-fertilizers for agricultural production was developed by 2013, as required. Approximately 94% of the biogas plants supplied sludge to nearby farms as organic fertilizer for fruit, vegetable, and crop production by 2017 (target was 85%). The farmers' use of chemical fertilizers was reduced by 190,000 tons as it was replaced by biogas sludge. This surpassed the 50% annual reduction originally envisioned.

21. For output 3—capacity development for improved sector performance—all outputs were completed. A handbook on operation and maintenance (O&M) of MLBGPs was developed. Guidelines on the establishment of CBPs were finalized. Four provincial technical service centers supported biogas plants, about 320 technicians were trained in the O&M of biogas plants, a performance monitoring system for the design and operation of MLBGPs was prepared, and business models for CBPs were established. All outputs for output 4—project implementation support—were also completed. One PMO with five staff and four with 7–10 staff were established in 2010 and were operational during project implementation. Domestic funds were provided according to the project implementation progress. A project performance management system (PPMS) was set up in 2012 and updated yearly. Subprojects were prepared, reviewed, and approved in line with the review process.

22. The project was classified as category B for environment in accordance with ADB environment policy (2002). Under this policy, involuntary resettlement and indigenous peoples are not categorized.<sup>11</sup> Category B was appropriate given the limited impact of the proposed project and negligible land acquisition and resettlement impacts at each site. This validation notes

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<sup>11</sup> It was not until the introduction of the Safeguard Policy Statement in 2009 that three separate categories were assigned for environment, indigenous peoples, and involuntary resettlement.

that while the number of biogas plants substantially decreased compared to the originally envisioned (65 vs. 118 MLBGPs, 6 vs. 10 centralized plants), the amount of CO<sub>2</sub> reduction and biogas production more than doubled, compared to initial estimates. The PCR did not explain the reasons for this counterintuitive result. This validation assesses the project effective based on largely achieved outcome and output targets.

### **C. Efficiency of Resource Use**

23. The PCR rated the project efficient. The project's economic internal rates of return (EIRRs) ranged from 11.5% to 24.1% at project completion—close to the appraisal estimates of 12.2% to 23.6%. All subprojects' EIRRs were at or higher than the opportunity cost of capital of 12.0%. Implementation was less than efficient with implementation arrangements overly layered. Coordinating all four PIOs was difficult with respect to submission of project scope change requests and reallocation and cancellation of loan proceeds that resulted from the cost underruns. Project cost underruns were mainly due to the reduced amount of civil works and goods for constructing the MLBGPs and CBPs. The project was completed with an 18-month delay.

24. The EIRR recalculation was conducted in local currency (yuan), with domestic price as numeraire and a shadow exchange rate factor of 1.023 calculated for the period of 2011–2015, as issued by ADB's Economic Research and Regional Cooperation Department.<sup>12</sup> The PCR indicated how the project's capital cost was shadow priced. However, little was said about O&M costs and the opportunity cost of the agricultural wastes seemed to have not been considered.<sup>13</sup>

25. The project's outputs were biogas, essentially methane, and sludge. However, the PCR was unclear how these benefits were valued. Since methane in the form of natural gas is a tradable good and an incremental benefit, all biogas production should have been valued in terms of international natural gas prices. Sludge is a substitute for chemical fertilizers and, therefore, it is a non-incremental benefit that should have been valued in terms of its substitute. The PCR was also unclear how the project reduced GHG emissions and to what extent. In the "without project" scenario, agricultural waste would have produced methane emitted into the atmosphere. In the "with project" scenario, this methane would have been converted into CO<sub>2</sub> and then emitted into the atmosphere. Therefore, the environmental benefit would be the difference in the environmental impacts of the methane and CO<sub>2</sub>.

26. In validation's view, there are shortcomings in identifying and valuing project economic benefits, which may have overestimated the economic benefits. On the whole, this validation assesses the project efficient due to the likelihood that net project benefits were substantial.

### **D. Preliminary Assessment of Sustainability**

27. The PCR rated the project likely sustainable. A financial reevaluation was conducted for each representative subproject by calculating the financial internal rates of return (FIRRs) and the weighted average cost of capital (WACC). The representative subprojects' FIRRs ranged from 1.1% to 17.1% at project completion against the estimated range of 6.0% to 11.9% at appraisal. Except for the Lihai subproject in Shandong Province, all representative subprojects had FIRRs exceeding their respective WACCs. The sensitivity analysis indicated that the subprojects were highly sensitive to cost increases, benefit decreases, and operation reductions. The project's environmental sustainability was significant as it reduced CO<sub>2</sub> emissions.

<sup>12</sup> ADB. 2017. *Guidelines for the Economic Analysis of Projects*. Manila.

<sup>13</sup> This assumes that there would have been some economic use for the agricultural waste without the project.

