EXPERIENCE AND LESSONS LEARNED FROM IMPLEMENTATION OF MUTNOVSKY INDEPENDENT POWER PROJECT

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ABSTRACT

The 50 MW Mutnovsky geothermal power plant located in Kamchatka, Far Eastern Russia is the first independent power project of its kind for both the EBRD and Russia. The power station, designed by consultants in Russia and New Zealand, was constructed in difficult climatic conditions and blends the best of Russian and Western technology with plant components manufactured in Russia, Europe and the US. It is a showcase of lessons for financing and implementing renewable projects in transition countries. The paper gives an insight of EBRD's due diligence and implementation monitoring requirements to ensure the project was economically and environmentally justified, fully financed, properly managed and able to repay its debt. The geothermal power station's price determination provisions and tariff setting are discussed in terms of its being the first IPP in Kamchatka, displacing generation from existing state owned CHPs.. Strategy and procedures adopted for designing the procurement program are discussed including issues arising from lack of competition. Lessons learned from the manufacturing and construction phases are discussed with emphasis on managing design, manufacturing, testing and transportation of plant and equipment destined for remote and severe climate locations. The paper also touches on lessons learned from institutional, organizational, logistical and technical difficulties encountered during drilling and plant construction. The project timeframe and final costs are compared with targets set and estimates made at the feasibility stage with explanations given regarding the substantial time overrun. The paper concludes that while key technical, financial and environmental project objectives set at the feasibility stage have been achieved, important issues of concern to international financiers such as the EBRD need to be given more attention to minimize delays during project implementation.

1. PROJECT BACKGROUND

The Mutnovsky Project is situated in Kamchatka Oblast (Region) in the far eastern part of Russia (Figure 1), approximately 100 km south of the Region's administrative centre located in the City of Petropavlovsk-Kamchatsky. The region's population of approximately 450,000 is mostly located in the Petropavlovsk-Kamchatsky and Yelizovo District. The remainder of the Kamchatka peninsula is sparsely populated and include important habitats for arctic flora and fauna.

The primary industry of the peninsula is fishing and fish processing, which contributes more than half of the regions gross output and three quarters of Kamchatka's exports. The naval base in Petropavlovsk-Kamchatsky is both an important source of federal subsidies to the Region and a technical manpower resource for operating and maintaining complex power plants. There is also

some potential for developing mining projects (gold and copper), tourism and mineral water bottling plants.

