



1. Project Data

Project ID P100968	Project Name CN-Shanxi Coal Bed Methane Development	
Country China	Practice Area(Lead) Energy & Extractives	
L/C/TF Number(s) IBRD-77050	Closing Date (Original) 31-Dec-2014	Total Project Cost (USD) 80,000,000.00
Bank Approval Date 19-May-2009	Closing Date (Actual) 30-Jun-2017	
	IBRD/IDA (USD)	Grants (USD)
Original Commitment	80,000,000.00	0.00
Revised Commitment	80,000,000.00	0.00
Actual	80,000,000.00	0.00

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2. Project Objectives and Components

a. Objectives

Original objective. The original Project Development Objective (PDO), as defined in the Loan Agreement (p.5), was to assist Shanxi Province in increasing the production and utilization of coal bed methane (CBM) and coal mine methane (CMM) to replace coal as a fuel for thermal use and to reduce greenhouse gases (GHGs) and local air pollutants associated with coal combustion. The PAD provided an essentially similar wording of the PDO, describing it as : "...to increase the production and utilization of CBM/CMM to replace coal as a fuel for thermal use and to reduce GHGs and local air pollutants associated with coal combustion." This review is based on the PDO as stated in the Loan Agreement.



Revised objective. The PDO was revised through a Level 1 restructuring in 2016. The revised PDO in the Loan Agreement and the second restructuring paper was to “increase production of coal bed methane to reduce GHGs associated with coal combustion in the project area.” Essentially, CMM was dropped and the PDO was refocused to the “project area” proper from the Shanxi province as a whole. In addition, the phrase “to replace coal as a fuel for thermal use” was dropped from the original PDO because it turned out that the CBM and liquefied natural gas (LNG) produced under the project could be used for various purposes such as power generation, city gas and car fuel.

At the time of restructuring, 57.8% of the Bank loan was disbursed.

b. Were the project objectives/key associated outcome targets revised during implementation?

Yes

Did the Board approve the revised objectives/key associated outcome targets?

Yes

Date of Board Approval

19-May-2009

c. Will a split evaluation be undertaken?

Yes

d. Components

The project consisted of two components:

1. Investment Component (Cost: US\$202.6 million at appraisal, US\$222.4 million at the time of Level 1 restructuring, US\$214.4 million actual). This component had three subcomponents, as follows: exploration and development of CBM production wells; (ii) construction of gas collection pipelines and CBM gathering station; and (iii) construction of an LNG plant, consisting of four modular, transportable liquefaction plants, each with a production capacity of 50,000 tons per year.

2. TA Component (US\$1.7 million at appraisal, US\$1.2 million at restructuring, US\$1.2 million actual). This had two subcomponents, as follows: (i) capacity building and institutional development at the implementing entity; and (ii) a program for to assist key stakeholders among the Shanxi provincial authorities to enhance their capabilities for subsector policy making and implementation, to scale-up the CBM/CMM industry in the province.

While at the Level 1 restructuring the core structure of the project components remained, technical designs for the investment component were adjusted to incorporate the latest technological advance in gas drilling and liquefaction as well geological conditions in the expanding upstream gas-drilling area. The TA-



subcomponents were also adjusted consistent with the revised PDO and capacity building with a view to focus more on capacity building in the implementation agency.

e. Comments on Project Cost, Financing, Borrower Contribution, and Dates

Project Cost. Total cost at project closing was US\$215.6 million, slightly higher (by 5.5%) than the estimated cost at appraisal of \$204.3 million.

Financing. At appraisal, the total project cost of US\$204.3 million was to be financed by an IBRD loan of US\$80 million (fully disbursed), the borrowers contribution of US\$47.3 million, and local sources of borrowing, which were expected to contribute US\$77.0 million. At the first restructuring, in November 2013, the Bank loan had disbursed US\$22.48 million. By the second restructuring, in February 2016, more than half of the Bank loan, or US\$46.27 million, was disbursed.

Dates: The project was originally envisaged to close on December 31, 2014. A Level 2 restructuring was introduced in 2013, which resulted in an extension of closing date by 1.5 years, to June 30, 2016. These modifications did not result in any change in the PDO or indicators. A second (Level 1) restructuring took place in February 2016, seven years after loan approval, at which time the PDO was revised, and the projects closing date further extended to June 30, 2017. In all, the project took seven years and nine months from effectiveness to be implemented.

3. Relevance of Objectives

Rationale

The relevance of the project's development objectives is high and continues to be so in the context of China's current conditions. The country, especially in the major cities and industrial "hot spots", continues to experience severe air pollution because of the primary reliance on coal in meeting rising energy demand.

