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Report No: 21876

IMPLEMENTATION COMPLETION REPORT
(20569)

ON A

GRANT

IN THE AMOUNT OF US$5.8 MILLION

TO THE

CZECH REPUBLIC

FOR A

CZECH REPUBLIC - Kyjov Waste Heat Utilization Project

10/15/2001

Energy Sector Unite
Europe and Central Asia Region

CURRENCY EQUIVALENTS

(Exchange Rate Effective September 15, 2001)

Currency Unit = Czech Koruna
CZK 1 = US$ 0.0267
US$ 1 = CZK 37.4
Exchangerate at Appraisal (03/98): US$1 = 34.1
Average Exchangerate in 1999: US$ 1= 37.6
Average Exchangerate in 2000: US$ 1= 38.6
Average Rate to date in 2001: US$ 1= 38.4

FISCAL YEAR
January 1 December 31

ABBREVIATIONS AND ACRONYMS

CEZ - Ceske Energeticke Zavody (National supplier of electricity)
CHP - Combined Heat and Power
CO_2 - Carbon Dioxide
CR - Czech Republic
DH - District Heating
FIRR - Financial Internal Rate of Return
GEF - Global Environment Facility
GHG - Greenhouse Gas
GW - Gigawatt
GWh - Gigawatthour
HEX - HEX Capital s.r.o. (financial consultants of TPK)
HVB - Hypovereinsbank
ICB - International Competitive Bidding
JME - Jihomoravska Energetika, a.s. (South Moravian Power Company)
JMP - Jihomoravska Elektroenergeticka, a.s. (South Moravian Power Co.)
kV - Kilovolt
Kyjov - the City of Kyjov
MoE - Ministry of Environment of the Czech Republic
MW - Megawatt
MWh - Megawatthour
NBF - Non-Bank-Financed
NCB - National Competitive Bidding
PAD - Project Appraisal Document
PCD - Project Concept Document
SCM - Standard Cubic Meter
SDR - Special Drawing Rights
SEF - State Environmental Fund
tCe - Tons of Carbon Equivalent
tCO_2 - Tons of Carbon Dioxide
TPK - Teplarna Kyjov (District Heating Company of Kyjov)
UNFCCC - United Nations Framework Convention on Climate Change
VAT - Value Added Tax
VMG - Vetropak Moravia Glass

Vice President:	Johannes F. Linn, ECAVP
Country Manager/Director:	Roger Grawe, ECC07
Sector Manager:	Henk Busz, ECSEG
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CZECH REPUBLIC
CZECH REPUBLIC - Kyjov Waste Heat Utilization Project

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Project ID: P045572	*Project Name:* CZECH REPUBLIC - Kyjov Waste Heat Utilization Project
Team Leader: Helmut Schreiber	*TL Unit:* ECSEG
ICR Type: Core ICR	*Report Date: October 15, 2001*

1. Project Data

Name: CZECH REPUBLIC - Kyjov Waste Heat Utilization Project *L/C/TF Number:* 20569

Country/Department: CZECH REPUBLIC *Region:* Europe and Central Asia Region

Sector/subsector: PY - Other Power & Energy Conversion; VP - Pollution Control / Waste Management

KEY DATES

			Original	Revised/Actual
PCD:	08/08/1997	*Effective:*	11/18/1998	
Appraisal:	03/17/1998	*MTR:*		
Approval:	08/27/1998	*Closing:*	06/30/2000	03/31/2001

Borrower/Implementing Agency: CZECH REPUBLIC/MINISTRY OF ENVIRONMENT

Other Partners:

STAFF	Current	At Appraisal
Vice President:	Johannes F. Linn	Johannes F. Linn
Country Manager:	Roger Grawe	Roger Grawe
Sector Manager:	Henk Busz	Michele E. De Nevers
Team Leader at ICR:	Helmut Schreiber	Helmut Schreiber
ICR Primary Author:	J. Christian Duvigneau; Victor B. Loksha	

2. Principal Performance Ratings

(HS=Highly Satisfactory, S=Satisfactory, U=Unsatisfactory, HL=Highly Likely, L=Likely, UN=Unlikely, HUN=Highly Unlikely, HU=Highly Unsatisfactory, H=High, SU=Substantial, M=Modest, N=Negligible)

Outcome: S

Sustainability: L

Institutional Development Impact: SU

Bank Performance: HS

Borrower Performance: HS

	QAG (if available)	ICR
Quality at Entry:	S	S
Project at Risk at Any Time:	No	

3. Assessment of Development Objective and Design, and of Quality at Entry

3.1 Original Objective:

The major objective of the Project was to reduce emissions of greenhouse gases (GHG), notably CO_2. This objective was to be achieved by means of increasing the efficiency and reliability of heat supply to the city of Kyjov (Kyjov), and of the heat and power supply to the Vetropack Moravia Glas s.a. (VMG) Factory, through introduction of gas-fired combined-cycle heat and power (CHP) production and through intensified use of waste process heat generated at VMG. Associated project objectives were to (a) demonstrate gas-fired combined-cycle cogeneration in the Czech Republic where this technology was not yet widely used; (b) stimulate technological and institutional changes that would promote energy efficiency through developing CHP systems for joint industrial and municipal purposes; (c) achieve local environmental benefits by reducing the proportion of pollution-intensive fuels (such as lignite) in the fuel mix used for heat and power supply; and (d) demonstrate the possibility of cooperative efforts between the Czech Ministry of Environment (MoE) and the private sector in enhancing the environmental benefits from such a project.

3.2 Revised Objective:

The above objectives remained unchanged throughout implementation of the Project.

3.3 Original Components:

The Project consisted of five physical components and one component for project supervision and dissemination activities. The following paragraph provides indications on the package, its estimated costs (US$ million) and procurement arrangements:

Component A: Procurement and installation of a gas-fired combined-cycle heat and power (CHP) plant, estimated to cost US$ 20.35 million, and comprising two gas turbines (8.0 MW of electric capacity each) as well as one steam driven turbine (7.0 MW of electric capacity) The plant was procured as a turn-key contract under international competitive bidding (ICB)). The total capacity of the CHP Plant was to be 23 MW of electricity and 18 MW of heat generation.

Component B: Replacement and retrofitting of waste heat boilers at the Glass Factory (new boiler # 51, replacing a hot water boiler by a steam boiler, and retrofitting of boiler #52); estimated to cost US$ 1.56 million (to be contracted under ICB).

Component C: Construction and Re-construction of existing buildings at the VMG glass factory; estimated to cost US$ 0.745 million (contracted under local competitive bidding prior to appraisal).

Component D: Modernization and expansion of the district heat (DH) network of the City of Kyjov; estimated to cost US$ 1.64 million, (procured as a turn-key contract under ICB). This would involve supply and installation, in channel-free design, of preinsulated pipes of about 6km with instrumentation and control cables.

Components A to D were to be implemented by the private company Teplarna Kyjov s.a. (TPK) which would own and operate the CHP plant.

Component E: Decommissioning of about 13 boiler houses in Kyjov (partly gas fired, partly coal fired) and heat supply replacement by connection to the DH network and by installation of substations with heat exchangers. Estimated to cost US$ 0.52 million (procured under local competitive bidding). This component would be implemented by the City's district heat enterprise.

Component F: Project supervision and dissemination activities, including training and public relations matters, to be implemented by the MoE with the help of staff and consultants. Estimated to cost US$ 0.120 million. to be procured under Bank Guidelines.

3.4 Revised Components:

Original Components were not revised in substance. Minor modifications were undertaken with respect to improvements to the waste heat boilers' design, improvements to gas turbines and steam turbine, after these were not meeting criteria for specified efficiencies during the first tests, There were modifications to the heat exchanger system at the hospital, an enlarged heat network. By component, these modifications took place during implementation as follows:

Component A: During testing and start-up a number of minor modifications were introduced to the CHP system to allow for improved efficiencies of individual sub-components which would permit to meet the targeted efficiency parameters for the CHP plant. The capacities were almost reached as planned (96.4%), but gas consumption of the gas turbines was slightly higher than targeted (about 8%). The capital costs for this major component (covering almost 80% of the total project costs) were only 0.5% higher than originally estimated.

Component B: The timing and scope of this component was modified, with boiler #52 only to be retrofitted after the completion of testing and early operation of the boiler #51. This was done to apply lessons from the operation of the new boiler #51 to be applied to boiler #52. As a result of these lessons, the scope of replacements for boiler #52 was significantly higher than earlier estimated which explains the higher costs of that component (34% increase).

Component C: The original plans for making use of existing buildings were modified in light of evolving requirements for the CHP plant which was to be housed in the modified buildings. Cost savings were realized in the process (29% decrease).

Component D: This component was executed as planned. Costs turned out to be higher (31%) with civil works for laying pipes underestimated.

Component E: This component was executed as planned, with 15 boilers replaced instead of 13 boilers. Costs turned out to be higher (29%) with the number of boilers, and costs of boiler disposal, installation of substations with heat exchanger underestimated.

Component F: This component was executed as planned but costs turned out to be slightly higher than estimated (17%).

Overall the Project was executed as planned in terms of capacities, costs, and timing, with cost overruns for the total Project amounting to only about 4%.

3.5 Quality at Entry:

The project was developed and structured in the context of green house gas emission reduction requirements in the Czech Republic, with the global impact as outlined in the Country Program and the general project eligibility criteria guidelines of the GEF. The Czech republic signed the UNFCCC in 1993, and entered into obligations as mandated by the Kyoto Protocol. The

government agreed to undertake measures to reduce green house gas emissions and meet requirements of reducing emissions at or below 1990 level by the first commitment period 2008-2012. The Country agreed to reduce green house gases emissions by 8% according to Kyoto protocol provisions.

The Project was thoroughly prepared with Czech technical consultants, economic expertise and a Czech financial consulting firm. It was reviewed and appraised by the Bank-staff who contributed substantially with proposals for improvements in technical, economic and financial aspects. The joint venture concept of the implementing company, Teplarna Kyjov s.a. (TPK) led to an overall agreement among the shareholders to meet the Project objectives in spite of their diverging interests. Although the sellers of gas and waste heat would want to see high prices for their deliveries, although the customers for heat and power would want to see minimal purchase prices, compromise formulae were developed and contractually agreed, which maintained the viability of the Project. Thus the shareholders (which were suppliers of inputs and/or customers for the outputs of the Project) reached agreement which were designed to help the Project to achieve its objectives. The thorough preparation of a prospectus for the company and Project, led to vivid interest among over 70 potential investors with 10 evaluated in detail, and two selected for final negotiations. A similar approach was used to select the commercial Bank competitively.

