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Coal for Power Generation

Projects recently audited by OED in Indonesia, Thailand, and Turkey shared the goal of developing coal for use in electricity generation, either to reduce the need for imported oil or, in Indonesia, to save oil for export.*

While the Mae Moh lignite projects in Thailand were successful, the Elbistan project in Turkey and the Bukit Asam coal project in Indonesia were not. Elbistan, a very large investment, has also been particularly disappointing to date. All the projects require follow-up action to mitigate their effects on the environment.

In all three countries, the quality of project management was crucial. The experiences offer lessons for the future.

Indonesia

In the early 1980s the Bank supported Indonesia's move to diversify its energy sources. Greater domestic use of coal would release oil for export, helping to sustain foreign exchange earnings. A loan for $185 million (1982) supported the development of the Air Laya mine at Bukit Asam in South Sumatra, to supply coal for power generation at Suralaya, and the construction of related transport facilities. Plans to develop the mine were synchronized with those for the Suralaya power station, its "captive" customer, whose development was separately supported by the Bank. Initial plans were for lignite production of 3 million tons a year (mtpy) by 1987, to supply Suralaya's first two 400MW units.

Approach

The Bukit Asam project, the first major coal project in Indonesia, was an ambitious undertaking for agencies with little mining experience. The Bank took an unusually prominent role in supervising the design, engineering, development, and analysis of the project. Several early decisions strongly influenced the project's unfortunate outcome.

Management: Though the main parties in the project broadly agreed on the goals for mine development and coal transport, they did not resolve important differences over organizational and procurement procedures. Authority for the project remained dispersed across three entities—the mine company, the railway company, and the shipping company—which were under the jurisdiction of different ministries, and the project lacked strong management. Despite the Bank's concern, based upon prior experience in Indonesia and elsewhere, about the government's ability to coordinate such a complex project it did not make the loan conditional on an effective management structure.

Technology choice: A bucket-wheel excavation system (BWE) was selected before conclusive data were available on the characteristics of the coal seam. In retrospect, BWE was the wrong technology for Bukit Asam: it is an inflexible system requiring a high degree of organization and planning, and technical staff with advanced training. It also requires a large inventory of some 14,000 different parts, but the mine is so remote that parts and equipment are difficult to obtain. Shortages of foreign currencies also caused delays in obtaining parts. The risks of using BWE in the rainy climate of Bukit Asam were underestimated, leading to serious shortfalls in the excavation rate. A shovel-truck-conveyor system would have been a better choice.

Prices and production costs: The economic value of Air Laya coal in 1991 was only 28 percent of the appraisal estimate. Coal prices have fallen by about 70 percent in real terms since the project was appraised,

**"Performance Audit Report, Indonesia: Coal Mining and Transport Project, Bukit Asam Coal Mining Development and Transport Project, Coal Exploration Engineering Project", Report No. 10829, June 1992; "Performance Audit Report, Thailand: Mae Moh Lignite Project and Second Mae Moh Lignite Project", Report No 11957, June 1993; "Performance Audit Report, Turkey: Elbistan Project, Second Tek Transmission Project, Karakaya Hydropower Project, Third Tek Transmission Project, Elbistan Operation and Maintenance Assistance Project", Report No. 12069, April 1993. OED reports are available to Bank Executive Directors and staff from the Internal Documents Unit and from Regional Information Services Centers.*

Box: Environmental Issues

Bukit Asam

The main environmental concern during project appraisal was to prevent damage to water resources, and PBTA agreed to prepare guidelines on water pollution control and to meet pollution control guidelines at the mine site and shipping terminal. Yet borrower and Bank paid little attention to environmental protection during the construction phase. Improvements have been made since then. Dams at the dump site prevent mud and water runoff, topsoil is being spread on reclaimed areas, and fast-growing trees have been planted. Water quality is adequate in the settling ponds. Effluent discharge needs more thorough monitoring.

Mae Moh

Lignite from Mae Moh has very high sulfur and ash content, and though the later power units have higher stack heights, sulfur dioxide levels may have reached the maximum permitted by Bank standards. Future power units will require more sophisticated measures to contain sulfur dioxide.

EGAT is reviewing the arrangements for ensuring water quality at Mae Moh. Contaminant levels in the reservoirs are higher than permitted by World Bank and/or National Environmental Board standards for surface water, and those in waters associated with the mine are several times higher than in the reservoirs. Environmental staff may need to be strengthened to enable EGAT to monitor and manage pollution problems at the mine.

EGAT sets aside about 1 percent of revenue for an impressive ongoing plan to return the land disturbed by mining to a better-than-original state. The plan includes reforestation, a plant nursery, and cultivation programs.

Elbistan

Under normal circumstances, plant operation at Elbistan complies with Turkey's and the Bank's environmental standards in force at the time the project started. Fly-ash emissions from the power station are sometimes above maximum limits; if the lignite received were of consistent quality, there would be no problem complying with environmental regulations.