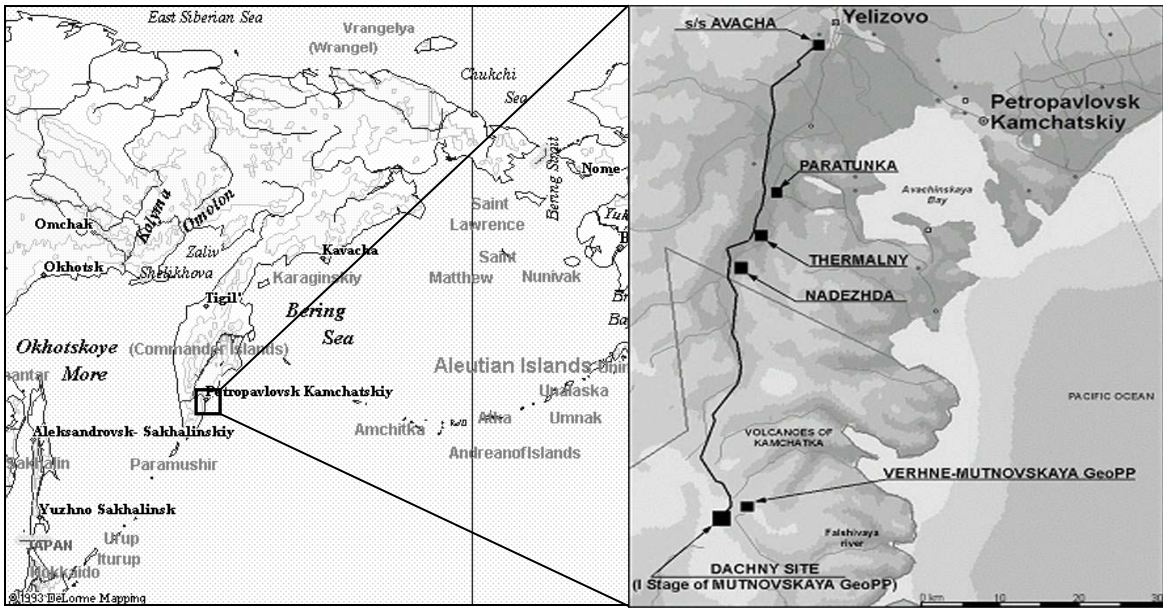

Figure 1. Project Location

2. KAMCHATKA POWER SECTOR

Due to the regions isolated geographical position, Kamchatka is not interconnected with the Russian electricity grid relying on electricity generated locally, mostly through outdated and polluting combined heat and power plants (CHP). These are fired on Heavy Fuel Oil (HFO) shipped from Asia or transported by train to Vladivostok and then shipped from Vladivostok to Petropavlovsk when navigation is possible. Despite generous federal fuel subsidies, electricity tariffs in are higher in the region than in mainland Russia, largely due to high fuel transport and storage costs. Fuel shortages and the high cost of electricity in the mid late nineties resulted in restrictions of energy use particularly by households during the long and severe winter period.

The Russian state power utility RAO UES owns the national grid, around 35 of the largest power stations and has majority shares in the 73 regional energos (mostly integrated power and heat companies). A separate state company owns nine nuclear power plants. Power generation, transmission and distribution in Kamchatka are the responsibility of Kamchatskenergo (KE), which is 56% owned by RAO UES. The regional power networks are fragmented with only Petropavlovsk-Kamchatsky and surrounding towns interconnected in the Central Energy System. Its installed capacity of 423 MW accounts for over 90% of all power distributed in Kamchatka.

The Kamchatka energy sector faces technical challenges and institutional barriers typical for most Russian regions, such as: low efficiency of operating energy systems, high level of debt by the power company, limited incentives to reduce costs, distorted tariff structure, non-payments, political interference and irrational regulation of the market. In Kamchatka these problems are exacerbated by the adverse weather and the regions dependence on imported coal and diesel fuel.

The exploitation of hydro potential of the region is seen as less attractive, due to the remote location of potential sites. These are far from areas of demand and requiring extensive construction and infrastructure work with the associated possible environmental damage to fragile arctic ecosystems. Nevertheless and despite continuous financing problems, the 45 MW Tolmachyovsky hydropower plant is nearing completion and will complement Mutnovsky in supplying the Central Energy System following completion of the interconnecting high voltage transmission line.

The Regional Government is also promoting the development of natural gas resources located on the west coast of the Kamchatka peninsula. It has plans to bring gas to Petropavlovsk-Kamchatsky to supply the two existing CHP plants and large boiler houses to eliminate the need for fuel oil. Construction of a proposed 400 km long gas pipeline was halted after 70 km of the line were completed in 2002 due to lack of financing and doubts about the extent of the gas reserve. This experience demonstrated to the local authorities the importance of performing adequate due diligence, as was done on the Mutnovsky project, to secure finance before starting construction.
The Kamchatka region has extensive geothermal resources that if exploited prudently, could replace polluting fossil fuels with renewable energy, at a competitive price. Development of the resource began in the nineteen sixties with the construction of the Paugetskaya plant in the southern part of the peninsula and which is still operating today. Exploration of the Mutnovsky resource commenced in the seventies and a small 400 kW backpressure turbine generator provided essential power supplies to the construction camp until the late nineties.
GEOTHERM was established in the early nineties by Nauka, KE, the Provincial Government and RAO UES to develop the Mutnovsky Geothermal resource. GEOTHERM arranged local financing, constructed and commissioned the 3x4 MW Verkhne-Mutnovsky power plant in late 1999. On its part KE had constructed the over 100 km of 110 kV transmission line and the main access road to the site. When approached for funding for the 50 MW development, EBRD recognised that GEOTHERM's ownership arrangements were not ideal in terms of establishing a independent power plant, but considered that for a first time operation, back-to-back commercial agreements and obligations could be designed to minimise conflicts of interest and secure counterparty financing. Following commissioning of the 2x25 MW Geothermal power station in late 2002 a total of 62 MW geothermal generating capacity is now available to the CES to supply approximately 23% of the winter peak demand.