As a result of the above, the quality at entry is considered to be satisfactory. There was a QUAG Review at entry, which commended the project concept and preparation. It saw a number of highly satisfactory aspects (Project concept, institutional set-up, private sector development with highly efficient tendering for foreign investors and commercial bank lending, project preparation). It also made a point about the economic incremental cost analysis with respect to future expansion costs of the electricity grid arguing that these may have been overestimated, making the project appear too positive from a GEF point of view. It also pointed to a discrepancy between the environmental report which claimed replacement of gas fired and coal fired boilers whereas the appraisal report talked about gas fired boilers only. As it turns out, the majority of boilers replaced was gas fired but there was also a number of coal fired boilers. (Can we get the exact numbers of these categories). Overall, the QUAG rated the Project as "Satisfactory" at entry.

4. Achievement of Objective and Outputs

4.1 Outcome/achievement of objective:

The objective of the project, namely to reduce GHG, was achieved, as well as the associated objectives, as described in Section 3.1 above. All Project components were successfully erected and completed on time, and commissioned.

The major component of the project, the ***CHP plant***, including auxiliary equipment, was completed in April 1999 after a year of intensive building and installation activities. After completion of the trial testing of the CHP Plant, the heat and power facility was put into operation in October 1999. The CHP Plant utilizes waste heat from the VMG glass factory and additional new gas-firing facilities (gas turbines), as well as a steam turbine, to produce heat and electricity. The gas is supplied by the South Moravian Gas Company (JMP). The CHP Plant

supplies heat and electricity to VMG, sells its electricity surplus to the regional grid of the South Moravian Power Company (JME), and sells heat to the district heating system of the adjacent City of Kyjov. JMP, JME, and VMG, were main shareholders in the Project until a foreign shareholder was selected after an international call for tenders. Subsequently, VMG sold its shares to the foreign shareholder (Isar-Ampere Werke, now EON of Germany). The city of Kyjov also holds a small share in the company.

The objective of ***modernization and expansion of the district heating network*** in the City of Kyjov and ***linkage with the CHP Plant*** was also achieved. For the purposes of project implementation the City of Kyjov converted its district heating department into a fully owned self-standing company TEPLO KYJOV. Fifteen old boiler houses (two more than originally planned) were decommissioned, reconstructed and replaced with new heat exchanger sub-stations. In addition to GEF funds, the State Environmental Fund (SEF) in the Czech Republic provided funds for expansion of district heating system and its reconstruction. Moreover, the City of Kyjov granted additional money from its own budget to carry out complementary activities of this component not covered by the SEF and GEF Grants. Nevertheless total heat demand has been significantly lower than estimated at appraisal. Bank supervision missions have repeatedly suggested to make special efforts to increase the heat load of the Project through aggressive promotion of the district heat system, to compensate for the reduced heat demand resulting from energy efficiency measures of customers.

After completion of the first trial testing of both components and of all auxiliary equipment, the project was put into operation in October 1999 when the CHP Plant and district heating system were fully operational. The State Environmental Fund (SEF) approved of the achievement of estimated objectives and of correct disbursement statements prepared by the Project owners, as well as by the City of Kyjov in their statements issued in January 2000. The district heating system currently operates at steady state regime and ensures satisfactory and reliable function of the heat supply to the city.

Due to some initial problems with the efficiency and specific gas consumption of the gas turbines and lower than expected efficiency of the steam turbine, at the first testing, the full start of operations of the plant was delayed, and due to repeated testing, showed a slower learning curve than estimated at appraisal. Despite a number of improvements, subsequently undertaken in the sub-components of the CHP plant (with substantial inputs from the Bank's supervision teams), TPK will have to live with marginally lower efficiencies (about 2% to 4%) and slightly higher gas consumption (between 3% and 8%) than originally estimated. The tests for individual components had to be repeated at least once, and several times for the operation of the first waste heat boiler. This was due to initially insufficient filtering of waste heat streams from the glass furnaces which required substantial cleaning of the boilers and steam turbine. This problem was subsequently overcome.

Thus the major objective of the project, reduction of the emissions of green house gases, was realized in an overall satisfactory manner.

In line with the Project Appraisal Report, the secondary project objectives were also realized: a)

improved energy efficiency through the introduction of combined-cycle heat and power generation for the joint utilization in industrial sector and for municipal purposes; b) local environmental benefits through the reduction of the share of lignite in the fuel mix for heat and power generation; and c) cooperation between the government, regional institutions and private industry to help enhance the environmental benefits from such a Project.

4.2 Outputs by components:

4.2.1 CHP Plant

Construction of CHP plant in the City of Kyjov represented the core component of the project. The CHP Plant includes installation of two gas turbines, a condensing steam turbine, one exhaust gas boiler, transformer station, connection to the electric grid and gas supply network, heat feeder and heat exchange station, a 22 kV transformer station, and, finally, a water treatment plant. The CHP Plant nominal output was designed to be 23 MW of electricity and 18 MW of heat in the form of steam as well as hot water. As per the design, the CHP Plant utilizes waste heat from Vetropack Moravia Glass a.s.(VMG) factory, supplemented by gas firing, and produces steam, hot water and electricity. This is to displace production of electricity in a nearby lignite-fired power plant, as well as heat production from gas- and coal-fired boilers in the City of Kyjov through TPK supplied district heat for the City's expanded DH network.

At appraisal, the annual output of the plant was estimated to be 196.6 TJ of heat supplied to VMG and to the City, and 184 GWh of electricity for sale to VMG and the regional electricity grid of JME. This output was based on inputs of waste heat from the VMG plant as well as an estimated gas consumption of 40.24 million SCM per year. On the basis of these figures and an assumed replacement of electricity produced by lignite firing, the project would save approximately 143.2 thousand tons of CO_2 per year during the twenty year of project life-cycle (total of 2.87 million tons of CO_2 over the life-cycle).

During the first year of operation, in the year 2000, the output of electricity was below the output targets set up at the start of project. Due to the repeated testing, the actual availability of the CHP plant in year 2000 was lower than estimated, with resulting lower production of electricity (162 GWh) and sales of only 158.3 GWh instead of the planned sales of 176.4 GWh. In terms of heat sales the situation was more dramatic due to lower than estimated demand. Thus, actual sales of 196.6 TJ compared with actual sales of only 111.0 TJ, as actual consumption was, on average, about 43% lower than estimated for all major customers (DH network, Hospital, and VMG). The availability of the CHP plant was affected due to several technical problems and unexpected frequent cuts off of the plant. It was observed that the plant faced frequent difficulties with the gas turbines, a steam turbine and waste heat boiler 51. In addition, TPK had to fix several technical and mechanical problems connected with different equipment (e.g. leakage of steam at the high-pressure steam distributor; insufficient capacity of the condenser at higher temperatures than 30 degrees C; repeated failure of the fuel controlling element at the gas turbines; excessive noise from the condenser fans, which had to be replaced by plastic fans to meet environmental standards). These technical problems resulted in frequent stops of plant. The total availability was also affected through repeated testing of equipment and guarantee measurements carried out by the operator of the plant. In addition, the lower heat demand

affected the overall efficiency of the CHP plant. As a result, the efficiency of the electricity production declined further. Therefore, specific measures were proposed and technical improvements were carried out to improve availability of the plant and achieve a higher output of electricity. The improvements and measures are summarized below:

a) Gas Turbines:

Technical improvements at the gas turbines were undertaken to achieve improved efficiencies and the specific heat consumption guaranteed by the general supplier of equipment.

A stock of major spare parts and a refinement of the service contract with the gas turbine supplier were established to enable TPK to shorten the time needed for repairs of different equipment, to decrease losses from lower electricity production, and to increase total availability of the plant.

The frequency of washings of turbines could be reduced, thereby increasing availability and electricity generation.

The high difference of the temperature of the burner flames during the restart of the gas turbines was reduced to shorten the time needed for restart and increase availability.

b) Steam Turbine

The high noise generated by the fans at the air cooled condenser was reduced through replacement with plastic fans. As a result of the then possible increased fan speed, the steam turbine output could be increased.

A new heat exchanger was added in the room housing the steam turbine. By using heat from that heat exchanger, the plant is making better use of its steam. The heat from the heat exchangers at the end of the heat recovery boilers is used to pre-heat the condensate to an approximate temperature of 90 C. A smaller quantity of steam is sent to the feed water tank (degasifier) with more steam available for the turbine, resulting in a small increase in electricity generation.

The supply of heat to VMG was changed from steam to hot water, and heat from the heat recovery boilers of the gas turbines is now used for more electricity generation. The impact of this innovation is an increase in electricity production, because the steam is no longer spent on VMG's technological needs.

c) Waste Heat Boilers of the Glass Factory

The first waste heat boiler (behind glass melting furnace #51) was put into operation at the same time as the CHP Plant. During early operation the boiler suffered from a number of mechanical problems caused mainly by sucking in particulate matter from the glass melting furnace. This particulate matter affected the operation and maintenance of the boiler, which considerably reduced boiler availability. The supplier of the boiler was asked to undertake changes in the design to reduce the uptake of particulate matter and thereby to reduce the frequency of washing

of the boiler. The resulting increased availability is now satisfactory.

TPK decided as a result of these initial problems with the first waste heat boiler (#51), to postpone the production and installation of the second waste heat boiler (#52) until after the correction of the mechanical problems of the first. The second waste heat boiler was installed and commissioned in December 2000, i.e more than six months after originally planned completion.

A further problem of waste heat boiler operation resulted from the fluctuation of the daily level of glass production and the composition of raw material inputs, which influenced the daily steam production. of the waste heat boiler. Daily glass production averages about 300 tons throughout the year, but may vary up or down by 20%. Furthermore, recycled glass, used as "raw material", needs less heat than glass produced from silicates, but the proportion of recycled glass, used in total production, varies. The average glass production of 300 t of glass per day corresponded to about 4.3t/h of steam from one waste heat boiler at projected availability. As the frequency of cleaning the waste heat boiler could be reduced significantly, there will be no problem to produce the needed quantity of 8 t/h of steam, on average, from the two heat boilers .