Progress on afforesting the reclaimed mine area is satisfactory and the plant and mine effluents are properly disposed of. Much of the water pumped from the mine is used for irrigation.

In 1992, environmental quality in the plant area at large was not adequately monitored; the Bank should follow up on the actual levels of pollution and the availability of pollution monitoring equipment originally installed under the project.

and the economic analysis at appraisal underestimated the downside price risks. Neither did it compare costs in similar mines elsewhere. Such analysis might have led to an in-depth review and subsequent revision of the project. Investment costs per unit of capacity were 4 - 5 times higher at Air Laya than those of mines in coal exporting countries. Combined with the difficulties the mine has had in attaining production targets, the cost of production of Air Laya coal is about twice the net sale price.

Contractors' performance: Contractors were often selected without regard for ability or experience, and some were chosen just to obtain small cost savings. Components involving rail line upgrading, bridge rehabilitation, mine service facilities, and rail service facilities suffered as a result.

Consulting services for feasibility studies, design, and construction supervision were provided by a joint venture of firms and subcontractors with different areas of expertise. Hence the same consultants could be involved with both the engineering/feasibility and subsequent construction phases. Close supervision is needed in such cases, to eliminate the risk of biased recommendations.

Risks associated with important features of the project were either poorly defined or significantly understated; more thorough analysis would have yielded significant doubts on the viability of the project as designed.

Results

After a four-year delay in completion, the mine was producing 20 percent below its 3 mtpy goal. The high investment cost of developing the Air Laya mine, and the continuing wide gap between its design capacity and actual rates of operation, means that its financial rates of return will continue to be negative.

PTBA suffered mounting losses on account of falling coal prices, the substantial shortfall in coal production at Air Laya, and accumulation of interest due on the loans used to develop the mine and related facilities. Its operations in the region are being restructured, with the government assuming a much higher proportion of its debts.

The failure of the Air Laya mine to meet its output targets led PTBA to expand production in other mines at Bukit Asam with the help of private contractors using shovel/truck-based techniques. These other mines are highly profitable, with a production cost only 29 percent of that at Air Laya.

Thailand

In Thailand, the Bank supported two highly successful projects to help the Electricity Generating Authority of Thailand (EGAT) expand lignite production for power generation at Mae Moh. The projects supported a national energy development strategy to reduce Thailand's heavy dependence on imported fuel.

The first project ($72 million, approved 1980), helped finance the expansion of lignite output to 2.8 mtpy, to support the growth of the Mae Moh power station to 375 MW. The second project ($59 million, approved 1984) was designed to raise lignite production to 5 mtpy, to increase generation capacity at Mae Moh to 825 MW.

Approach

Management: Projects were implemented on schedule, and EGAT showed a high level of initiative and vision. The Mine Department was set up as a separate implementing unit and profit center within EGAT. This gave the department enough authority to operate successfully and to be financially viable, and it has formed a core of trained and experienced technical and supervisory staff. For the second project, overall responsibility was entrusted to the directorate of the department, with management responsibility delegated to the deputy director, an engineer with long experience at Mae Moh.

Private sector involvement: During implementation, EGAT engaged domestic private contractors for much of the overburden removal and transport operations. This greatly reduced costs and the concomitant need for Bank financing; 75 percent of the second loan was canceled.

Technology choice: EGAT's choice of technology was conservative but had the virtue of flexibility and a proven operating record. Excavation in the first project used a truck/shovel and lignite conveyor system similar to that already used at Mae Moh; in the second project, a truck/shovel system was successfully combined with semi-mobile crusher and conveyor systems.

In the early stages, frequent breakdowns of equipment depressed production. Some difficulties also arose from lack of operating skill and inexperienced maintenance. They were rectified by hiring more staff with theoretical knowledge and giving them hands-on training. The increase in staff numbers was worthwhile, because it provided a core of trained personnel to serve the next stage of mine expansion.

Low production costs: Production costs of lignite at Mae Moh fell during project implementation and are now lower than f.o.b. prices for Australian coal. In most producer countries, opencast lignite mining under overburden conditions like Mae Moh's cannot compete with opencast coal mining. Lower production costs have not only benefitted EGAT and its customers, but have also made more of the lignite deposits economically recoverable.

Bank's role: The Bank played a significant role in supporting design and engineering work at appraisal. It helped in the creation of profit centers and lignite pricing guideines within EGAT, and ensured that the long-term mine management plan and power plant development program were carried out.

Results

Both projects achieved most production targets within appraised costs. The lignite produced had somewhat higher calorific value than expected. At the time of audit, the power station had reached a generating capacity of 1,725 MW, some 900 MW greater than that foreseen by the mining projects. The mine has enough proven economically mineable lignite to support the planned expansion to 4,425 MW peak generating capacity.