The PDO of increasing the production and utilization of CBM/CMM and the associated reduction of GHG emissions was relevant and fully aligned with the World Bank's CPS 2006-2010 at appraisal, and remained aligned with the CPS 2013-2016 at the two restructurings. In particular, the project directly supported one of the key pillars in CPS 2006-10 (Managing resource scarcity and environmental challenges) and the Supporting Greener Growth strategic theme in the 2013-16 CPS, which supported the Chinese government's target of reducing carbon intensity by 20 percent under the 11th Five Year Plan (FYP; 2006-10) and by a further 16 percent under the 12th FYP (2011-15).

The project was also closely aligned with the 'go green' strategic objectives outlined in the China 2030 prepared jointly by the World Bank and China's Development Research Center of the State Council,



reflected in strong policy actions being taken by the government to diversify energy sources away from coal. Under the 2016 Paris Climate Agreement, the government committed to substantially reduce the intensity of GHG emissions relative to GDP by 60-65% below 2005 levels by 2030.

Rating
High

4. Achievement of Objectives (Efficacy)

Objective 1 **Objective**

“To assist Shanxi Province in increasing the production and utilization of coal bed methane (CBM) and coal mine methane (CMM) to replace coal as a fuel for thermal use”.

Rationale

Theory of Change:

The PAD does not discuss the project's theory of change. It only refers briefly to the higher level objective to which the project contributes, by stating that the project will, by supporting the development of indigenous clean energy and mitigation of air pollution, directly contribute to the managing of Chinas scarce resources and environmental challenges in order to address the countrys key constraints to future growth (PAD, para 12, p.3). The PAD's Annex 3 presents the project's Results Framework, containing year-by-year targets for intermediate and final outcome indicators. While useful for monitoring purposes, the Results Framework does not analyze causality and attribution aspects.

The ICR does however (Figs 1 & 2) present diagrammatically the project's theory of change - for the project as originally conceived and after restructuring. In so doing, it makes a laudable effort to delineate the key assumptions that would facilitate the progression of activities into outputs, and outputs into outcomes. As Fig 1 shows, the original PDO was expected to be achieved by (a) supporting the exploration, production and liquefaction of CBM to increase supply and market access, and (b) enhancing the sub-sectors policy framework and institutional capacity. After restructuring, which resulted in the elimination of provincial level TA activities (that had originally been included to help promote private sector participation, but were later found to be unnecessary) and refocus of the investment component on the direct project area, the theory of change was revised to reflect these changes. That said, one thing that the theory of change analysis fails to assess is whether the project's activities were the right ones, and whether they were also of adequate scale and timing.

Original PDO:



Outputs:

- By restructuring in 2015, 90 percent of the LNG plant had been completed, with one LNG line in operation and the other scheduled to be commissioned in mid-2016.
- By restructuring, Coal Bed Methane test wells had been drilled and were operating satisfactorily. Technical schemes for the remaining wells had been finalized and construction was expected to start in 2016.
- Capacity building activities for the Shanxi Coal Bed Methane Company (SCBMC) had been carried out as planned.
- Plans for capacity building activities at the provincial level (Shanxi Province TA activities) were not realized and the TA component was dropped at restructuring.

Outcomes:

The amount of CBM/CMM produced, captured and utilized was more than achieved for Shanxi Province as whole. Against an end target of 2 billion metric tons per annum, from a base of only 300 million cubic meters, actual achievement by December 2015, just prior to the restructuring, was of the order of 8.1 billion cubic meters per annum. Utilization of this CBM/CMM in Shanxi was of the order of 4.5 million cubic meters per annum, against a base of 200 million, against a target of 1.5 million cubic meters a similar overachievement. That said, there was a serious question of attribution of these results to the project. Given the relatively slow progress of well drilling, which led to an extension of project duration in the initial restructuring of 2013, and the fact that the LNG plant had yet to come fully on line, it is debatable how much of the province's achievement by restructuring could be attributed to the project. The cancellation of the provincial TA activities, which proved to be unnecessary once the government opened up the sector to private investment, reinforces this question. The ICR moreover makes no attempt to provide an estimate of the project's direct contribution. In the absence of any corroborative evidence, it is assumed that the objective of increasing CBM/CMM production and utilization was modestly achieved.

Rating
Modest

Objective 1 Revision 1
Revised Objective

“To increase production of coal bed methane to reduce GHGs associated with coal combustion in the project area.”