It was further observed that the maximum steam production of boiler #51 was 5.45 t/hour. Such a peak may occur several times a year, depending on glass production and raw material composition. But it is rather unlikely that this high production level would occur simultaneously in both boilers (glass melting furnaces #51 and #52). Thus, the gear of the steam turbine is unlikely to be overloaded (maximum permissible load is 9.1 MW).

d) Heat Supply to the City of Kyjov

Heat demand has been much lower in the DH network and the hospital than previously estimated. While it must be seen that the last two winters (1999/2000 and 2000/2001) were unusually warm, there has also been a significant reduction in demand due to energy conservation measures and some customers converting to gas heating. The Bank supervision team has recommended that TPK and the City aggressively promote district heating so that the heat load will rise back to the level estimated at appraisal. This would help to improve the efficiency of the CHP Plant.

The peak demand for district heat of the City, usually in the morning, has exceeded the maximum possible heat output of the heat exchangers at times (sometimes even in summertime). Steam was used to meet the additional demand. To avoid this and associated losses of electricity production, it was recommended that heat from the heat exchangers could be stored during night time, and then released during the morning peak demand hours. "Storage" could be achieved by increasing the temperature in the DH pipe system during the night and/or in new storage tanks, which could be constructed. This recommendations has not yet been acted upon.

The Achievement of Electricity Production

From the CO_2 emission reduction perspective, electricity output has a higher priority as it displaces coal-fired electricity production from the grid. The project originally estimated during steady state operation (i.e.from 2001) an annual amount of power output for sale of 183 GWh,

delivered to the users (approximately 57 GWh to VMG and 126 GWh to the regional electric grid). During year 2000, the CHP plant actually sold a total of 158.3 GWh against a plan of 176.4 GWh. Sales to VMG were realized at the contractual level of about 57 MWh, whereas sales to the regional grid of JME fell short by about 19 GWh, reaching only about 100 GWh, due to lower than estimated production.

TPK achieved lower output of electricity due to the lower than expected plant availability. The availability was affected by the frequent stoppages of equipment due to technical problems and non-availability of essential spare parts. Availability fluctuated considerably in 2000: during the first quarter TPK achieved an average of 86.6%, in the second quarter 90.2%, in the third quarter only 76.0%, and in the fourth quarter 94.7%. Actual availability in 2000 was calculated as the equivalent of maximal output of the plant (7631 hours achieved) compared to the theoretical availability of 8784 hours in the year 2000. Thus, actual total availability was 86.88% of annual availability.

Guarantee measurements carried out in December 2000 proved achievement of the guaranteed electric capacity of 19,959.75 kW with a tolerance of +/- 0.493%.

The Achievement of Heat Production

Under steady state operations (for heat already year 2000), annual heat production from the Project was estimated to amount to 196.6 TJ, with sales of 86.6 TJ to the City of Kyjov, 55.0 TJ to the Hospital, and 55.0 TJ to VMG. But, in 2000 TPK actually sold only 111.0 TJ (56% of estimate), with 60.4 TJ to the City, 30.0 TJ to the Hospital, 20.6 TJ to the VMG).

The sale of heat is below target due to lower than expected demand for heat. The lower demand was due to a number of factors such as (a) unexpected mild winters; (b) energy saving investments of heat customers; (c) improved efficiency of new heat exchanger sub-stations in the City, and (d) reduced heat losses of the heating network which, in parts was modernized with pre-insulated pipes. The DH Company and TPK should promote DH services and expand the system to gain new customers. This would compensate for some of the lost load and would help to improve the overall efficiency of the CHP Plant.

At this time, TPK estimates heat sales in 2002 amounting to a total of 148.9 TJ, with sales to the City network of 65.7 TJ, to the hospital of 33.0 TJ, and VMG of 50.2 TJ. This is still almost 25% below the targets estimated *ex ante*.

The Consumption of Fuel

The consumption of natural gas by the CHP Plant was estimated at Project appraisal to be 40.24 million SCM/year for the steady state situation. In fact, the actual gas consumption reflected the present technical parameters of gas turbines and their availability. Specific heat consumption measured at the occasion of the second guarantee tests, and expressed in kJ/kWh fluctuated above the set targets in the range from 1.5% to 3.5% including the spread of the tolerance of measurements (+/-1%). But of course, the repeated starts and stops of the plant in early 2000,

and the lower than estimated availability of the plant, increased unit gas consumption further. As a result of improvements carried out by TPK, together with the supplier of the gas turbines, specific heat consumption, in year 2000, showed continued improvements. In the first quarter the plant achieved, on average, 262.4 m3/MWh, in the second quarter 255.5 m3/MWh, in the third quarter 252.6 m3/MWh and, in the fourth quarter 249.9 m3/MWh. On average, the annual consumption was 255.0 m3/MWh compared to the estimate of 219.0 m3/MWh, or 16% higher than foreseen. The fourth quarter of 2000 was still 14% above target. The improvements carried out by the plant result in an estimated consumption, in 2002 of 43.7 million SCM at an electricity production estimated at 177.5 GWh. This is equivalent to 246 m3/MWh or 12 % above the originally estimated consumption. It is unlikely that TPK can significantly reduce this figure further.

The Achievement of Greenhouse Gas (GHG) Emission Reduction Targets

The amount of greenhouse gas (in this case, CO_2) emissions prevented from being emitted into the atmosphere due to the project is very difficult to measure directly. Thus, analytical methods are used. The basic hypothesis behind the CO_2 emission reductions resulting from this project is that TPK's CHP plant is one of the electric generation units feeding its output into an electric grid with a fixed demand for electricity in any given hour of the year. Hence, the electricity produced by TPK's plant displaces the electricity that otherwise would have been produced by other plant(s) which would be, arguably, more polluting (lignite-fired). An additional (although not large) amount of CO_2 emission savings results from the replacement of heat boilers in the town of Kyjov with the heat exchangers installed under the project. This is due to a higher efficiency of the CHP plant compared to these boilers and due to the fact that some of these boilers were coal-fired.

The quantitative estimates of CO_2 emission reductions achieved by TPK are based on the demonstrated performance of the CHP plant over the first two years of operation and the forecast for the rest of the 20-year lifetime of the project. The numbers below are based on the extrapolation of the existing performance of the plant for the rest of the project's lifetime. The appraisal estimates are used as the point of reference.

Parameter	Estimate at appraisal	Estimate at project closing	Difference	Percent difference
Lifetime greenhouse gas emission reduction, tons of CO_2	2,865,524	2,666,203	- 199,321	-7%
Cost per dollar of GEF grant, US$/t$CO_2$	2.02	2.18	+ 0.15	+7%
Cost per dollar of GEF grant, US$/tCe	7.42	7.98	+ 0.55	+7%

The shortfall on the original target for CO_2 reductions is thus estimated to be about 7% (199,321 out of 2,865,524 ton CO_2). This shortfall is largely due to the less-than-expected efficiency of the gas turbines and the resulting increase in the consumption of natural gas by the plant. Still, the shortfall is well within the uncertainty margins associated with the 20-year project cycle. The need

to allow for such uncertainty has always been recognized by the project team and described in the PAD in the context of sensitivity analysis for the cost of GHG emission abatement. The fact to emphasize is that the global objective of the project is not jeopardized due to this shortfall. The updated estimate of the unit cost paid by the GEF for carbon emission reduction is still below US$10 per ton of carbon and thus within the safety margin that still allows to view the project as an attractive investment for the GEF. The shortfall in terms of GHG reductions can be completely recovered by 3-4 years of additional operation of the plant.

The possibility of a reduced number of hours of operation of the plant has also been considered. The reduction could be due a change in the operation mode of the plant, which may switch from baseload to intermediate and peak load operation in an attempt to reduce the number of hours of unprofitable off-peak operation. The realization of this possibility would have a much greater impact on the CO_2 emission reductions. Still, the unit cost of CO_2 reduction for the GEF is likely to remain within US$10 per ton of carbon if the plant reverts to the baseload operation mode (8400 h/year or more) at some point in the future.

Number of hours of operation during the next several years	**Number of years before return to baseload operation**	**Lifetime greenhouse gas emission reduction, tons of CO_2**	**Cost per dollar of GEF grant, US$/tCe**
8400 (baseload operation)	-	2,666,203	7.98
5000	10	2,133,024	9.97
4000	7	2,183,206	9.74
3000	6	2,158,115	9.85
2000	5	2,164,387	9.83

The table above shows that a temporary reduction in the number of hours of operation of the plant may extend to several years without changing the conclusion that the project yields CO_2 reductions in an amount of more than 2.1 million tCO_2 and at a cost less than US$10/tCe to the GEF. However, the need to revert to baseload operation after several years needs to be emphasized. TPK's failure to do so would certainly lead to failure to deliver carbon emission reductions at less than US$10/tCe. The possibility and the timing of return to baseload operation would depend on the profitability of such operation in the context of the future market prices for electricity. It is expected that 5-8 years may pass before the price of electricity on the Czech grid is sufficiently high for TPK to operate profitably as a baseload unit. This would require an increase of the grid price of electricity. Such an increase would be necessary in order to allow for expansion of the Czech electric generation capacity. At present, there is no allowance for capacity expansion in the grid tariffs, but this is unlikely to continue for more than a few years.

Overall, barring major alterations of the existing regime of the CHP plant, the achievement of the global objective to reduce the emissions of greenhouse gases is considered satisfactory.

4.2.2 Modernization of Expansion of District Heating

This component originally envisaged decommissioning 13 boiler houses, the installation of new heat exchanger sub-stations in these buildings, expansion and modernization of the district heating network, and connection of the network with the centralized heat supply of the CHP plant. For the purposes of project implementation, the City of Kyjov established a heating company TEPLO KYJOV. The State Environmental Fund in the Czech Republic approved funds for financing of the reconstruction of district heating system.

The State Environmental Fund (SEF) signed an agreement with the City of Kyjov to provide grant support, amounting to CZK 17.5 million to help cover estimated costs of this component. The schedule of implementation of the reconstruction works was closely coordinated with the construction of the CHP Plant. Following a new concept of connecting the district hospital in Kyjov with the heat supply from the CHP Plant, the TEPLO KYJOV expanded the district heating network and erected two additional heat exchangers. Additional costs of this expansion were recovered through the budget of the City of Kyjov. In addition, the City of Kyjov funded preparation of design and technical documentation, all measurements related to this component and, testing of the heat exchangers during commissioning of the district heating system. In the end, 15 boiler houses were shut down and replaced by substations with heat exchangers.