3. LOAN AND FINANCING ARRANGEMENTS

The Mutnovsky geothermal power plant and steam field facilities were largely financed by an EBRD loan of US$ 99.9 million to Russia and on-lent by Ministry of Finance (MOF) to the project company GEOTHERM under a separate loan agreement. The balance of project financing was to be provided by the project sponsors: RAO UES, Administration of Kamchatka Oblast (AKO) and KE under a Partnership Financing Agreement (PFA) signed in 1998. The PFA obliged the Sponsors to provide US$ 54 million largely for taxes, interest-during-construction plus a lesser amount for local costs, and other unforeseen expenses in support of the Bank loan. EBRD's appraisal took into account the significant prior commitment by AKO and KE for the access road and electrical transmission line (at an estimated cost of USD 90 million); and the expectation that the 12 MW Verkhne-Mutnovsky Geothermal plant would generate sufficient revenue to support GEOTHERM's financing obligations.
The EBRD loan was declared effective in September 1998, about 6 months later than planned due to the long time taken to finalise enforceable legal agreements, obliging the Sponsors to ensure that GEOTHERM was able to function as a viable project company during the construction phase; and subsequently after commissioning able to generate sufficient revenues to pay its financing charges. Although the EBRD loan was essentially backed by a sovereign guarantee the Bank wished to establish model terms and conditions that could be used as a basis for financing other similar renewable energy projects in its countries of operation. Thus in addition to the loan agreement with the federal government, represented by MOF, the supporting legal agreements designed to clarify the respective obligations of the parties are listed below. In each case the EBRD insisted that such agreements were subject to a legal opinion as to their veracity and had to be in force before the loan could be declared effective.

(a) **Project Support Agreement** between EBRD and the AKO requiring the Oblast to create necessary conditions for GEOTHERM and KE to be able to perform their respective obligations;
(b) **Project Agreement** between EBRD and GEOTHERM setting out GEOTHERM's obligations for implementation and financial management and reporting;
(c) **On-lending Loan Agreement** between MOF, GEOTHERM and AKO establishing the terms of the loan and repayment conditions;
(d) **Project Assistance Agreement** between GEOTHERM and KE to ensure KE provided an enabling environment to ensure GEOTHERM could fulfil its obligations to supply and be reimbursed for energy;
(e) **Partnership Financing Agreement** setting out the financial obligations of the three main Sponsors;
(f) **Power Purchase Agreement** establishing the methodology and conditions for the tariff for the purchase of power from Mutnovsky GPP;
(g) **Environmental Action Plan** designed to ensure the geothermal development observes the principles set out in the Banks environmental guidelines.

4. POWER PURCHASE AGREEMENT AND TARIFF ISSUES

Tariff setting in the CES is the responsibility of the Regional Energy Commission (REC) which because of the economic downturn in the early nineties, was (and still is) concerned by the significant nominal excess generating capacity in Kamchatka. The REC considered the situation would persist for several years, even without the addition of 62 MW from the two Mutnovsky geothermal power plants. Accordingly it placed no great value on capacity from new IPPs and required Mutnovsky project to negotiate a tariff based on (the subsidized cost of) fuel savings from the displacement of electrical energy from the two existing oil fired CHP plants, TES 1 and TES 2. In its appraisal of the project the EBRD based its evaluation on the high economic cost of oil fuel supply and taking into account its more realistic estimates of the projected costs of developing Kamchatka's gas resource.
Retail tariffs in Kamchatka include cross subsidies between consumer categories to meet social and economic objectives. In principle industrial customers in the CES are required to subsidise domestic customers and consumers in KE's isolated grids. In general however their payment record is very poor, a subject of considerable concern to the EBRD during appraisal and a principal focus of the subsequent monitoring. Nevertheless the REC sets tariffs so that the weighted average of the retail prices based on past consumption patterns equals the reasonable costs of production, distribution and retailing plus a margin of 10%. The weighted average tariff in early 2002 was 2.27 RUR/kWh or around 7.5 ¢/kWh. The REC is concerned that even though domestic consumers generally pay their bills, tariffs are already at the limit of the willingness to pay for a large part of KE's customer base. It therefore reasoned that bulk purchases of electricity should be at a wholesale tariff that does not increase retail tariffs. Thus, the upper limit of any wholesale tariff must be 0.9 x weighted average retail tariff, or (as in early 2002) 2.04 RUR/kWh or around 6.8 ¢/kWh.
In late 1998 a formal PPA was signed between KE as the power purchaser and GEOTHERM as the power seller – thereby meeting a key condition of EBRD loan effectiveness. The essential feature of the original PPA is two-part tariff defined with separate prices for energy and availability. The parties to a contract are at liberty to change its terms by agreement and in addition to amending some features in line with the PPA's existing adjustment mechanisms, GEOTHERM and KE renegotiated others to better reflect the parties' current preferences. Among the changes made to date are replacement of the two-part tariff with a one-part energy only tariff and introduction of corresponding Take-or Pay provisions. The Mutnovsky wholesale tariff is reviewed annually with the agreed tariff since September 2002 being below the 0.9 x weighted

average retail tariff and presently not sufficient to allow GEOTHERM to meet its interest and loan principal repayments.