Turkey

The Elbistan mining and power project was one of several projects the Bank supported in the 1970s and 1980s to increase Turkey's power generation and transmission capacity, using non-exportable resources (hydropower and lignite). These projects also sought to strengthen Turkey's power agencies, improving their personnel policies, financial performance and management, project management capability, and training. For Elbistan, the Bank approved a loan of $148 million in 1974 to the Turkish Electricity Authority (TEK) and the Turkish Coal Authority (TKI), to support a 4 x 300 MW power plant, transmission lines, and an opencast mine supplying up to 18 million mtpy of lignite to the power plant.

Implementation

The Elbistan loan became effective two years after approval, in 1976, but large cost overruns led the loan to be drawn down much in advance of progress on construction, despite major delays. Five years into the project, the mine was only 15 percent completed, and its commissioning was delayed by seven years. Some 20 years after construction began, the power plant is still not working satisfactorily. The disappointing outcome reflects both repeated shortages of funds and poor project management.

Progress on the project was strongly affected by the political environment and by Turkey's economic performance, which in turn was affected by national and global developments, especially the oil price increases of 1973 and 1979. The government that came to power in 1975 defaulted on agreements the previous government had reached with the Bank. In response the Bank postponed the effectiveness of approved loans and interrupted the processing of operations in the pipeline. A foreign exchange crisis in the later 1970s limited the availability of funds for the project, and the project's own cost overruns compounded the funding problem. By the early 1980s, when government, the IMF, and the Bank were collaborating closely over a series of successful structural adjustment programs, TEK enjoyed the benefits of improved power tariffs. But in the later 1980s, fiscal discipline weakened as elections loomed, and TEK was technically bankrupt by 1990.

Issues

Management: Adding to the difficult political and economic

circumstances were a number of shortcomings:

- Two entities (TEK and TKI) shared responsibility for an integrated project, and arrangements for coordination between the two were set too high above the working level.

- Site managers were allowed very little authority by either agency. The extreme centralism prevented the effective use of the—much needed—expertise of the engineering consultants.

- Both TEK and TKI had to apply rigid government salary scales which were too low to attract the highly qualified staff needed to implement such a demanding project.

The institutional goals of the project were not achieved. By the early 1990s TEK was still highly centralized. It lacked adequate capacity for power system planning and for project management; its internal coordination was poor and its procedures cumbersome. It lacked autonomy in financial and personnel matters. Several of these problems were taken up again by follow-on projects.

Risks were underrated. The excavation technology chosen was entirely new to Turkey. Arrangements for managing the project were known to be too centralized. Other risks associated with TEK's institutional weakness—especially concerning the availability of enough qualified staff—were underestimated.

Fuel quality: An important reason for the poor performance of the power plant is that the lignite TKI supplies varies widely in quality. Better mixing of lignite before it leaves the mine could solve the problem, but TKI has no financial incentive to do this. A new supply contract is needed between TEK and TKI that would include bonuses or penalties for positive or negative departures from a specified fuel quality.

Results

Elbistan has cost roughly $2.5 billion in current terms: 258 percent of the original cost estimate. At the completion of disbursements on the Bank loan, the economic rate of return of 3 percent was much lower than the 18 percent expected at appraisal. Cost overruns in real terms were 100 percent, 75 percent, and 100 percent respectively for the power plant, the mine, and the transmission components.

The lignite mine should have ample reserve capacity when the fuel requirements of the power plant reach their maximum. The excavation equipment is working satisfactorily; the mining equipment is well maintained; and, unusually for a Turkish public enterprise, TKI's managers at the mine seem to have reasonable spending authority. However, the mining equipment is underused, and TKI suffers losses on the mining operation equivalent to about 15 percent of revenues.

Lessons

Information: Experience at Bukit Asam and Elbistan emphasizes that large and complex mining projects need exhaustive preparation. Thorough ground investigation needs to be done before feasibility studies, or evaluations of alternative mining systems and equipment, are begun.

Technical risks: A design or technology needs to be evaluated in the context in which it is to be used. Excavation technology needs to be suitable for the geophysical conditions, but also for the level of expertise of people who will use it, the weather conditions, and the ease of procuring parts for maintaining equipment.

Organizational arrangements: Before loan approval, agreement needs to be reached on an organizational structure for project implementation that will provide for effective management and control. Projects that involve major physical facilities should have a detailed implementation plan, to which the borrower and Bank are firmly committed, spelled out at the outset.

Procurement: Simple, fair, and expeditious procurement procedures are a key requirement for successful implementation.

Use of private contractors: Mae Moh's successful experience shows how the use of private contractors for major operations can add needed flexibility when labor needs vary over time, or when there are important procurement needs throughout a project.

"Borrower ownership": Borrowers and their implementing agencies need to "own" not only the physical goals of the project, and arrangements for implementation, but also the associated goals and arrangements for strengthening institutions. Experience at Elbistan emphasizes that centralism, competition among bureaucracies, and reluctance to delegate authority can negatively affect the outcome of a project and cannot be easily be altered.

Supervision: Project supervision should include frequent site visits, since the perspective of people close to a project often differs widely from that of senior officials in government or utility companies.

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