The entire Project component was completed in October 1999, when the CHP Plant and district heating system were commissioned. SEF approved of the achievements of the scope of work and the correctness of disbursements made for the Project component implemented by the City of Kyjov, and issued an Endorsement Statement on January 2000. The district heating system is currently run in a steady state regime and provides reliable services. Thus, the objective for this component was achieved without significant problems.

One positive environmental impact is manifest through the decreased NOx emissions in the critical localities of the City of Kyjov. The Project also contributed to the achievement of higher energy efficiency, heat savings and reduction of maintenance costs while running the district heat network in the City. After commissioning the heat exchanger sub-stations a number of personnel, needed earlier to maintain the district heating equipment, was reduced from 23 to 6. On the other hand, the CHP plant created sixteen jobs with required higher levels of education.

During the year 2000, several new customers in the city were connected with the centralized heating system, including: the Municipal House, the House of Culture, and a primary school building. In the future, the district heating system could be expanded further, and could attract new customers, provided the heat from TPK will be offered at competitive prices. The City of Kyjov plans to connect a number of buildings of Kyjov's schools and a small housing estates. In addition, some residential areas could also be connected with the district heating system, assuming that houseowner could be convinced about the attractiveness of district heat as compared to other sources. However, the proposed extensions of the district heating system will be constrained by limited investment funds as well as by distances of unconnected areas from the existing network.

Whereas all the heat loads, originally planned to be included, have been connected as planned, the district heat demand in the town of Kyjov proved to be almost 25% lower than originally envisaged under the Project. Some new customers were connected, but this will not lead to the demand assumed originally. Therefore it was proposed to the Board of TPK to launch a campaign for new district heat consumers (in cooperation with the municipality as far as possible).

Heat pricing is an important consideration in attempting to expand the City's district heating network. At present, a significant cross subsidy of natural gas prices between industry, on the one hand, and households and small consumers on the other hand, in favor of the latter, is being applied by the Czech Government. Under those circumstances, it is difficult for heat, supplied from cogeneration units, firing natural gas, to compete with prices of heat produced in gas-fired small local boiler houses. Therefore, unless prices of natural gas have been fully liberalized and the cross subsidies eliminated, the CHP plant will have to ensure competitive prices of district heat. The City's heating company has increased prices faster than gas prices which, at present acts as a deterrent to convincing new customers to connect to the district heating system. A more astute pricing policy may be called for. Moreover, the expected increase in the gas price for small consumers of heat may be a good opportunity to advocate the heat supply from TPK's plant (as opposed to operating small gas boilers).

4.3 Net Present Value/Economic rate of return:

4.3 Net Present Value/Economic Rate of Return

With regard to the economic analysis of the Project, the appraisal focused on an incremental cost analysis, comparing a baseline with the proposed Project. The baseline was assumed to consist of (a) improved heat supply to the City of Kyjov, with the industrial waste heat of the glass factory to be sent to the City's customers via a central connection from the glass plant through a modernized distribution network (involving conversion of existing small gas- and coal-fired boilers; but no co-generation of electricity at that site), and (b) equivalent amounts of electricity, as to be produced under the proposed Project, but generated in a lignite fired power plant of the Czech grid.

The incremental cost analysis compared investment and operating cost streams over a period of 20 years (up to 2019) of these two alternatives (baseline and proposed Project), by discounting them at a rate of 12%. It also calculated the amounts of CO_2 generated in the two alternatives and worked out the incremental cost of one ton of CO_2 reduced, as well as of one ton of carbon equivalent reduced (see also section 4.2.1. above). The results of this analysis, which have been documented extensively in Annex 4 to the appraisal report, have been updated to take account of actual economic costs for operations of the Project case.

The updated analysis takes account of actual costs and notably the significantly higher operating costs (in particular gas costs, but also non-fuel operating costs), until the year 2000, and best estimates for 2001, with projections until 2019 based on those of the year 2002. The important benchmarks at project closing include the following:

a) The projected unit abatement cost is US$24.6 per ton of carbon equivalent or almost

two-and-a-half times as high as that estimated at appraisal (US$10.9); see financial section 4.4 below highlighting the cost parameters which are responsible for these increases.

b) Per dollar of GEF grant spent on the Project, unit abatement costs are likely to remain within the cut-off rate of GEF of US$10 per ton of carbon equivalent (see again section 4.2.1 above).

The difference between the two above-mentioned estimates (US$24.6 and US$10) is due to the fact that the amount of the GEF grant at appraisal was fixed to only partly cover the incremental cost of the project. This was done intentionally as a measure of protecting the GEF against a possible cost overrun per unit of carbon abatement.

The analysis assumed that the plant will remain in operation until at least 2019. This expectation is only justified if TPK's competitiveness can be demonstrated. To assess TPK's competitiveness, a comparison of its cost structure was made with that of a typical existing lignite plant as well as with a new lignite-fired generation facility. This comparison demonstrated that the existing off-peak electricity prices in the Czech market are set at a level just enough to cover variable operating costs for cheap Czech lignite plants, plus a modest allowance for transmission delivery cost. There is little allowance for recapture of investment costs because the plants are fully depreciated. In other words, the current baseload ("low") tariff of about US$0.021/kWh is much lower than any price that could be justified if the investment costs of new generation capacity were provided for in the tariff.

The existing price structure would thus be improved by a timely increase in the electricity price to recognize that new plants will be required in the future. Under those circumstances the comparison shows that TPK would indeed be fully competitive with a new lignite-fired plant at costs of about US$0.045/kWh. A decision by the Czech Government to this effect would be a relief for TPK and other independent power producers in the Czech Republic. It would also facilitate the Governments plans of privatizing CEZ, the dominant public power producer of the country.

4.4 Financial rate of return:

On the financial side, the Project, ex post, has deteriorated dramatically. There are a number of reasons for this. The main reasons are (a) the reduced revenues, and (b) the increased operating costs. Details about these estimates for years 2001 and 2002, *ex-ante* and *ex-post*, are contained in the table in section 10. Further reasons for the decline in financial performance are the slightly higher capital costs and the delays in start-up and slower than estimated learning curve in 1999 and 2000.

Revenues of the Project consist of electricity revenues and heat revenues, with proportions, *ex-ante*, accounting for about 86% for electricity sales and 14% for heat sales. ***Electricity revenues*** of sales to the regional distributor JME have practically held their own, based on the off-take contract between JME and TPK, and reflect similar orders of magnitude as projected at appraisal. However, revenues from sales to VMG have declined significantly as compared to the original projections. This is due, on the one hand, to smaller than projected sales, and on the other hand to a significantly lower sales price. The price which VMG pays to TPK is supposed to be

5% below the price of the one which it would have to pay JME, if it purchased its power from JME. The market price for JME's electricity is low due to overcapacity in the Czech generation systems as a result of the start-up of the nuclear plant at Temelin, and the Government's hesitation to close old, depreciated coal-fired plants for reasons of maintaining employment, low operating costs, and the possibility of exports to neighboring EU Countries. The difference in electricity revenues, *ex-ante* and *ex-post,* is projected to be a shortfall of the order of CZK 23 to 25 million (US$0.45 to US$0.48 million) in years 2001 and 2002, representing about 7% of originally estimated revenues. If sales to JME were valued at presently prevailing depressed market prices, another CZK 60 to 65 million (US$ 1.56 to US$1.58 million) would be lost per year to the company! Heat revenues, *ex-post,* are also significantly lower due to significantly lower heat loads. But relatively high heat prices, which may be one reason for the low heat loads, compensate to some extent. Whereas sufficient heat loads are important for the efficient operation of the CHP plant, they are less important for the overall revenue.

Operating costs have even deteriorated more dramatically than revenues, comparing between appraisal and the actual operations to date. Thus, the increased gas consumption (about 8%) and a higher gas price (about 3%) have combined to increase gas costs alone by CZK 22 million for 2001 and 2002 according to TPK projections. Other energy cost (mainly waste heat purchases from VMG) have also dramatically increased as compared to the original projections (almost CZK 10 million). Moreover, maintenance costs, materials, services, labor and other costs have also significantly increased and account for a further cost increase of about CZK 17 million as compared to original projections. Thus, operating costs other than gas have increased by CZK 27 million for 2001 and 2002, bringing total operating cost increases to about CZK 49 million or almost 25% of operating costs as estimated at appraisal!

The capital costs have only increased by about 4% which is considered within reasonable limits, but also contributes to the deterioration of the rate of return.

Last, but not least, the ***start-up delays*** and the slower but expected learning curve to achieve full operational efficiency also contributed to lower results in 1999 and 2000.

However, the big influences on the ***IRR***, in descending order, are the increases in operating costs and the shortfalls in revenue. As a result, operating profits in 2001 and 2002 are projected to be only CZK 52 to CZK 54 million as opposed to original projections of CZK 110 and 121 million respectively, i.e shortfalls of more than 50%! With the projections beyond 2002 this shortfall increases further.

The resulting ex post IRR for the entire Project is 5.0%, as compared to an IRR *ex-ante* of 13.8%. Taking account of the GEF grant by reducing investment costs by the equivalent amount of the grant improves the *ex-post* IRR to 7.8%, as opposed to 18.4% ex ante. These devastating results were discussed with TPK which was urged to review its contractual arrangements with VMG, both for the electricity price of TPK sales to VMG, as well as the waste heat price paid by TPK to VMG. Moreover, TPK was urged to carefully review the other operating costs as well and identify scope for their reductions.

4.5 Institutional development impact:

The Project had a significant impact on institutional development. ***Two new companies*** were established for the purposes of implementation of the Project: ***Teplarna Kyjov*** (TPK), a private sector company, to erect and operate CHP Plant, and ***Teplo Kyjov,*** a City-owned company with potential for future privatization, to reconstruct and operate the district heating network. The establishment of TPK allowed for shareholders with diverging objectives, to reach compromise in the interest of realizing an attractive Project with significant environmental benefits. In addition, TPK signed a Shareholder's Agreement that enabled a new foreign strategic investor (Isar-Amperwerke), to join the company. The project distributed implementation responsibilities among several involved subjects that required cooperation of all parties. Teplarna Kyjov, Teplo Kyjov, the City of Kyjov, State Environmental Fund, Ministry of Environment, and Hypovereinsbank. While TPK and Teplo Kyjov took over the responsibility for the construction and reconstruction works related to the Project, MOE was the government agency responsible for supervising and monitoring Project implementation and operation, overseeing financial management, and coordinating the whole Project. GEF, SEF, Hypovereinsbank and the City of Kyjov provided grant and loan facilities for Project financing. The Project demonstrated the possibility for cooperation between a government agency, regional and local authorities, and the private sector. The Project brought also new management skills in the field of project financing, contracting, and procurement of goods and services. Last but not least, the Project helped enhance public awareness on environmental protection at regional and government level.