5. PROCUREMENT AND CONTRACTING STRATEGY

The EBRD required a international consultant be recruited to join GEOTHERM's team and the project to be executed with two Engineer, Procure and Construct (EPC) contracts; one contract covering the complete power plant and associated infrastructure facilities and one contract covering steam field facilities including drilling and repair of geothermal wells. This approach was intended make best use of international experience in geothermal development and to attract international competition by maximizing the value of turnkey contracts.

GEOTHERM and its consultants prepared pre-qualification documents for the EPC contract packages and tender documents followed EBRD standard procurement guidelines for Single Stage Tender. Conditions of Contract were based on FIDIC Orange Book for Design - Build and Turnkey and are particularly suitable for EPC type contracts where correct allocation of risks to and definition of responsibilities (including for design) of the Contractor is important. This approach is commonly required by most International Financing Agencies (IFI) for projects of this size and complexity[1]. The EBRD was closely involved in the procurement process; clearing all documents prior to issue, closely scrutinizing evaluation reports, authorizing the extent of what could be negotiated and verifying the contract documents and payment methods prior to first disbursements. As a result of its hard earned knowledge GEOTHERM is now well positioned to be able to undertake these types of projects in the future.

Although there were positive indications of support for the project primarily from Russian and Japanese contractors, the outcome of the tendering process for the construction contracts was disappointing. According to the results of preliminary qualification 4 participants were admitted to the bidding for power plant construction – Japanese companies "Sumitomo" and "Nippon Steel" and also Russian-Israeli and Russian-German-Japanese consortiums. But bidding offers were submitted only by "Sumitomo" and Russian company "Technopromexport". At the same time prices of "Sumitomo" (more than 120 mln. USD) and "Technopromexport" (more than 111 mln. USD) offers exceeded essentially the Project budget. As a result of this "Geotherm" had to begin lasting negotiations on reduction of works amount with the bidding winner – "Technopromexport" company which proposed the best technical decision. And in particular the lack of competition amongst companies tendering for the steam field contract required GEOTHERM to subsequently split the contract into a drilling contract and a second contract covering all above ground fluid collection and disposal systems (FCDS). Without wide participation from foreign companies it became even more critical to have healthy competition between Russian companies. However, reality showed that very few Russian companies had the technical and financial capability to carry out the contract scope of works in accordance with the specified conditions of contract. The resulted lack of competition resulted in relatively high turn-key prices and delayed contract award by 6-9 months.

The poor competition however was disappointing, both from foreign as well as Russian companies. All three EPC contracts were ultimately awarded to Russian companies with foreign companies participating only as subcontractors, supplying specialized items such as distributed

[1] Power plant and associated steam field facilities incorporate a very high level of plant automation and technical specifications for the power plant contract were prepared on the basis of maximising net electrical generator output from the available geothermal fluids supplied by the FCDS contractor at the contract interface, ie saturated steam at 320 T/h and 6.5 bara. Tenderers were requested to guarantee Plant Heat Rate[1], and the Net Power Output[1], with tender evaluation criteria awarding tenderers for offering plant with low Plant Heat Rate and high Net Power Output. Of the two bids received for the power plant, the successful Russian tenderer offered very efficient condensing steam turbines that resulted in construction of a 50 MW plant as opposed to the 40 MW plant envisaged during the feasibility stage.

control system, cooling towers, gas insulated switchgear, protection relays, well head equipment, etc. The lack of foreign interest in tendering for the EPC contracts was difficult to explain, but believed to be a combination of perceived difficulties doing business in Russia, combined with the logistical problems associated with severe climatic conditions at the project site. Given their mandate to support international competition it is considered unlikely that any IFI, could support another such project unless measures can be taken to encourage foreign tenderers to participate.