Revised Rationale

Outputs:



- Volume of enhanced CBM production was only 20 million cubic meters per annum in the project area (as against a target of 60 million). The production volume was however expected to keep increasing, as it normally takes about 9 months for CBM production to stabilize and reach its peak after drilling is completed. Evidence is presented in the ICR (Annex 5) to demonstrate that since project closing, monthly production of CBM has in fact been on a strong upward trend (showing an increase from 1.43 million cubic meters in July 2017 to 5.03 million in February 2018).

- Volume of LNG production: Outputs from the constructed LNG plants reached 100 percent of planned capacity at project closing. However, it was intended that the LNG plant would use both the company's own CBM as well as gas purchased from Petro China which ran into problems of availability, due to a change in government policy to accelerate use of gas, instead of coal, for heating, allowing the district heating sector and residential consumers to use natural gas on a priority basis. As a result, the availability of LNG from the project's activities was only 75 percent of the targeted volume (119,000 metric tons as against 160 million tons) by closing. This could however increase over time, as CBM produced under the project increases, and more gas pipelines are built.

Outcomes:

The project's development objective, post restructuring, of increasing CBM to reduce GHGs associated with coal combustion in the project area was only modestly achieved. Though CBM and LNG production did increase, resulting in GHG avoidance in the project area, this fell short of expectations. Targets that were set for expanding CBM production, LNG production failed to be achieved by a significant margin, by close of project. This had a direct bearing on the reduction of GHG emissions, which being directly proportional to the production and utilization of LNG failed to reach their targets also by a significant margin (avoided GHGs were estimated to reach only 75 percent of their targeted value by closing). That said, in light of the rising trend observed for CBM production, GHG avoidance in the project area is likely on track to meet or exceed targeted values by end-2019.

Revised Rating
Substantial

Objective 2
Objective

“To reduce greenhouse gases (GHGs) and local air pollutants associated with coal combustion”.

Rationale

The project appeared, on the face of it, to have achieved its objective of reducing Greenhouse Gas Emissions (GHGs). Though there was no indicator to directly measure the reduction of GHGs and local air pollutants, the reduction of GHGs was likely to be directly proportional to the amount of CBM/CMM produced/captured. To the extent that production of CBM/CMM was overachieved, GHG avoidance would



have been achieved to the same degree. However, the same question of attribution arises, as a result of which this outcome is similarly rated modest.

Rating
Modest

Rationale

Overall Efficacy Rating
Modest

Primary reason
Low achievement

5. Efficiency

Administrative and Operational Efficiency:

The project underwent a number of delays on account of changes in use of drilling and liquefaction technologies necessitating two extensions of closing date by a total of two and a half years. Disbursements were correspondingly slow up to 2013, though they picked up thereafter, allowing the project to be fully disbursed by closing. During this time, project costs increased by a small margin over appraisal estimates, standing at US\$215 million at closing, against an estimated US\$204.3 million at appraisal. These were financed by the borrower and through local sources of funding. The cost overruns took place mostly on account of management-related issues, as the borrower took time to settle on process technologies appropriate for the facilities, especially for the first phase of LNG plant construction.

Economic and Financial:

Economic analysis of the project at closing provides an estimated economic rate of return (EIRR) of 15 percent, without taking account of avoided carbon emission benefits. With these benefits added, the EIRR rises to 18 percent. This is somewhat lower than the EIRR estimated at appraisal of 25 percent, before including environmental impacts which raised the estimate to as much as 40 percent. On the other hand, the financial rate of return (FIRR) calculated at closing indicated a 12 percent return, higher than the estimate of 9 percent at appraisal.

The slow disbursement rate and delays in implementation, accompanied by a lower rate of economic return for the project, are to some extent offset by the improvements in well drilling technologies that resulted, which



could to lead to improved long run productivity. Based on the above, the efficiency of the project is rated Substantial.

Efficiency Rating

Substantial

a. If available, enter the Economic Rate of Return (ERR) and/or Financial Rate of Return (FRR) at appraisal and the re-estimated value at evaluation:

	Rate Available?	Point value (%)	*Coverage/Scope (%)
Appraisal	✓	25.00	100.00 <input type="checkbox"/> Not Applicable
ICR Estimate	✓	18.00	100.00 <input type="checkbox"/> Not Applicable

* Refers to percent of total project cost for which ERR/FRR was calculated.