5. Major Factors Affecting Implementation and Outcome

5.1 Factors outside the control of government or implementing agency:

Guidelines of the World Bank regarding to the procurement of goods and services enabled a transparent, smooth and unproblematic completion of the first phase of the Project. Employment of foreign currencies by the Project and a favorable exchange rate development helped TPK to take advantage of the GEF Grant committed in SDR, of the loan facility, and helped to reduce the foreign exchange risk.

The international energy prices which are to a large extent oriented along the presently high oil prices, have also caused gas prices in the Czech Republic to rise significantly. As long as the present overcapacity in the power sector in the Czech Republic prevails, there is likely to be a growing difference between the domestic gas price which is governed by international market developments, and power prices in the country (see section below).

5.2 Factors generally subject to government control:

In general, the positive approach of the government agency (MOE) and associated institutions, including a genuine interest in the Project's realization, ensured its smooth implementation. Strict adherence to the environmental standards, constraing emissions from the Project, and to construction permits, issued by the regional authorities, led to the achievement of targeted parameters by the Project. On the other hand this adherence to norms and standards had an impact on Project implementation, with extra efforts expended to cope with some minor problems (e.g. adherence to noise pollution limits, adherence to quality standards for ambient air, etc.).

The cross-subsidy on gas prices in favor of small gas consumers and households, and at the expense of large gas consumers, makes it difficult for TPK and Teplo Kyjov to compete with small individual gas boilers in the City's heat market. It is hoped that the Government will change this policy in the near future in the context of energy market deregulation, in line with EU directives, under the efforts to join the EU. This would help TPK and Teplo Kyjov to become more attractive and competitive in the Kyjov heat market.

The overcapacity of the power sector is a result of Czech energy sector policies. On the one hand, the expensive Temelin Nuclear Power Plant Project was pursued by the Government, against earlier expectations, throughout the implementation period of the Kyjov Project. On the other hand, old and largely depreciated coal- and lignite fired power plants are being maintained and operated, as they employ a large number of people, as their marginal cost of production is still low (largely depreciated!), and as the Czech Republic can export cheap power to the neighboring countries of the EU. However, at the same time the domestic price of power, controlled by the Government-owned CEZ company, is very low and would not be maintainable, if new capacity was required. This has had a negative impact on small independent CHP investments and has even contributed to shutting recently completed plants down. TPK is spared this fate due to the contractual arrangements of its long-term power purchase contracts. But it could motivate the shareholders interested in buying electricity (JME and VMG) to call for renegotiation of their purchase agreements or even unravel the Project.

But the implications of the Government policy of maintaining very low prices has much wider implications for the country which plans to privatize its power industry in the near future. As long as the prices will remain as low as at the present, privatization of the sector would bring very low offers from potential investors or may not be feasible at all. On the other hand, the surplus capacity in some EU countries and the projected market liberalization in the EU might put further downward pressure on power prices, unless capacities in the EU are also shut down.

5.3 Factors generally subject to implementing agency control:

The implementing agency, TPK, found it difficult to solve the problem satisfactorily regarding the performance of the gas turbines that showed higher natural gas consumption than that estimated by the project design. The problem of gas consumption appeared during the trial operation of the plant and continued along the current run of the equipment. After a number of negotiations with the general supplier of the equipment, TPK worked out a list of technical improvements that were carried out to reduce gas consumption. A major problem was that the guaranteed values for gas consumption of the turbines could not be fully achieved by the turn-key contractor. It was observed, then, that due to inconsistent conditions in the contracts among TPK, the general turn key contractor, and his sub-suppliers for the gas turbines, the guaranteed values specifically relating to the gas consumption were not fully identical.

Inadequate attention was also focussed on the supply contract for the CHP Plant with regard to the need for spare parts and regular maintenance of the gas- and steam-turbines. When the troubles with the turbine performance were recognized, the need for regular maintenance was discussed and a costly maintenance contract was negotiated. This could have been avoided by including the supply of spare parts and the provision of maintenance in the competitive bidding for the turn-key contract.

5.4 Costs and financing:

Overall costs of the project were US$ 26.04 million compared to US$ 24.9 at appraisal. Thus the investment cost of Project was 4.4% above the appraisal estimate. These cost increases were basically concentrated in the ancillary components (other than the CHP Plant). Thus, the waste heat boilers at the glass factory were more expensive due to the larger scope for the second boiler. Higher actual cost were also incurred in the expansion of the district heating network, by adding two heat exchangers; in the installation of an additional heat station at VMG, to supply hot water instead of steam, the purchase of auxiliary equipment from VMG not estimated by the project, and surplus costs to solve some technical problems. On the other hand, the turn-key supplier is likely not to receive the retention payment of CZK 12.6 million (US$0.33 million), because of the higher than guaranteed gas consumption. This will decrease TPK's investment costs, but has significantly increased operating costs.

During the implementation of the project no specific problems occurred regarding financing of goods and services procured from suppliers. Both, the GEF grant funds and the SEF grant funds were disbursed smoothly, and according to the set terms and conditions. TPK made withdrawals of a loan facility provided by the Hypovereinsbank in line with the competitively established terms and conditions (ten commercial banks had made offers for loans; in the end, TPK negotiated with the two most advantageous banks to further improve its conditions). The City of Kyjov also made funds from its budget available, in line with the requirements of Project progress. This was possible because of a very good financial management of the Project and its components, adhering to the agreed guidelines and procedures, as well as to the established time schedule of construction and erection activities. Since the funds granted through SEF were not available for financing the measurements, design, and testing related to the Project component implemented by Teplo Kyjov, the City of Kyjov provided additional funds from its own budget to settle these extra costs.

Overall, the capital costs of the total CHP Plant, including components A to C (Plant, Waste heat Boilers and Buildings), but excluding the DH network, the link to it and the project supervision and dissemination, amounted to US$ 23.09 million as compared to an estimated amount of US$ 22.66 million. Thus, actual costs of the total plant exceeded estimated costs by only 1.9 % (US$ 0,43 million). Higher actual costs include installation of a heating station at VMG to supply hot water instead of steam, additional purchases of auxiliary equipment by TPK, originally property of VMG not estimated under the project, and surplus costs needed to solve some technical problems (e.g. washing of waste heat boilers).

Total costs of the district heat network and link were above estimate by 30,2 % (US$ 2.81 million as opposed to an estimate of US$2.16 million). The City of Kyjov spent in total US$ 0.67 million compared with estimate US$ 0,52 million on boiler conversions to heat exchanger substations. The expansion and linkage of the network amounted to US$2.14 million, compared with an earlier estimate of 1.64 million. Higher costs were due to surplus costs of testing, measurements and include two heat exchange stations added to the heat network as well as difficulties with the laying of insulated pipe and related civil works.

6. Sustainability

6.1 Rationale for sustainability rating:

The plant and DH system were commissioned in October 1999. Subsequent testing and early operations revealed a number of problems and issues as highlighted in section 4. These technical problems were largely resolved (see section 4 again).The modifications, improvements and subsequent testing demonstrated the ability of the plant to operate almost according to the specified parameters (except for specific gas consumption and with more intense maintenance than estimated *ex ante*). Thus, operation of the CHP Plant has entered into a stable, steady state and TPK is coming close to the full required availability and efficiency of the plant. It is now important to operate the plant based on existing contracts and taking account of the contractual pricing formulae which include for the pricing of power sales the price basis of natural gas including escalation. However, at present, TPK is making a net loss, with cash generation allowing it to service all interest payments and about two thirds of its debt service. The estimated cash shortfall during year 2001 is about CZK 12 million (US$0.3 million). It is important, therefore, to review the schedule of operating costs and to introduce as many savings as possible to allow for the project to become profitable under present contractual arrangements and to allow it to service its debt.

As highlighted in section 5.2 above, the gas price for CHP Plants in the Czech Republic is high reflecting international energy price developments as well as the cross subsidies in favor of small consumers and households. On the other hand, electricity prices are very low, reflecting deliberate government policy not to antagonize small consumers, as well as the present overcapacity of power generation facilities, given the completion of the Temelin nuclear plant. This inverse "scissor of pricing" (high input costs and low sales prices), which could last for a few years, could motivate some shareholders of TPK to abandon their contractual obligation: JME, the purchaser of electricity is obligated under its contract with TPK, to purchase power at certain price levels (presently on average at about CZK 1681/MWh or US$0.044/kWh) which, due to the inclusion of gas price escalation formulae, are higher than the market price in the Czech Republic (CZK 1050/MWh or US$0.027/kWh). In the interest of continued CO_2 reductions, as well as reduced local pollution, the plant should continue to operate.

Furthermore, the electricity sales made directly to the glass factory VMG (which sold its shares in TPK to Isar-Ampere Werke (now Eon of Germany)) are knowingly made at a loss because, according to the contract, the price of electricity sold to VMG is to be 5% below the grid price (the price offered by JME). In 2000 the price offered by JME was about CZK1,180/MWh (or US$0.031/kWh), so TPK was selling it for CZK1,120/MWh (or US$0.029/kWh). The heat tariffs for VMG are also concessional at CZK209.3/GJ (or US$5.45/GJ), while the other three buyers of TPK's heat (the town of Kyjov, the Kyjov hospital, and a small commercial customer Bytos) are paying around CZK 262/GJ (or US$ 6.82/GJ), net of VAT. Thus, VMG is not only benefitting from higher reliability of power supply, but also very attractive prices for power and heat which it would not obtain in the open market at this time. While VMG may have opportunities to shop for different power suppliers under evolving liberalized regulations, TPK should have negotiation leverage both from a contractual standpoint and from JME's position as the delivery agent for any power purchased from others. Thus TPK should be able to improve its

financial situation by renegotiating its sales conditions with VMG.