While the three-EPC contract approach eventually produced satisfactory results (though not without problems), a future similar project may benefit from splitting the project scope into many smaller packages. This will allow a wider range of companies to participate in the tender process. A possible extension to this strategy will be for GEOTHERM to carry out all drilling works using in-house or contracted drilling equipment in addition to managing and monitoring the geothermal resource. To achieve this objective GEOTHERM's drilling and scientific expertise will have to build up to resource the drilling of production and reinjection wells for the next phase as well as the ongoing drilling of make-up wells for the first stage 50 MW plant.

However, the downside of the above approach is that IFIs would need to be assured that the large number of physical and contractual interfaces was properly managed, with the project company or its prime contractor able to demonstrate it could take financial and technical responsibility for process and interface design. Special attention should also be given to drafting commercial contract clauses in accordance with the latest Russian laws and regulations. For this purpose the inclusion of Russian contract law specialists in the project team would be essential to ensure that such clauses are not in conflict with IFI procurement rules.

6. PLANT MANUFACTURE, DELIVERY AND CONSTRUCTION

The power plant and FCDS contractors performed reasonably well technically, but both exceeded the contractual Time for Completion. Their project management was inadequate and in the case of the power plant contractor it was always for difficult for GEOTHERM to get an accurate assessment of their problems. Despite both being Russian contractors they appear to have underestimated the impact of the climatic conditions at the project site and which contributed to project delays. In addition largely due to cumbersome arrangements for paying subcontractors, procurement of plant and equipment from overseas suppliers was protracted and caused late delivery in some cases. These are important issues that will need to be more carefully considered in a future project.

Initially transportation of plant and equipment from mainland Russia via rail to Vladivostok and from there by ship to Kamchatka was poorly planned and coordinated by the power plant contractor and delayed delivery of building structural steel, wall panels and roofing. As a result the short summer construction season of 2000 was not fully utilised and without buildings enclosed little installation work could continue indoors the following winter. To make up time lost during the plant manufacturing phase giant air cargo planes were used to transport steam separators, turbines and main cooling water pumps from Moscow directly to Petropavlovsk-Kamchatsky. Many smaller components such as control system equipment were also transported by air to safe time and avoid damage in transit. In retrospect if Asian companies had been encouraged to tender they may have not had to face these sorts of logistical problems.

Climatic conditions at Mutnovsky are severe and outdoor construction activities including placing of structural concrete can only proceed during a short four-month summer period. To minimise the civil construction time, extensive use was made of prefabricated concrete building foundation blocks placed in excavated 3 m deep pits and later backfilled. The 5 tonne foundation blocks were pre-cast in factories near Petropavlovsk-Kamchatsky during the long winter period and transported to site by truck or on sledges pulled by bulldozers. For future projects in similar locations the level of pre-fabricating building and plant components should be increased even further to streamline and reduce the on site construction phase.

The harsh climatic conditions also dictated that all power plant and FCDS equipment be located inside four main building structures and interconnected by enclosed air bridges to ensure safe plant operation and access in winter when snow cover on the site is 6 metres high. Purpose build enclosures are also used around each wellhead and control valve station to provide protection from wind and snow. Ventilator cooling towers manufactured by Psichrometric System Inc. company (USA) proved to fit not enough for work in severe winter conditions, so future projects the winterisation aspects of cooling towers should be critically reviewed.



Fig. 2. Aerial View of Mutnovsky Power Plant

7. PROJECT MANAGEMENT

The Project Management Unit (PMU) was established by GEOTHERM and consisted of GEOTHERM staff located in Moscow and Kamchatka; backed up by its consultants from New Zealand and Russia. The PMU manager reported to the GEOTHERM Board and consultant staff advised PMU staff members on technical and project implementation issues. The Moscow based PMU was responsible for preparing technical documentation, project procurement, concept design review and liaison with EBRD and government agencies. Managing site activities, implementation of construction contracts as well as operation and maintenance of the Upper Mutnovsky and GeoPP1 power plants and associated steam field facilities is the responsibility of the Kamchatka based PMU Group.

A well functioning PMU, good communications between offices and good progress reporting is always a pre-requisite for a successful project outcome. The PMU consisted of full time staff and this avoided distractions from their heavy workload and considerable project responsibilities. PMU staff replacements during implementation of the Project were kept to a minimum and ensured continuity of management and technical expertise. Collectively PMU and consultant staff successfully implemented the project and is committed to pursue the continued reliable operation of the power plant, steam field facilities and the geothermal reservoir.

