PR of China: Rehabilitation of Beijing Thermal Power Plant

Ex-post evaluation

OECD sector	23063 – Coal-fired power plants	
BMZ project ID	1997 65 082	
Project-executing agency	Shenhua Energy Company (Beijing Co-Generation Branch Co.)	
Consultant	Consortium Steag-Fichtner	
Year of ex-post evaluation	**2005**	
	Project appraisal (planned)	**Ex-post evaluation (actual)**
Start of implementation	3rd quarter 1997	1st quarter 1998
Period of implementation	34 months	31 months
Investment costs of the FC component (FDP):	EUR 49.80 million	EUR 42.17 million
Counterpart contribution	EUR 26.28 million	EUR 14.79 million
Financing, of which Financial Cooperation (FC) funds	EUR 23.52 million	EUR 27.38 million
Other institutions/donors involved	n.a.	n.a.
Performance rating	2	
• Significance / relevance	1	
• Effectiveness	2	
• Efficiency	2	

Brief Description, Overall Objectives and Project Objectives with Indicators

Beijing Thermal Power Plant is one project from a sequence of projects that comprises the modernisation of six existing coal-fired power plants that are all located near the city centre. The project comprised the renewal and extension of the existing coal-fired power plant in the capital of Beijing (= power plant component financed by the project-executing agency) and the installation of a flue gas desulphurisation plant (FGD-Plant) downstream of two boiler systems in order to reduce SO_2 emissions (= FC project component). The project was aimed to contribute (a) under the power plant component to closing the supply gap and to reducing the specific coal consumption of the power plant and (b) under the FC project component to reducing the SO_2 levels in the city. The overall objective of the project was to contribute to reducing the immission levels in the greater Beijing area.

To make the power and district heating supply in Beijing more efficient several older boiler systems were replaced by four new 410 t/h boilers, which were followed downstream on the flue-gas side by four electrostatic filters and an FGD and on the steam side by two imported 200 MW extraction-condensation turbines. In parallel the district heating supply was extended in

Beijing and a gypsum drying plant and a gypsum board production line were constructed for the FGD. The project objective was to reduce SO_2 emissions from the power plant, the modernisation and enlargement of which was only acceptable from an environmental point of view if a flue-gas desulphurisation plant was installed. The indicators to measure the achievement of the project objective of the FC component were defined as follows:

-- when the two upstream 410 t/h boilers are operating at full capacity the filtration rate of the flue-gas desulphurisation plant will in continuous operation be 95 %;

-- the annual quantity of electricity and district heat generated by the four boilers and two 200 MW turbine units amounts to 2,586 GWh net power equivalent.

A target/actual comparison for the indicators shows that due to the improved time availability and utilisation rates as well as the higher net capacities the targets were over-achieved (actual filtration rate: 97%; actual quantity of power equivalent generated: 2,898 GWh/a).

Project Design / Major Deviations from the original Project Planning and their main Causes

In 1998 SO_2 double-control zones (areas with acid rain and with specifically high SO_2 pollution levels in strongly growing conurbations) were established in China. Here the first flue-gas desulphurisation plants were to be installed in connection with the rehabilitation and extension of existing power plants in order (a) to fulfil the requirements of local environmental authorities, (b) to compensate for any efficiency losses caused by the FGD by producing efficiency gains from the rehabilitation of plants and (c) to be able to test and demonstrate the readiness for use of FGD limestone washing. Further ancillary aspects were to play a role in the first plants: (a) The transfer of know-how for reliable flue-gas desulphurisation techniques was to be accelerated, (b) the project-executing agencies should qualify as pioneers in spreading flue-gas desulphurisation plants and (c) practical experiences were to be gained from the operation of and construction of FGD-components for the first plants.

The project was implemented largely as had been planned. For the purpose of transferring know-how, a licence agreement was concluded with a Chinese FGD producer in the context of the construction of the flue-gas desulphurisation plant. Dieser errichtete in Peking mit Eigenmitteln des Trägers eine der zwei REA's. Die Konzeption einer mehrschichtigen Einbindung der FZ-REA-Projekte in die Projektsequenz für Kraftwerke mehrerer Megastädte in unterschiedlichen Strom-Regionalmärkten hat sich rückblickend bewährt. Die Auswahl von Peking erfolgte, weil dort die örtlichen Umweltbelastungen mit hohen SO_2-Spitzenkonzentrationen sowohl eine Gesundheitsgefährdung für die Bevölkerung im Umfeld der Kraftwerke als auch eine Bedrohung von kulturhistorisch und landschaftlich besonders schutzwürdigen Gebieten (die östliche Innenstadt und der Platz des Himmlischen Friedens) darstellten.