On the other hand, JME is suffering an unproportional large "loss" given the opportunity costs it pays for the TPK power (as opposed to other generators' supplies). Under the current prices based on the above-mentioned contracts, TPK's operation causes a disproportionately high "loss" to be borne by JME as it is buying TPK's electricity at a price substantially higher than the current tariffs for electricity from the Czech power grid. At the same time, all the calculations provided by TPK show that a downward revision of the electric tariff paid by JME would lead to a dramatic deterioration of TPK's financial position.

6.2 Transition arrangement to regular operations:
From GEF's perspective, the main target is to achieve the maximum availability and thus achieve targeted CO_2 reductions. Technically, regular, steady state operations are already occurring. TPK has taken a number of steps (improved maintenance contract, better coordination of maintenance activities, better operational controls, round the clock monitoring of operations) to prevent unproductive downtime of the various components of equipment. TPK is also reviewing its operational costs, tries most importantly to further reduce specific gas consumption, but also critically reviews other operating cost items, to help generate an operating profit under present contractual conditions of purchase of inputs and sales of outputs.

Given the presently extremely low power prices, TPK's shareholders are also reviewing the situation to continue plant operations at more evenly shared financial burdens. It is expected that the power prices will recover in the medium term, thereby assuring an improved financial situation which over the medium term will bring the return of investments earlier expected by the shareholders.

It was recommended to TPK's Board of Directors to review the gas cost and power price situation and to find an equitable solution to the temporary losses which JME is making at this time and the company's prospects for generating adequate financial returns. Alternative proposal developed by TPK would need to redistribute the burden of the financial losses more evenly among the shareholders. This is being considered by TPKs owners presently.

7. Bank and Borrower Performance

Bank
7.1 Lending:
The Czech teams of MoE, the City of Kyjov, TPK and its consultants had full support from the World Bank teams throughout the preparation in technical, financial, economic and environmental matters important for this Project. GEF grant funds were made available in due time and met requirements of all eligible expenditures. Good planning was a vital element in the implementation of the project to meet its time table, as well as all financial and commercial commitments. The support was also prompt and strong with regard to the selection of a private foreign strategic partner and a commercial bank to help fund the Project. Financial issues were processed smoothly and professionally. The performance was considered satisfactory.

7.2 Supervision:
Supervision missions were frequent, intensive and all missions were staffed with technical,

financial and environmental specialists. The working relationships of the groups involved in the Project, namely the Bank, the grant recipient, implementing agencies and Czech consultants, were excellent. Spot checks during supervision missions were sufficient to establish that rules, regarding GEF eligibility criteria, procurement- and financial reporting guidelines, were being followed. Bank missions provided useful guidance and recommendations on technical issues, and institutional strengthening advice to the MoE and the implementing agencies.

The Bank agreed to extend the Project closing date by 9 months, when it became apparent that the initial technical problems required continued support, and that these problems delayed the entry of the Project into steady state operations.

The Bank's performance in preparation, appraisal and implementation was highly satisfactory. The Bank's missions were staffed with professionals well qualified in technical, financial and economic fields. Above all, the technical assistance extended by the missions contributed in solving technical problems of the CHP Plant. A financial mission of July 2000 already pointed to the potential financial problems of the company. A QUAG Review of supervision efforts during a chosen period of time resulted in a "highly satisfactory" label.

7.3 Overall Bank performance:

Overall performance of the Bank was highly satisfactory. The principal objective of reducing greenhouse gas emissions was achieved by erecting the CHP Plant and by reconstructing the district heat network in the City of Kyjov, by commissioning the whole project in due time, according to the schedule set up in the GEF Grant Agreement. The project began to generate reductions of CO_2 emissions by displacing electricity production in lignite-fired power plants and production of district heat in old gas- and coal-fired local boilers.

Borrower

7.4 Preparation:

The Recipient's performance was satisfactory through the whole Project cycle. Performance during preparation progressively improved thanks to commitment of the MoE and the future investor. Agreement among the Czech shareholders and the selected strategic shareholder, who made a firm commitment to provide technical assistance for the Project, contributed to a great extent to enhance the professionalism of the Czech engineers during the preparation of design of the project.

7.5 Government implementation performance:

All main legal covenants were met in a timely fashion, although the project closing date was extended once by 9 months. The extension was required because of minor technical problems, the number of proposed measures for improvements, and time required to carry out technical improvements. The government (MoE) satisfactorily coordinated all activities related to Project implementation, and regularly met with the Bank's missions to review Project progress. The daily routine work was carried out through a local consultant hired for the purposes of Project coordination, monitoring, reporting and financial management.

7.6 Implementing Agency:

The main responsibility for the project implementation was carried by Teplarna Kyjov (TPK), the

owner and implementing agency of the CHP Plant and its future operator. Performance of TPK continually improved thanks to experience gained during the erection of the facility and after commissioning of the plant, when a number of technical problems appeared. TPK also encountered commercial difficulties when an inconsistency between the general contractor and sub-contractors led to technical problems that resulted in difficulties to achieve expected performance of gas turbines. However, TPK made best efforts to meet all challenges resulting from project implementation, and was largely able to meet the Project timetable until commissioning. It cooperated very well with the Bank's teams, local engineers and suppliers of equipment to solve the early technical problems.

Given better experience in contracting, TPK might have spotted the inconsistencies between its contract with the turn-key supplier and the turn-key suppliers subcontract with the gas turbine supplier.

The City of Kyjov carried out the project through its implementing agency Teplo Kyjov. The agency performed well and did not meet any particular problems.

7.7 Overall Borrower performance:

All Czech implementing agencies and institutions involved in the project performed in a very good fashion. The performance of both main implementing agencies, TPK and Teplo Kyjov, was outstanding throughout the whole implementing period. Project implementation and financial management was efficient and punctual.

8. Lessons Learned

A major lesson of this Project is of institutional nature: The Kyjove Project was considered interesting by a number of investors and donors for various reasons as follows: enhanced energy efficiency through use of industrial waste heat, improved local environmental performance, reduction of CO_2 from the operation of the Project, market for the sale of gas, provider of reliable heat and electricity. The agreement among a group of interested investors whose interests were diverging, to form a joint venture to realize this Project, made efficient Project preparation and implementation possible. The interests of the initial key investors were "bundled" and they reached compromise solutions among each other to realize the interesting Project. It is hoped that during the temporary "crisis" of extremely low power prices in the Czech market, the concept of the joint ownership and joint risk-sharing will prevail and come out in favor of continued full operation of the plant.

All components of the project were implemented according to the Project time table. Important lessons were learned along the way, particularly by TPK. First, targets of specific gas consumption, estimated by the Project and stipulated in the turn-key contract, could not fully be realized during the trial operation, and TPK had to settle for a higher value because of contractual inconsistencies. Second, technical problems with the waste heat boiler #51 at the glass factory postponed the implementation and start-up of the second waste heat boiler #52, until the technical problems of the first boiler were solved. Lessons learned from boiler #51 were fully incorporated in #52.

The resulting higher fuel consumption of gas turbines is not critical to the achievement of the objective to reduce CO_2 emissions, but can lead to higher operating costs and therefore reduced profits than those estimated for the Project.

Technical problems of the waste heat boiler at VMG were not anticipated at the beginning of the Project. Most problems were due to the technological process of glass production at the glass factory that was not within TPK's control. Huge amounts of particulate matter sucked from the glass melting furnace were the most troubling elements because some mechanical parts of the boiler could not work properly with the contaminated air and the boiler had to be cleaned frequently. Gradually this problem was solved. However, it might have been solved earlier if the boiler had been tested properly at the beginning of operation.

The most critical design issue for this type of project is the choice of an optimum electric capacity to install, considering reliability, production costs, and relationship between the heat and electric load served. For the maximum efficiency of cogeneration, the electric generation capacity of CHP plants should be only as large as the available heat load allows. The experience of the Kyjov Waste Heat Utilization Project has demonstrated two important lessons. While these lessons have been derived in the context of the Czech Republic, they are relevant to other countries in transition as well, particularly when electricity prices are being kept low. The first lesson is that it is difficult for a small independent power producer (IPP) to enter into, and stay within, a long-term contract with the electric grid company if the production cost of the IPP's electricity is not sufficiently competitive. Thus, only if the benefits of cogeneration are high enough due to a sufficiently high heat load, is the operation of such a plant competitive in the liberalizing electricity market. Secondly, the Kyjov project has demonstrated that the existing off-peak (base- and intermediate load) electricity prices in the Czech Republic are currently set at a level to cover variable operating costs for cheap lignite plants, plus a modest allowance for transmission delivery cost. There is little allowance for recapture of investment costs, because the plants are fully depreciated. The existing price structure would thus be improved by a timely increase in the electricity price to recognize that new plants will be required in the future. A decision by the Government to this effect would be a relief to independent power producers, and might help to reopen the gas-fired CHP Plant elsewhere in the Czech Republic which was shut down because of the low power price regime in the country.

9. Partner Comments

(a) Borrower/implementing agency:

Implementation of the Project in Kyjov reflected the objective of the State Environmental Policy aimed at systematically improving the quality of the environment in the Czech Republic. It thus contributed towards the solution of global environmental problems. The Country Program, inter alia, promotes activities to limit health- and environmental hazards, as well as to incorporate environmental costs into production processes and to begin integrating the principles of environmental protection into social and economic activities.

In the process of economic transformation the Project contributed to: (i) the ongoing process of liberalization of the energy sector with respect to power and heat production, sales, pricing and distribution systems; (ii) the strengthening of the emerging market economy; and (iii) the

restructuring of industrial sectors towards production processes that was less demanding on energy and natural resources.

The objective of the Project was in line with the Government's commitment to reduce green house gas emission. Thus, it helped support the process of replacing power generated in obsolete, depreciated lignite fired power plants. The Project would also reduce emissions that originated during production of heat in local small boiler houses that had low energy efficiency and high energy losses.

In the most crucial areas important achievements were obtained. The basic legal and economic infrastructure was put in place. In 200, the Country started implementation of the program of privatization of large energy sector entities, including power generation and distribution, as well as privatization of gas distribution companies. Moreover, price liberalization of fuels and power was in progress. The erection of the CHP Plant and its auxiliary equipment was completed in time and almost within the planned budget. The CHP Plant was put into operation and began to produce power and heat for the public grid and local clients. The Project contributed to the achievement of higher energy efficiency, heat savings and reduction of operation and maintenance costs. Global and local reduction of emissions was achieved, therefore.