Communication between all project participants, including the financing agencies is an important aspect for successful project implementation and language barriers can easily cause problems and misunderstandings. The project was fortunate that the development of Email had become viable for facilitating high speed electronic transfer of reports, drawings and project scedules between offices. Taking advantage of the different time zones reports could be thus prepared in Auckland, vetted in Kamchatka and Moscow and forwarded to London within 24 hours.

While the EBRD required English language reporting, the contract language for the project was Russian and with only Russian contractors employed for the project there were no language barriers between them and GEOTHERM. However, contractors often did not comply with requirements to submit copies of many project documents in English and this introduced information barriers for the foreign consultants. The EBRD was also concerned that reporting was not always accurate, making it difficult for the Bank to fully monitor the efficacy of co-financing arrangements and the status of construction. Voice communications between foreign consultant, PMU and contractor staff were also constrained by language barriers, but all official meetings were provided with competent interpreter services. Future projects whereby the contract language is Russian will benefit from employing foreign consultants with a good command of the Russian language.

A project in an isolated and cold climate location such as Mutnovsky relies heavily on effective and safe transportation of personnel and equipment between the project site and Petropavlovsk-Kamchatsky. The Kamchatka PMU has at its disposal purpose built vehicles able to cope with the frequently adverse weather conditions and since the start of the operational phase, scheduled plant operator crew changes have been implemented together with snow clearing operations around the power plant site and access roads.

8. IMPLEMENTATION SCHEDULE

The project implementation schedule prepared in 1997 as part of the Feasibility Study envisaged project completion in April 2001. Delays by GEOTHERM's sponsors in meeting EBRD Loan effectiveness conditions compounded by a prolonged procurement phase delayed signing of the power plant EPC contract until September 1999, more than one year behind schedule. A significant delay was caused after about 2 years into the project by the lack of timely local financing mainly to cover the cost of taxes and IDC. Although the MOF initially suspended payments to GEOTHERM's contractors because of the accumulated unpaid taxes, the situation was eventually resolved between the various agencies involved. However this was not enough to satisfy the EBRD which subsequently insisted the project should remain suspended until the sponsors could demonstrate they had budgeted to cover the projected local currency expenditures. The EBRD was concerned that the situation could result in a "white elephant", a common problem with under-funded incomplete projects in the former Soviet Union. These present a serious reputational concern for any IFI, even though their loans are protected by sovereign guarantees.

In spite of Project financing cessation for half a year on the part of EBRD, Geotherm managed to pass this serious test, confirm the local financing and go on realizing the Project.

Delays during the manufacturing and construction phases of the power plant contract caused further slippages and trial operation of the two units did not commence until late 2002. Test on Completion or Performance Guarantee Tests for both Unit 1 and Unit 2 were carried out in early 2003, but lengthy discussion of the results delayed Taking Over of both units until late 2003.

Implementation of the FCDS contract proceeded more or less to schedule and, while the contractual Time for Completion was extended twice, did not cause project delays. Delayed award of the drilling works contract, slow drilling progress and poor drilling success rate caused a shortfall in steam supplies during the first year of plant operation with corresponding revenue losses for GEOTHERM.
A reduced implementation timeframe will be essential for future projects and will substantially reduce interest charges accumulated during the construction period. With lessons learned from the project, particularly in terms of adopting more off-site prefabrication and having a much better understanding of site conditions there is every opportunity to shorten project implementation for future similar projects.

9. ENVIRONMENTAL ACTION PLAN

The project is designed in compliance with the relevant Russian Environmental Regulations and relevant international environmental standards. At the start of the project GEOTHERM developed and implemented an extensive Environmental Action Plan (EAP) for the Project. The EAP effectively controlled design and construction activities to minimise the adverse environmental impact of the plant during construction and operation.
Measures were implemented in the design stage to minimise ground concentrations of hydrogen sulphide (H_2S) and thus minimise exposure of personnel. The technology selected for the project involves the disposal of non-condensable gases, containing most of the H_2S, at the top of the cooling tower stack. Experience to date shows that diffusion of the gases into the cooling tower plume, aided by the prevailing strong winds achieves good dispersion and results in acceptable and safe ground level concentrations around the project site.
The project also includes systems to reinject all separated water and condensed steam back into the reservoir and thus avoid discharge of geothermal fluids into surrounding waterways. Similarly all station waster water streams are treated to acceptable and safe limits before discharge into surrounding waterways. As such the project has minimal impact on fish or other aquatic life in nearby streams.
Since the start of plant operation regular monitoring and reporting of H_2S emissions and compliance with the relevant environmental regulations is being carried out. As part of the ongoing monitoring programme GEOTHERM also record and report on:

- Changes in natural hot-springs flow and chemical composition.
- ·Changes in ground water level and quality.
- ·Changes in river water flow and quality, particularly the condition of the Falshivaya River.
- ·Performance and maintenance of the reinjection system
- ·Restoration, planting and re-growth of vegetation.
- ·Measures taken to protect personnel health and safety.

In the latter stages of project implementation a local NGO directly approached the EBRD to complain that GEOTHERM was not fully implementing its monitoring obligations. While the situation was soon resolved, it is important to take note that the EBRD, like many other IFIs, is a public institution that will stop funding a project if in fact such claims were true. Thus it is essential that NGOs are given adequate opportunity to participate both in then the appraisal and monitoring process.

10. PROJECT COSTS AND ECONOMICS

Cost estimates prepared in 1997 for the feasibility study predicted US$ 154 million for a 40MW plant. The actual total cost is approximately US$ 151 million, despite the installed capacity of the

power plant increasing from 40 MW to 50 MW. The 25% higher plant capacity significantly increases power sales and has improved project economics. The fixed price EPC contract approach minimized contract variations and no significant cost overruns occurred.
Project economic feasibility is evaluated based on a cost benefit analysis comparing the predicted 342.5 GWh annual power sales of the Mutnovsky plant with avoiding the marginal fuel and operating cost of existing oil fired CHP plants to achieve equivalent electrical power sales. This advantage of this methodology is that the agreed electricity tariff does not enter the equation. Until 2010 it is assumed that the present excess generating capacity in the CES will continue, however, if Mutnovsky had not been constructed KE would after 2010 have to construct equivalent new thermal plant at a costs of US$ 65 million. The cost of fuel oil to KE is estimated today at US$ 183 per tonne plus operation and maintenance costs for existing and new thermal plants estimated at US$ 1.3 million.
The construction of the access road by KE is been treated as a sunk cost, but US$ 25 million has been allocated to the Mutnovsky project for the construction of the HV transmission line by KE. Annual operation and maintenance costs including for the transmission line and future development of the steam field are estimated at US$ 3.65 million. Environmental benefits of the project have been included in the form of carbon credits valued at US$3.5 per tonne of CO_2. Taxes, IDC and inflation have been excluded from the analysis.
Future stages of development at Mutnovsky will have a substantially higher CBR, because the excess generating capacity will no longer exist and thus the avoided capital cost for new thermal plant can be attributed to the geothermal project at the start of the project life.

11. ISSUES OF CONCERN TO THE PROJECT FINANCIER

As the regional IFI involved in the Eastern Europe and the Former Soviet Union, the EBRD has a mandate to support environmentally benign, economically feasible projects that can be used to encourage the transition to a market economy. While the EBRD prefers that its projects involve significant private sector investment, exceptions can be made where other institutional objectives can be fulfilled. In this case the Bank accepted that for the first stage of the Mutnovsky renewable development, the project could be sponsored by the federal government, with the project company largely owned and controlled by public agencies (RAO and KE). The EBRD therefore focused its attention on the transparency of the financial and management process, closely monitoring procurement and project implementation together with the Sponsors adherence to covenanted agreements.
Throughout the implementation the Bank insisted on timely reporting by enforcing tight control over disbursements from the loan direct to GEOTHERM's contractors. The Bank was in continuous contact by Email and Fax and carried out numerous monitoring visits to Moscow and Kamchatka. In addition to its due diligence investigations, the Bank subsequently performed a comprehensive mid term review of the project followed up by a separate environmental review and internal audit of its own due diligence process. During the construction phase the Bank employed two specialist Lender Engineers to visit the site on a bimonthly basis to oversee the activities by GEOTHERM, its consultants and its contractors.
In its final project completion report the Bank regarded project implementation as generally successful although it had doubts about the efficacy of the implementation of legal agreements. Recognising the numerous time consuming exchanges of views throughout the project, GEOTHERM accept that there were considerable financial, environmental and legal issues of concern to the EBRD that need to be considered in more detail for future loan applications. Some of the problems that arose were outside GEOTHERM's control and some related to the political-economic situation in Kamchatka. In most cases when problems arose the EBRD was largely sympathetic and helpful but in retrospect time was lost because of a failure to understand the Bank's concerns.