Key Results of the Impact Analysis and Performance Rating

A FGD training and demonstration centre, which serves supra-regionally to train staff for the operation of flue-gas desulphurisation plants, was built at the Beijing site. Individual deficiencies in the operation of the FGD and the power station were eliminated in the first years of operation. The availability and the net efficiency of the power plant units were even improved through own efforts by the Chinese partners. The charges to be paid for SO_2 emissions were drastically increased. Coal prices and power tariffs were raised in real terms. The project objectives were met. The planned filtration rate (indicator for the achievement of the project objective) was even outperformed. The utilisation of the established capacities is higher than had been expected.

Due to the flue-gas desulphurisation plant and the employed power plant technologies the Beijing power plant location, which was good overall, was ensured on a sustainable basis and modernised with a future orientation. Overall, the effectiveness is satisfactory (sub-rating 2).

The microeconomic results for the combined project components of the power plant and the flue-gas desulphurisation plant are good because several favourable factors had occurred (if FGD's are installed operating licences may be prolonged, the utilisation of existing parts of the plants can be continued, there are no additional network losses, historical mistakes in the design of older components were eliminated, capacities were increased and at the same time environmental pollution levels were reduced, due to real increases in coal prices that had occurred and efficiency increases the investments became more profitable). More favourable power generation costs and a positive internal rate of return of 8 % were achieved for Beijing. The high multiplier achieved for the flue-gas desulphurisation plant and the extension of the FGD training and demonstration centre entail a high macro-economic benefit, in which Beijing participates to a great extent. SO_2 avoidance costs are relatively high for Beijing, however, these costs have to be seen in the context of the high ecological benefit. Overall, the efficiency for Beijing is satisfactory (sub-rating 2).

As the project objective was reached (emissions were limited) it is plausible to assume that an adequate contribution was made to limiting immissions. Though the immission limits have not always been met, the overall pollution levels were reduced and the situation improved overall. The multiplier of 15 to 20 plants, which was reached over a period of five to seven years, is very good. Against the background of the SO_2 problem, which is extremely severe in China, and the good multiplier effect (broad-scale impact) the project is rated as having high developmental relevance and significance (sub-rating 1).

After weighing the above mentioned key criteria we classify the Beijing project as having generally satisfactory developmental efficacy (rating 2).

Besides Beijing, two similar FGD-projects have been implemented in Chongqing and Banshan.

General Conclusions and Recommendations

In the course of the implementation of the different projects the key efficiency figures of the flue-gas desulphurisation plants and the Chongqing, Banshan and Beijing power plants was improved while the overall SO_2 filtration levels remained unchanged. This was achieved through the use of modern power plant technologies and the optimisation of the combined unit of power plant and flue-gas desulphurisation plant, which helped to exploit existing potentials for increasing capacities and reducing the plants' own power consumption. Thus, when implementing FDP projects particular attention should be paid to optimising the combined unit of power plant and flue-gas desulphurisation plant.

The success of the FGD projects in Chongqing, Banshan and Beijing is due to a large extent to the model and demonstration character to solve the nation-wide environmental problem of increasing SO_2 emissions, even though at project appraisal the path to solving the problem and the inclusion of the projects on this path had been shown only in a very rudimentary manner. In the event of similar projects and problems the following items should be evaluated more comprehensively with regard to the model and demonstration function of the projects: (a) the problem on a nation-wide scale, (b) possible solutions and (c) the integration of the project in finding solutions.

Legend

Developmentally successful: Ratings 1 to 3	
Rating 1	**Very high or high degree of developmental effectiveness**
Rating 2	**Satisfactory developmental effectiveness**
Rating 3	**Overall sufficient degree of developmental effectiveness**
Developmental failures: Ratings 4 to 6	
Rating 4	**Overall slightly insufficient degree of developmental effectiveness**
Rating 5	**Clearly insufficient degree of developmental effectiveness**
Rating 6	**The project is a total failure**

Criteria for the Evaluation of Project Success

The evaluation of the "developmental effectiveness" of a project and its classification during the ex-post evaluation into one of the various levels of success described in more detail below concentrate on the following fundamental questions:

- Are the **project objectives** reached to a sufficient degree (aspect of project **effectiveness**)?
- Does the project generate sufficient **significant developmental effects** (project **relevance** and **significance** measured by the achievement of the overall development-policy objective defined beforehand and its effects in political, institutional, socio-economic and socio-cultural as well as ecological terms)?
- Are the **funds/expenses** that were and are being employed/incurred to reach the objectives **appropriate** and how can the project's microeconomic and macroeconomic impact be measured (aspect of **efficiency** of the project conception)?
- To the extent that undesired **(side) effects** occur, are these tolerable?

We do not treat **sustainability**, a key aspect to consider for project evaluation, as a separate category of evaluation but instead as a cross-cutting element of all four fundamental questions on project success. A project is sustainable if the project-executing agency and/or the target group are able to continue to use the project facilities that have been built for a period of time that is, overall, adequate in economic terms, or to carry on with the project activities on their own and generate positive results after the financial, organisational and/or technical support has come to an end.