On the other hand, the results were slightly below expectations due to lower heat and power production than originally anticipated by the Project. While all the heat loads had been connected as planned, the district heat demand in the City of Kyjov turned out to be less than originally envisaged by the Project. In the first and second year of plant operations, the sales of heat were below targets due to the lower than expected demand. It appeared that customers made efforts to achieve energy conservation and thus save money. Further, unexpected mild winters, sound energy efficiency of the installed heat exchangers, and elimination of heat losses (modernization of the district heating network) contributed to the decreased heat demand in the City of Kyjov. During the first year of operation the output of electricity was below the output targets, set at the start of the project, due to lower availability of the CHP plant than estimated .

Minor technical problems in the first period of operation and slightly lower outputs of the CHP Plant resulted in the shortfall on the original target of CO2 reductions which is thus estimated to be less by 7%. However, this figure places the shortfall well within the uncertainty margins associated with the twenty year project cycle.

The Bank's performance in all aspects of the Project cycle was excellent.

(b) Cofinanciers:

(c) Other partners (NGOs/private sector):

The Project was implemented through the private company Teplo Kyjov, Ltd. The major objective of the project was the reconstruction of the district heating system (DHS) in the City of Kyjov. Under the Project, old boiler houses were reconstructed and replaced with 15 heat exchangers. The Project started in April 1998 and was completed in September 1999. A month later, the reconstructed DHS was commissioned and began the supply of heat to the customers in the city.

Funds were provided through the State Environmental Fund and from the municipal budget of the City of Kyjov. In the beginning of the heating season in 1999/2000 minor technical problems occurred. However, all problems were solved satisfactorily within reasonable time. Currently the DHS supplies heat to all customers in the steady state regime. Cooperation of the City of Kyjov and of the implementing agency, company Teplo Kyjov with the MoE, SEF, TPK and the World Bank was highly satisfactory. Excellent cooperation contributed to the smooth implementation of the Project and helped solving minor technical problems that occurred in the course of construction and commissioning of the equipment.

Miroslav Tychtl
Teplo Kyjov, Ltd.

2. Teplarna Kyjov, Joint Stock Company

The Intention of the glass manufacturer VMG, to utilize excess heat produced in its glass melting vans, initiated preparation and development of the Kyjov Project. In January 1997 a joint stock company, namely Teplarna Kyjov, was founded, in April 1998, a contract was signed with the turn-key-contractor, in March 1999, the erection of CHP Plant was completed, and in July 1999, trial runs of the plant were started.

The Testing of equipment showed minor technical problems, related to the reliability and efficiency of turbines which were slightly lower than called for under the specifications. This situation resulted in a number of technical improvements of equipment undertaken by TPK and its contractor to achieve Projected parameters. The CHP Plant is currently operated in a base load regime and has achieved projected parameters within acceptable tolerance. It therefore contributes to the reduction of CO2 emissions. The actual capital costs were almost in line with the estimated amounts. Currently, economic sustainability of the CHP Plant is slightly diverging from the original financial model anticipated by the Project. The main reason is that the prices of fuels and electric energy in the Czech Republic have developed in a different way than was anticipated by the Project.

Funds to cover the capital costs were provided through the GEF grant, a commercial loan from HypoVereinsbank, and owners' equity. Implementation of the Project required a smooth and close cooperation of all parties involved. In spite of the fact that the mutual cooperation was rather demanding, the very active role of all parties (The World Bank, MoE, the City of Kyjov and shareholders) during Project development, erection of equipment and testing of equipment resulted in a successful story. Currently, the CHP Plant has been in commercial run for two years.

Josef Boltnar
Director
Teplarna Kyjov

10. Additional Information

Withdrawal of Funds

GEF TF Grant Withdrawal (US$ million equivalent)					
Appraisal Estimate			Actual/Latest Estimate		
1998	1999	2000	1998	1999	2000
	5.800		1.043	4.983	0.023
Loan Withdrawal –HVB (US$ million equivalent)					
5.158	6.142		3.719	7.225	

Production of Heat and Electricity

	Appraisal Estimate (TPK)			Actual/Latest Estimate		
	1998	1999	2000	1998	1999	2000
Heat Total (TJ)		69,83	199,73		37,23	110,98
Hospital		22,00	55,00		10,37	29,96
City		36,00	86,00		26,22	59,61
VMG		10,00	53,50			20,61
Bytos					0,30	0,80
Others		1,83	5,23			
Electricity Total (GWh)		89,00	176,268		60,28	161,95
VMG		30,00	57,485			57,45
JME		59,00	118,783		60,28	100,85
Station Demand						3,65
Gas Consumption (SCM million)						41,302
Average m3/MWh						255,0

Estimated and Actual Heat Demand by the City of Kyjov

Total annual heat consumption estimated by Teplo Kyjov:	86 107 GJ
Actual annual heat consumption in 1999:	78 298 GJ
Actual annual heat consumption in 2000:	58 573 GJ

Comparison of Income Statement Projections 2001/02
ex-ante (HEX) and *ex-post* (TPK)

Teplárna Kyjov, 2001/2002 Comparisons					Orig Hex Projections		TPK Projections		%TPK/Orig.Proj	
					2001	2002	2001	2002	2001	2002
REVENUES	electricity	JME	revenues	th.CZK	203,031	206,793	202,536	206,754	99.8%	100.0%
			price	CZK/MWh	1,604	1,634	1,681	1,716	104.8%	105.0%
			p.increase	%			6.6%	2.1%		
			volume	MWh	126,566	126,566	120,500	120,500	95.2%	95.2%
		VMG	revenues	th.CZK	77,676	79,617	61,099	61,099	78.7%	76.7%
			price	CZK/MWh	1,351	1,385	1,072	1,072	79.3%	77.4%
			p.increase	%			-5%	0%		
			volume	MWh	57,485	57,485	57,000	57,000	99.2%	99.2%
		Total	revenues	th.CZK	280,706	286,410	263,635	267,853	93.9%	93.5%
			volume	MWh	184,051	184,051	177,500	177,500	96.4%	96.4%
	heat	Teplo,s.r.o	revenues	th.CZK	19,308	19,610	16,954	17,395	87.8%	88.7%
			price	CZK/GJ	223	227	262	269	117.3%	118.5%
			p.increase	%			8.3%	2.6%		
			volume	GJ	86,568	86,568	64,785	64,785	74.8%	74.8%
		Nemocnice	revenues	th.CZK	12,909	13,208	8,639	8,864	66.9%	67.1%
			price	CZK/GJ	234.71	240.15	261.80	269	111.5%	111.8%
			p.increase	%			8.3%	2.6%		
			volume	GJ	55,000	55,000	33,000	33,000	60.0%	60.0%
		Bytos	revenues	th.CZK	0	0	235	241		
			price	CZK/GJ	0.00	0.00	261.70	268.50		
			p.increase	%			8.3%	2.6%		
			volume	GJ	0	0	897	897		
		VMG	revenues	th.CZK	10,592	10,837	10,507	10,778	99.2%	99.5%
			price	CZK/GJ	192.57	197.03	209.30	214.70	108.7%	109.0%
			p.increase	%			8.2%	2.6%		
			volume	GJ	55,000	55,000	50,200	50,200	91.3%	91.3%
		Total Heat	revenues	th.CZK	42,809	43,655	36,335	37,277	84.9%	85.4%
			volume	GJ	196,568	196,568	148,882	148,882	75.7%	75.7%
	other revenues			th.CZK						
	Total revenues			**th.CZK**	**323,515**	**330,065**	**299,971**	**305,130**	**92.7%**	**92.4%**
EXPENDITURE	energy	Gas costs	costs	th.CZK	180,678	185,909	202,292	206,338	112.0%	111.0%
			price	CZK/m3	4.49	4.62	4.63	4.72	103.1%	102.2%
			p.increase	%			9.3%	2.0%		
			volume	th.m3	40,240	40,240	43,692	43,692	108.6%	108.6%
		Electricity		th.CZK	contained in	contained in	2,135	2,242		
		Water		th.CZK	Waste Heat	Waste Heat	1,800	1,890		
		Waste Heat		th.CZK	3,891	3,891	8,610	9,041	221.3%	232.3%
		Purchase energy		th.CZK	184,569	189,800	214,837	219,510	116.4%	115.7%
	Material			th.CZK	inWasteHeat	inWasteHeat	1,320	1,386		
	Maintenance			th.CZK	7,000	7,000	20,000	21,000	285.7%	300.0%
	Services			th.CZK	500	500	4,800	5,040	960.0%	1008.0%
	Labour Costs			th.CZK	3,755	4,131	6,972	7,321	185.6%	177.2%
	Other Expenses			th.CZK	6,000	6,000	2,600	2,730	43.3%	45.5%
	Total other operating costs			th.CZK	17,255	17,631	35,692	37,477	206.8%	212.6%
	Operating Profit			**th.CZK**	**121,691**	**122,634**	**49,442**	**48,144**	40.6%	39.3%

Annex 1. Key Performance Indicators/Log Frame Matrix

Outcome / Impact Indicators:

Indicator/Matrix	Projected in last PSR[1]	Actual/Latest Estimate
CO2 emission abatement in comparison with baseline scenario: (a) cumulative to date: (b) updated life-cycle projection over years 1998 - 2019.	(a) 165 thousand tons CO2; (b) 2,690 thousand tons CO2.	(a) 165 thousand tons CO2; (b) 2,666 thousand tons CO2, assuming that the plant remains in operation until 2019.
Average cost of CO2 emission abatement against the baseline scenario: (a) not to exceed US$ 15 per ton of carbon based on full incremental cost of project; (b) not to exceed US$ 10 per ton of carbon based on actual size of GEF grant of US$5.8 million.	(a) not calculated; (b) US$ 7.91 per ton of carbon.	(a) US$ 24.6 per ton of carbon; (b) US$ 7.98 per ton of carbon, assuming that the plant remains in operation until 2019.
Improved reliability of heat and power supply (known by reduced frequency and duration of outages) to VMG plant and Kyjov residential consumers;	Based on preliminary data for CHP plant performance in 2000, improved reliability (relative to the before-the-project situation) could be anticipated by project completion.	Reliability of the heat and electricity supply was tangibly improved. Frequency and duration of outages at VMG were substantially reduced with a minimum impact on glass production facility. Now, in case of any outage of grid electricity supply VMG can immediately switch to electricity supply from TPK. Reliability of heat supply improved considerably for both consumers - VMG and the town of Kyjov.
Energy efficiency gains measured as energy inputs per unit of heat and electricity (compared with the baseline scenario): (a) Electrical efficiency of CHP plant; (b) Total efficiency of the CHP plant (total heat and power outputs divided by fuel input).	(a) 43%, which is much higher than 30-35% typical for lignite-fired plant of CEZ grid; (b) 54%; no data available for CHP efficiency of baseline plants.	(a) 42%, which is much higher than 30-35% typical for lignite-fired plant of CEZ grid; (b) 53%; no data available for CHP efficiency of baseline plants.