6. Outcome

The project's relevance of objectives is rated High. Efficacy of the original project is rated Modest, but Substantial for the revised project. Project efficiency is rated Substantial. The overall outcome rating is based on a split evaluation, for the Original and Revised project, whereby the projects overall outcome rating is rated Moderately Satisfactory (or 4.0 on a 6-point scale) against both original and revised PDOs, weighted by the disbursements made before and after restructuring (57 percent and 43 percent respectively) i.e. $(3.0 \times 0.57) + (4.0 \times 1.72) = 3.43$, or Moderately Satisfactory.

a. Outcome Rating

Moderately Satisfactory

7. Risk to Development Outcome

Following the second (Level 1) restructuring, the project's outcomes can be considered to be fairly sustainable. The implementation agency has a well-trained staff and considerable operational experience to build on, going forward. As discussed earlier, the operation is likely to achieve its revised PDO (along with key indicators and outcomes) by the end of 2019.. The financial sustainability of the project company is projected to be stable and satisfactory. The LNG market price is a significant risk. Although the most recent LNG price was lower than



expected at appraisal, the World Bank, along with other credible agencies, projects a significant increase in the Asian LNG price to 2030.

8. Assessment of Bank Performance

a. Quality-at-Entry

Extensive preparation was undertaken by the Bank's large project team, working closely with the client to identify specific needs and design specific components. One drawback however was that the Shanxi provincial authorities were not as involved as the implementing agencies or focal points. This may in part have contributed to the design of the TA component for supporting subsector policy and institutional reforms in the province, which subsequently turned out to have been unnecessary. Similarly, though the rapid advance in relevant technologies, including the advantages of the horizontal gas drilling technology, were well known at the time of project preparation, these were not fully factored in to the design, leading to subsequent delays as the client took time to determine the well drilling and other technologies most appropriate to the needs of the operation. Against this background, the Bank team's assessment of the operations critical risks may not have been completely realistic. The Negligible **risk** rating for the Shanxi Governments commitment to the project may, in this context, have been overoptimistic.

Quality-at-Entry Rating
Moderately Satisfactory

b. Quality of supervision

The ICR reports that the Bank team undertook regular supervision to review progress and identify issues on time. The TTL's permanent presence in China enabled a more frequent and effective dialogue with the client. Dedication of the Bank team to the operation was strong, as was recognized by the client. Overall, the quality of supervision for the key investment component was broadly satisfactory.

However, it is unclear why the Bank team and management allowed the highly problematic TA component to be carried by the project for more than half a decade, postponing the Level 1 restructuring essentially to the last minute. Bank management could have acted more proactively by initiating such a restructuring soon after it became apparent that there was (i) a serious attribution issue; and (ii) no province-level buyer for the envisaged broad subsector reforms.

Quality of Supervision Rating
Moderately Satisfactory



Overall Bank Performance Rating

Moderately Satisfactory

9. M&E Design, Implementation, & Utilization

a. M&E Design

The original PDO results indicators (including intermediate indicators) suffered from weaknesses to properly monitor and evaluate the project. In particular, there were significant shortcomings concerning two aspects: (i) GHG reduction was a key objective, but there were no indicators to quantify this impact; (ii) the PDO included a number of province-level outcome indicators (including intermediate ones), but it was impossible to evaluate how much the project contributed to reported regional improvements; and (iii) the Debt Service Coverage Ratio (DSRC) was included among the intermediate indicators, but was not enough to ensure long-term financial sustainability. In addition CMM (jointly with CBM) was a primary PDO indicator despite the fact that there was no distinct CMM subcomponent in the project (as confirmed by IEG's interview with the TTL). These weaknesses were however addressed under the second restructuring, so that the final results framework and indicators were appropriate and adequate to measure project progress.

b. M&E Implementation

Taking into account the above-mentioned weaknesses, the M&E framework was a reasonably efficient guide to inform project implementation in a reliable manner and for the Bank to monitor and evaluate project progress towards achievement of the PDO. The implementing agency collected, consolidated and analyzed data in a regular manner, in line with the M&E design. The methodology and reporting was of high quality and acceptable (ICR, p.21). When necessary, an external monitoring team was recruited for surveys.

c. M&E Utilization

The implementing agency and World Bank were able to use the indicators on a regular basis to monitor progress of the project. Regular consultations were held to search for improvements based on data derived from M&E activities.

M&E Quality Rating

Substantial

10. Other Issues



a. Safeguards

The project was classified as Category A from an environmental point of view, and according to the PAD - triggered the following safeguards: Environmental Assessment (OP/BP 4.01) and Involuntary Resettlement (OP/BP 4.12). An Environmental Impact Assessment and Environmental Management Plan (EMP), including a Safety Management Plan, were prepared during project preparation addressing impacts that could arise from the construction and operation of well drilling and LNG plant construction. A comprehensive analysis of alternatives was prepared for the site location of the LNG plant and pipeline route, and technology for wastewater management.