The main lessons learned from these activities in dealing with any IFI are

- *Reporting*. It is essential that high quality accurate timely progress reporting in English is done on a regular basis from the commencement of the project. Regular updating of the project chart is essential and the IFI must be kept informed when any important financial of technical problem arises.
- *Financial Management*. A qualified senior Financial Manager should be appointed in the project team at an early stage to ensure that the IFI can discuss its concerns regarding financial and legal issues. Financial reports must be consistent and clear.
- *Project Management*. IFIs are concerned that the programming and management of complex major projects utilizes all its resources. In particular the technical consultants can offer considerable experience in modern project management skills.
- *Environmental Monitoring*. Most IFIs take the environmental aspects of their projects very seriously and are very sensitive to concerns expressed by NGOs. It is important to involve NGOs at all stages of the project to ensure they are properly informed.

12. CONCLUSIONS

The project met its main objectives although not without significant delays largely due to procurement and financing problems. GEOTHERM has learned a lot about dealing with IFIs from the project, lessons which will stand it in good stead to take on other similar projects in Russia and internationally. At the start of Mutnovsky project the main objectives were for the Kamchatka Region to:

- ·Reduce dependence on costly imported fossil fuels;
- ·Reduce the cost of power generation;
- ·Retire old, inefficient and environmentally damaging fossil fuel power plants;
- ·Improve diversification of the energy base of the region;
- ·Introduce commercial operation in the regional power utility; and
- ·Develop the first commercially managed independent power producer in the region.



Fig. 3. Mutnovsky geothermal field

Most of the above objectives have been achieved with the exception of the objective to reduce the cost of power generation in the Region. The objective dealing with commercial operations was partly achieved making it difficult to arrange financing for a future project under the same conditions. The relatively high investment cost of the Mutnovsky project and need to repay project debt requires a relatively high tariff in the initial years of plant operation, something which to date has not been achieved. However, following repayment of the debt the cost of power generation from Mutnovsky will be substantially lower than from those using fossil fuels.
In conclusion it should be marked that Kamchatka got the most modern geothermal power plant with the cost about 150 mln USD and up to 55 MW of cheap electric power. Earlier blocked funds for steam field, roads, transition lines are reanimated at Kamchatka.
Construction organizations of Kamchatka and many specialists got the possibility of realizing their potential.
RAO "EES of Russia" which invested about 30 mln USD into this project, in fact became the owner of power plant with the cost of 150 mln USD. At the same time RAO "EES of Russia" realized for the first time the large power project in full accordance to international standards; this allowed to attract already now the investments for construction of II stage Mutnovsky GeoPP and other projects.
26 mln USD were received by the budget of the Russian Federation as taxes from this project.
Geothermal industry was created shortly; this provided the construction of highly effective power plant in the world. Experience of Mutnovsky GeoPP creation led to development of new direction in Russian science and technique and strengthened the bases of factories and institutes.
EBRD realized for the first time in Russia the large power project and made certain that even in remote regions of the country (Kamchatka) there is a possibility to implement effectively the projects on key basis in planned terms and economically; this allows it to pass on to implementation of new project – 100 MW II stage Mutnovsky GeoPP already now.
So Mutnovsky GeoPP is an example of successful cooperation of scientists, specialists, builders, bankers from various countries (Russia, Ukraine, Germany, USA, Finland, New Zealand, England etc), it opened the way for investments into power objects.
After putting GeoPP into operation Russia again entered the number of leading countries of the world able to create independently all equipment for construction of modern GeoPPs notable for economy and high level of automation.

In terms of the other project objectives, the following points are worth noting:

1. The Mutnovsky Power Plant will displace approximately 110,000 tonnes per year of fuel oil, which at current prices is valued at around US$ 20.2 million/year.
2. The Mutnovsky Power Plant will reduce emissions of CO_2 by some 230,000 tonnes per year with future carbon credit trading worth around US$ 1 million/year.
3. The Mutnovsky Power Plant will reduce emissions of SO_2 in the order of 5,500 tonnes per year and emissions of NOx in the order of 1,200 tonnes per year. In addition there will be a significant decrease in emissions of vanadium pentoxide and soot.