28. The PCR was unclear how the operating entities from the biogas and sludge generated revenues. It indicated that there were electricity sales from biogas conversion and cost savings from substituting liquefied petroleum gas with biogas, although no information was provided on the amount of output traded. The PCR also indicated a financial benefit from a net revenue increase from farm products that resulted from utilizing biogas sludge for eco-farming practices. This revenue should not be considered a financial benefit accruing to the project. It should have been valued instead in terms of the sludge's sale price or fertilizer cost savings. This validation notes that the FIRR's were sufficiently higher than WACCs, and it assesses the project likely sustainable.

### **III. OTHER PERFORMANCE ASSESSMENTS**

#### **A. Preliminary Assessment of Development Impact**

29. The PCR rated the project's development impact satisfactory. The project created new jobs, including constructing and operating MLBGPs and CBPs, and expanded eco-farming and sales of organic fertilizers, thus, it benefited poor farmers. During project construction, 3,069 local workers were employed, including 1,519 female workers (around 50%) and 375 workers from poor households (12%). A total of 1,450 workers were recruited for the O&M of the biogas plants, of which 805 were women (around 56% of the total staff). Through the eco-farming expansion, 1.48 million tons of biogas slurry manure were used to produce organic fertilizers. This benefited 16,047 rural households in 281 villages, reducing chemical fertilizer expenditures and raising their agricultural products' sale prices.<sup>14</sup>

30. In terms of environmental benefits, the project replaced coal consumption and absorbed carbon, thus reducing a significant volume of CO<sub>2</sub>. Expanded eco-farming enabled the conversion of barren land to arable eco-farming land through the Taiyu subproject in Shandong Province. However, the PCR failed to explain how the project led to convert barren land to arable eco-farming land. Health benefits included improvement in 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 that benefited local people, poor households, and female workers. The project improved rural environmental management and access to biogas energy, although the PCR had no evidence of these benefits.

31. The PCR also indicated that the project met the DMF's performance indicators of the development impact. However, the DMF performance targets did not properly capture the project's expected impact. This validation notes that several of the outcome indicators are more appropriate to measure project's impact, such as increases in farmer incomes or improved household access to clean energy. Improvements in air and water quality are also to be expected from the project, although were not measured. This validation considers that development impact is expected to be positive based on outcome achievement, although limited evidence is presented to adequately quantify it. This validation assesses the project's development impact satisfactory.

#### **B. Performance of the Borrower and Executing Agency**

32. The PCR rated the overall performance of the borrower, the executing agency, and the four implementing agencies satisfactory. They fulfilled their obligations agreed to in the loan,

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<sup>14</sup> The PCR did not explain how the use of biogas slurry manure resulted in higher sale prices of their agricultural products.

project, and two grant agreements. The Ministry of Finance fulfilled its responsibilities, including submission of requests to ADB for project scope changes and extensions to the loan and two grants' closing dates. Although no major deviations from the loan covenants occurred, gaps existed in the level of commitment and capacity of the PIOs. The implementing agencies in Jiangxi and Shandong provinces demonstrated strong leadership and overcame technical hurdles and external risks so that the loan and grants' proceeds were used efficiently. They actively promoted innovative solutions to resolve slow project implementation. However, the PMO played only a moderate role in demonstrating leadership and ownership of the project. This validation assesses the performance of the borrower, the executing agency, and the four implementing agencies satisfactory.

### C. Performance of the Asian Development Bank

33. The PCR rated ADB's performance satisfactory. ADB's PRC Resident Mission provided timely support to correct and streamline issues related to procurement for the loan and two grants and accelerated contract awards and disbursements. Due to a worsening livestock market, ADB cancelled loan savings and extended the loan and grants' closing dates in a timely manner to achieve the performance indicators. To improve the project's low investment returns, ADB made a timely change in scope and expanded the coverage of eco-farming in Henan, Jiangxi, and Shandong provinces. ADB also worked closely with the GEF and the CEFP Facility secretariats to obtain their endorsement of the grant closing date extensions and actively disseminated best practices of on-grid connection experiences in Jiangxi through internal and external media channels. This validation notes that the project had some design issues that could have been anticipated, and also considers that ADB responded appropriately to changes in market conditions. This validation assesses ADB's performance satisfactory.

## IV. OVERALL ASSESSMENT, LESSONS, AND RECOMMENDATIONS

### A. Overall Assessment and Ratings

34. The PCR rated the project successful. It was relevant to the government's development strategy, ADB's CPS, and thematic priorities, at appraisal and at completion. It was effective in achieving the outcome and all four outputs, except for one performance indicator of output 1 that fell slightly below the level targeted. The project demonstrated three resource-recycling models: (i) livestock waste to biogas, (ii) biogas to commodities, and (iii) biogas ancillary commodities to improved ecological well-being. The project was also efficient and likely sustainable. This validation assesses the project relevant, effective, efficient, likely sustainable, and overall successful.