As regards resettlement, a Resettlement Action Plan (RAP) was prepared during project preparation to address impacts arising from land acquisition and occupation for the projects LNG and gas exploration activities. Compensation paid for the land acquired for the LNG site was of the same order of (or higher than) the amounts recommended in the RAP. Along with permanent land acquisition, additional areas were acquired temporarily for construction of related facilities, such as transmission lines, gas pipelines, access roads, etc., and affected households were similarly compensated. On the positive side, the LNG plant brought considerable social benefits to the village, as it provided employment to villagers during project construction, along with demand for their agricultural produce. According to a social survey conducted most villagers experienced a significant increase in income during the construction period. During the course of project implementation, the external monitoring team conducted regular monitoring exercises and produced a total of eight resettlement monitoring reports, providing a comprehensive review of various land acquisition impacts. According to the reports, all compensations following the RAP were paid to the affected people, and the process and outcome of resettlement were found to be satisfactory for them.

Overall, compliance issues identified during implementation were addressed or remedied, and did not have a residual impact on the environment.

b. Fiduciary Compliance

Financial Management (FM): Appropriate FM arrangements were in place to ensure proper use of the financing and to provide proper accounting of project funds. Since the project was managed by a State-Owned Entity (SOE), FM arrangements in turn benefited from the SOEs corporate governance and internal controls. Project audits were undertaken by independent auditors and audit reports were submitted to the World Bank on a timely basis, in compliance with the loan covenant. Though some audit reports did raise some minor finance-related problems, these were addressed by the borrower during implementation, with the supervision of the auditors and World Bank team.

Procurement: The procurement performance rating was satisfactory throughout implementation of the project. The World Bank's procurement policies and procedures were followed properly and no procurement issues were reported. A total of 144 contracts were concluded under the project, 57 of which were funded under the



Bank loan. A project management consultant was employed by the client to provide technical and project management support for the engineering, procurement and construction (EPC) contract that was effectively implemented.

c. Unintended impacts (Positive or Negative)

d. Other

11. Ratings

Ratings	ICR	IEG	Reason for Disagreements/Comment
Outcome	Satisfactory	Moderately Satisfactory	The weighted average of the ratings for pre- and post-restructuring efficacy, relevance and efficiency provides a value of 3.43 on a six-point scale, i.e. an MS rating.
Bank Performance	Satisfactory	Moderately Satisfactory	Project preparation was deficient in fully identifying specific client needs and designing the project components accordingly. During implementation, the Bank unnecessarily postponed the much-needed Level 1 restructuring to the “last minute” despite years of evidence of significant concerns with the “attribution issue” and inadequate ownership of the TA component from Shanxi Government.
Quality of M&E	Substantial	Substantial	---
Quality of ICR		Substantial	---

12. Lessons



IEG draws the following lessons from the ICR:

1 . It is essential to prepare for the deployment of new technologies even during implementation: The project entity made an effort to deploy new technologies that it felt would work better than those that were originally planned for, though this led to some delays in construction and implementation. It is however important however to evaluate the availability and cost-effectiveness of all new technologies that are potentially available at the time of project preparation, to ensure that the most appropriate ones are chosen.

2. In some project situations, it can be more cost effective to (i) bundle small separated works and procurements into a consolidated EPC (Engineering, Procurement and Construction) contract with a single responsibility; and (ii) outsource a part of construction management tasks. In the initial phase of LNG plant construction of the project, individual procurement packages were often too small to be attractive to potential bidders which contributed to construction delays and generated additional costs. Subsequently, many packages were consolidated into a larger EPC package, which turned out to be more efficient and cost-effective.

13. Assessment Recommended?

Yes

Please explain

The Substantial Outcome rating for the post-Level 1 restructuring period is based on the high likelihood that the PDO will be achieved within two years after project closure, on account of a technologically driven "ramp-up rate" effect. In the first eight months of 2018 CBM production more than tripled compared with the same period of 2017. However, in or around 2020 the actual CBM production should be ascertained to verify if the CBM targets were met by end-2019, as projected.

14. Comments on Quality of ICR

The ICR is fairly detailed and clearly written. It provides a good summary of the projects background, implementation and challenges faced. It also provides a detailed theory of change (that was lacking in the PAD), along with details of the results matrix and of the various changes made during restructuring. Its analysis is generally evidence-based. Among weaknesses, a disbursement profile for the project is lacking, and the split evaluation in Section 6 is not estimated strictly according to guidelines (numerical values need to be assigned to outcome ratings).



a. Quality of ICR Rating
Substantial