Output Indicators:

Indicator/Matrix	Projected in last PSR[1]	Actual/Latest Estimate
A. CHP Plant constructed (US$ 20.35 m)	Fulfilled.	Fulfilled.
B. Heat recovery boilers #51 and #52 installed at VMG (US$ 1.56 m)	Fulfilled.	Fulfilled.
C. Building for CHP and auxiliary facilities constructed (US$ 0.75 m)	Fulfilled.	Fulfilled.
D. The district heating network of Kyjov expanded and modernized (US$ 1.64 m)	Fulfilled.	Fulfilled.
E. Heat-only boilers shut down and replaced with heat exchangers connected to the district heating network of the project CHP plant (US$0.52 m)	Fulfilled.	Fulfilled.
F. Supervision of the project and dissemination activities undertaken by the Ministry of Environment (US$ 0.12 m).	Fulfilled.	Fulfilled.
The annual amount of electric power delivered to the users: (a) 57 GWh to glass factory VMG; (b) 126 GWh to electric grid company JME.	(a) 57 GWh; (b) 119 GWh.	(a) 57 GWh; (b) 120.5 GWh.
The annual amount of heat delivered to users: (a) 55 TJ to glass factory VMG; (b) 55 TJ to hospital; (c) 86.6 TJ to the city of Kyjov.	(a) 54 TJ; (b) 32 TJ; (c) 67 TJ. Note: These targets were revised from those set at the start of the project due to lower than expected demand for heat.	(a) 50.2 TJ; (b) 33 TJ; (c) 65.7 TJ.

[1] End of project

Annex 2. Project Costs and Financing

Project Cost by Component (in US$ million equivalent)

Project Cost By Component	Appraisal Estimate US$ million	Actual/Latest Estimate US$ million	Percentage of Appraisal
A. CHP Plant (procurement package K1)	19.79	20.47	103.4
B. Replacement and retrofitting of boilers at VMG)	1.47	2.09	142.2
C. Construction and reconstruction of buildings	0.67	0.53	79.1
D. Modernization and expansion of district heat network (package K2)	1.56	2.14	137.2
E. Decommissioning of gas-fired boilers and replacement with heat exchangers	0.51	0.67	131.4
F. Project supervision and dissemination activities Contingencies	0.12	0.14	116.7
Total Baseline Cost	24.12	26.04	
Physical Contingencies	0.75	0.00	
Price Contingencies	0.07	0.00	
Total Project Costs	24.94	26.04	
Total Financing Required	24.94	26.04	

NOTE: The present template does not allow to calculate meaningful actuals as percentage of appraisal estimates!

Project Costs by Procurement Arrangements (Appraisal Estimate) (US$ million equivalent)

Expenditure Category	Procurement Method[1] ICB	NCB	Other[2]	N.B.F.	Total Cost
1. Works	0.00	0.00	0.00	0.75	0.75
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
2. Goods	23.55	0.00	0.00	0.52	24.07
	(5.70)	(0.00)	(0.00)	(0.00)	(5.70)
3. Services	0.00	0.00	0.12	0.00	0.12
	(0.00)	(0.00)	(0.10)	(0.00)	(0.10)
4. Miscellaneous	0.00	0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
5. Miscellaneous	0.00	0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
6. Miscellaneous	0.00	0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Total	23.55	0.00	0.12	1.27	24.94
	(5.70)	(0.00)	(0.10)	(0.00)	(5.80)

Project Costs by Procurement Arrangements (Actual/Latest Estimate) (US$ million equivalent)

Expenditure Category	Procurement Method[1] ICB	NCB	Other[2]	N.B.F.	Total Cost
1. Works	0.00	0.00	0.00	2.95	2.95
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
2. Goods	18.20	4.38	0.00	0.00	22.58
	(5.95)	(0.00)	(0.00)	(0.00)	(5.95)
3. Services	0.00	0.00	0.51	0.00	0.51
	(0.00)	(0.00)	(0.09)	(0.00)	(0.09)
4. Miscellaneous	0.00	0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
5. Miscellaneous	0.00	0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
6. Miscellaneous	0.00	0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Total	18.20	4.38	0.51	2.95	26.04
	(5.95)	(0.00)	(0.09)	(0.00)	(6.04)

[1/] Figures in parenthesis are the amounts to be financed by the Bank Loan. All costs include contingencies.

[2/] Includes civil works and goods to be procured through national shopping, consulting services, services of contracted staff of the project management office, training, technical assistance services, and incremental operating costs related to (i) managing the project, and (ii) re-lending project funds to local government units.

Project Financing by Component (in US$ million equivalent)

Component	Appraisal Estimate			Actual/Latest Estimate			Percentage of Appraisal		
	Bank	Govt.	CoF.	Bank	Govt.	CoF.	Bank	Govt.	CoF.
A. CHP Plant	5.04	0.00	14.75	5.44	0.00	15.03	107.9	0.0	101.9
B. Replacement and Retrofitting of Boilers	0.00	0.00	1.47	0.00	0.00	2.09	0.0	0.0	142.2
C. Construction and Reconstruction of Buildings	0.00	0.00	0.67	0.00	0.00	0.53	0.0	0.0	79.1
D. Modernization and Expansion of District Heating	0.66	0.50	0.40	0.51	0.51	1.12	77.3	102.0	280.0
E. City Connection Costs	0.00	0.00	0.51	0.00	0.00	0.67	0.0	0.0	131.4
F. Project Supervision	0.10	0.02	0.00	0.09	0.05	0.00	90.0	250.0	0.0
Contingencies									
Physical Contingencies	0.00	0.00	0.75				0.0	0.0	0.0
Price Contingencies	0.00	0.00	0.07				0.0	0.0	0.0
Subtotal, Contingencies	0.00	0.00	0.82				0.0	0.0	0.0
Total Project Cost	5.80	0.52	18.62	6.04	0.56	19.44	104.1	107.7	104.4

Annex 3. Economic Costs and Benefits

Please see Sections 4.2.1. on "Achievement of Greenhouse Gas Emission Reduction Targets" and Section 4.3. on "Net Present Value/Economic Rate of Return".

Annex 4. Bank Inputs

(a) Missions:

Stage of Project Cycle	No. of Persons and Specialty (e.g. 2 Economists, 1 FMS, etc.)		Performance Rating	
Month/Year	Count	Specialty	Implementation Progress	Development Objective
Identification/Preparation				
06/1996	*2*	Environment Specialist Economist		
12/1996	*3*	Environment Specialist Environment Economist Operations Officer		
Appraisal/Negotiation				
March 1998	*3*	Environment Specialist Environment Economist Economist		
Supervision				
02/1999	*1*	Environment Specialist	HS	HS
07/1999	*2*	Environment Economist Power Engineer	HS	HS
05/2000	*4*	Environment Specialist Environment Economist Economist Power Engineer	S	S
10/2000	*2*	Environment Specialist Power Engineer	S	S
ICR				
01/2001	*5*	Environment Specialist Environment Economist Economist Power Engineer Consultant		

(b) Staff:

Stage of Project Cycle	Actual/Latest Estimate	
	No. Staff weeks	US$ ('000)
Identification/Preparation	17.5	145.0
Appraisal/Negotiation	53.2	206.4
Supervision	31.7	176.9
ICR	4.2	43.2
Total	106.6	571.5

Annex 5. Ratings for Achievement of Objectives/Outputs of Components

(H=High, SU=Substantial, M=Modest, N=Negligible, NA=Not Applicable)

	Rating
☐ *Macro policies*	○ *H* ○ *SU* ○ *M* ○ *N* ● *NA*
☐ *Sector Policies*	○ *H* ○ *SU* ○ *M* ○ *N* ● *NA*
☒ *Physical*	○ *H* ● *SU* ○ *M* ○ *N* ○ *NA*
☒ *Financial*	○ *H* ○ *SU* ● *M* ○ *N* ○ *NA*
☒ *Institutional Development*	● *H* ○ *SU* ○ *M* ○ *N* ○ *NA*
☒ *Environmental*	● *H* ○ *SU* ○ *M* ○ *N* ○ *NA*
Social	
☐ *Poverty Reduction*	○ *H* ○ *SU* ○ *M* ○ *N* ● *NA*
☐ *Gender*	○ *H* ○ *SU* ○ *M* ○ *N* ● *NA*
☐ *Other (Please specify)*	○ *H* ○ *SU* ○ *M* ○ *N* ● *NA*
☒ *Private sector development*	● *H* ○ *SU* ○ *M* ○ *N* ○ *NA*
☒ *Public sector management*	○ *H* ● *SU* ○ *M* ○ *N* ○ *NA*
☐ *Other (Please specify)*	○ *H* ○ *SU* ○ *M* ○ *N* ○ *NA*

Annex 6. Ratings of Bank and Borrower Performance

(HS=Highly Satisfactory, S=Satisfactory, U=Unsatisfactory, HU=Highly Unsatisfactory)

6.1 Bank performance	*Rating*
☒ *Lending*	○ *HS* ● *S* ○ *U* ○ *HU*
☒ *Supervision*	● *HS* ○ *S* ○ *U* ○ *HU*
☒ *Overall*	● *HS* ○ *S* ○ *U* ○ *HU*

6.2 Borrower performance	*Rating*
☒ *Preparation*	○ *HS* ● *S* ○ *U* ○ *HU*
☒ *Government implementation performance*	● *HS* ○ *S* ○ *U* ○ *HU*
☒ *Implementation agency performance*	○ *HS* ● *S* ○ *U* ○ *HU*
☒ *Overall*	● *HS* ○ *S* ○ *U* ○ *HU*

Annex 7. List of Supporting Documents

1. TPK Business Plan, 1997 and Project Implementation Plan
2. TPK Prospectus to invite a Strategic Investor, 1998
3. Annual Reports for JME, JMP, VMG 1997
4. Letter to TPK's board of September 2001