#### Overall Ratings

Validation Criteria	PCR	IED Review	Reason for Disagreement and/or Comments
Relevance	Relevant	Relevant	
Effectiveness	Effective	Effective	
Efficiency	Efficient	Efficient	
Sustainability	Likely sustainable	Likely sustainable	
<b>Overall Assessment</b>	<b>Successful</b>	<b>Successful</b>	
Preliminary assessment of impact	Satisfactory	Satisfactory	
Borrower and executing agency	Satisfactory	Satisfactory	

Validation Criteria	PCR	IED Review	Reason for Disagreement and/or Comments
Performance of ADB	Satisfactory	Satisfactory	
Quality of PCR		Satisfactory	Para. 40.

ADB = Asian Development Bank, IED = Independent Evaluation Department, PCR = project completion report.  
 Source: ADB (IED).

**B. Lessons**

35. The PCR identified three lessons: (i) implementation arrangements should be simple and not overly complex; (ii) the National Energy Administration should have had a leading role in the project due to its technological know-how to guide and demonstrate policy commitment to achieve the renewable energy targets; and (iii) procurement should ensure that contract packaging, contracting methods, and standard bidding documents are defined to suit the needs and capacities of the executing and implementing agencies to avoid changes and noncompliance during implementation.

36. This validation offers two additional lessons on the project-level. The project’s design was not optimal at appraisal. A more thorough analysis of the livestock industry in assessing large- and small-scale enterprises and in assigning appropriate technologies to the subproject’s specific requirements and capacity of its operators can help reduce scope changes during project implementation. The lack of evidence of development impacts in the PCR suggested that the PPMS was insufficiently developed to record project outputs and establish baseline data for these outputs. Clearly defined system parameters in the RRP and including PPMS as a covenant in the loan agreement can ensure an adequately established PPMS.

**C. Recommendations for Follow-Up**

37. The PCR suggested eight recommendations. The first four recommendations were lessons rather than recommendations. First, a ministry with a strong commitment and binding political and policy targets should lead project design and implementation. Second, stringent technical parameters should be established for anaerobic digestion capacity, biogas power generation capacity, and grid connection. Third, to hedge against external shocks and maintain robust cash flows, the selection of subprojects should focus on enterprises with diverse operations, such as livestock in combination with cold chain, crop, or grain processing, or organic fertilizer purification. Fourth, the selection of subprojects should focus on the PRC’s southern region due to its stronger policy coordination and financial capacities and its warmer climatic conditions. One or two central or northern provinces could then follow the implementation experiences. Fifth, the Wannianxinxing subproject in Jiangxi Province, to successfully achieve 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.

38. The PCR also suggested that the executing and implementing agencies should monitor and report to ADB the outcome-level indicators for the fourth quarter of 2019–2021, and the Shandong PIO should monitor the Lihai subproject for any further technical progress. The loan covenant, “a subproject shall meet general quantitative feedstock requirements” related to pigs, broilers, beef cattle, and dairy cattle, should be changed to “subprojects in each province shall, on the average, meet the targets of” those feedstock requirements due to the many uncontrollable factors in the livestock industry. The Henan, Jiangxi, and Shandong PIOs should follow up with and offer intergovernmental coordination support to subproject owners’ efforts to obtain subsidies for the feed-in tariff. This validation has no other recommendations to offer.

## **V. OTHER CONSIDERATIONS AND FOLLOW-UP**

### **A. Monitoring and Reporting**

39. The PCR indicated that quarterly and annual progress reports, environmental monitoring reports, and audit reports were timely submitted. A PPMS 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 PPMS incorporated progress reports and provided sufficient information and data to measure project progress and cover socioeconomic, social, gender, and sector development. However, the PCR did not assess the PPMS, as required under the project's output 4. This validation is of a similar view with the PCR that the DMF had design weaknesses to measure project achievements. No information was collected to improve environmental quality (air and water), grid connections, or electricity produced.

### **B. Comments on Project Completion Report Quality**

40. The PCR was succinct and assessed all the evaluation criteria. There were some shortcomings in identifying, quantifying, and valuing incremental benefits in the economic and financial analyses. The PCR could have done a better job in substantiating evidence to support the development impact rating, although DMF had some design weaknesses and there was no PPMS assessment. Information presented on project achievements with respect to the DMF should also have been documented more clearly, such as data sources per indicator and assumptions behind the results. Despite some of the shortcomings, this validation assesses the PCR's quality satisfactory.

### **C. Data Sources for Validation**

41. Data sources used for this validation include the RRP, back-to-office reports, and ADB's CPSs.

### **D. Recommendation for Independent Evaluation Department Follow-Up**

42. The PCR recommended that the project performance evaluation report be prepared in 2022 or later, when the situation of the swine flu and coronavirus pandemic is under control in the PRC and subproject enterprises have more feedstock for biogas production, so that the biogas plants' operations are more sustainable. This validation supports this recommendation.