GLOBAL ENVIRONMENT FACILITY

MOHAMED T. EL-ASHRY
CHIEF EXECUTIVE OFFICER AND CHAIRMAN

October 6, 1995

Dear Council Members:

The World Bank, as the Implementing Agency for *Republic of Lithuania - Klaipeda Geothermal Demonstration Project*, has submitted the attached project document for CEO endorsement prior to final approval of the project document in accordance with World Bank procedures.

Over the next four weeks, the Secretariat will be reviewing the project document to ascertain that it is consistent with the project proposal that was included in the work program approved by the Council in May, 1995, and with GEF policies and procedures. The Secretariat will also ascertain whether the proposed level of GEF financing is appropriate in light of the project's objectives.

If by November 3, 1995, I have not received requests from at least four Council Members to have the proposed project reviewed at a Council meeting because in the Member's view the project is not consistent with the Instrument or GEF policies and procedures, I will complete the Secretariat's assessment with a view to endorsing the proposed project document.

Sincerely,

cc: Alternates, Implementing Agencies, STAP

Attachment

GEF SECRETARIAT, 1818 H STREET NW, WASHINGTON, DC 20433 USA
TELEPHONE (202) 473 3202 FAX (202) 522 3240/3245

Report No. 14614 LT

Republic of Lithuania
Klaipeda Geothermal Demonstration Project

Project Document
September 20, 1995

Natural Resources Management Division
Country Department IV
Europe and Central Asia Region

CONTENTS

PART I: PROJECT SUMMARY

REPUBLIC OF LITHUANIA
Klaipeda Geothermal Demonstration Project
Grant and Project Summary

GEF Focal Area:	Climate Change
GEF Financing:	US $ 6.9 million (grant)

Financing Plan:

	Local	Foreign	Total
	—— US $ million ——		
IBRD (loan)	0.21	5.69	5.90
GEF (grant)		6.90	6.90
MOE, Denmark (grant)	0.20	2.30	2.50
EU-Phare (grant)		0.12	0.12
Government of Lithuania	2.60		2.60
TOTAL PROJECT COSTS	**3.01**	**15.01**	**18.02**

Grant Recipient:	Republic of Lithuania
Grant Beneficiary:	Enterprise Geoterma (EG)
Economic Rate of Return:	11.7% (including national and global environmental benefits)
Environment Category:	B

THE REPUBLIC OF LITHUANIA
KLAIPEDA GEOTHERMAL DEMONSTRATION PROJECT

1. Background. The Bank's overall strategy in Lithuania is to support the country's efforts to accelerate structural reforms leading to a full transition to a market-based economy and, at the same time, to support efficient investments in high priority sectors to facilitate a return to economic growth. The recently completed Public Expenditure Review, jointly prepared by the GOL and the Bank, highlighted the need to support priority investments in energy, transport, and environmental services. The proposed Project is in line with the National Energy Strategy, which supports the development of indigenous and renewable energy sources. The use of geothermal energy as a replacement for imported fossil fuels in district heating systems could ultimately replace up to 50% of current fuel consumption.

2. During 1989-1993 a Danish consultant group financed by the Danish EPA carried out a comprehensive study to determine the size and quality of geothermal resources in Latvia and Lithuania and to assess the potential for utilizing geothermal energy to replace currently used fossil fuel for heat generation. Because the temperature of the water resources is between 30-95°C, the energy can only be used for heating and would normally be financially unviable without access to a district heating system. Additionally, the high cost of drilling operations could only be supported by a large consumer, such as a district heating system. The study confirmed that substantial geothermal aquifers occur within the Devonian and Cambrian strata, and it identified a number of cities where the use of geothermal energy could substitute for fossil fuel up to 50% of energy consumption. The study also determined that the largest and most promising storage areas are located in Lithuania.

3. The findings of the study underscore the existence of a significant indigenous resource. The GOL requested the Danish EPA to extend the Baltic Geothermal study to include the preparation of a feasibility study for construction of a *geothermal demonstration plant in Klaipeda*, which was identified as being the best location for a demonstration project. The city of Klaipeda is situated on the Baltic Coast on the mouth of the Kursiu Lagoon. With its population of 204,000, Klaipeda is Lithuania's third largest city. The town has an existing district heating network with a related annual heat demand (1994) of 5,600 Terajoules (TJ), which is expected to increase to 7,500 TJ by year 2000. The study indicated that a suitably sized demonstration plant could provide about 10% of the heat demand to the Klaipeda District Heating System. Energy could be extracted from the geothermal water by using heat pump technology based on absorption heat pumps. The feasibility study also determined that by reducing the temperature regime in the district heating network, *an additional 24% of geothermal energy could be extracted without any additional investments in the geothermal plant*. The proposed geothermal plant would produce 530 TJ without a reduction in the network temperature. This energy amount corresponds to about 16,500 tons of oil or 19.5 million m^3 of natural gas. An assumption is made that reduction of the network temperature will be implemented in the next energy/district heating project, and this could result in a production of 650 TJ/year.

4. The proposed Project would be the first geothermal project to supply heat to a district heating system in the Baltic States. It is also the first geothermal project financed by the Bank where the geothermal energy is transferred to a district heating system by use of heat pump technology. The Project is considered a national priority, and is in compliance with the National Energy Strategy's stated aim of developing indigenous energy resources. It also reduces environmental impacts, both localized air pollution (particulates and sulfur dioxide) and those with broader impacts, such as emissions of greenhouse gases (GHG) and sulfur dioxide (SO_2) which are covered by international agreements ratified by the GOL, the Montreal Protocol, and the Framework for Climate Changes Convention. The Project would reduce the emission of greenhouse gases from the boiler houses in Klaipeda by about 10%. The

Klaipeda. The geothermal water would be extracted from two production wells, and returned to the same depth with reduced temperature. The Project is based on well established technology and the utilization of proven operational equipment. Geological risks are negligible.

10. Project Financing. The project cost is estimated at US $18.02 million equivalent, with a foreign exchange component of US $15.01 million including contingencies, or about 83% of the total project cost. The Bank would finance US $5.9 million (32.7% of total project costs). The loan would be repaid by the GOL over 20 years including 5 years grace with repayments calculated on an annuity basis at the Bank's standard variable rate of interest.

11. The GEF would cofinance the project with a grant of US $6.9 million, equal to 38.1% of total Project cost. This would cover agreed upon incremental costs as described in para. 14. Parallel cofinancing on a grant basis by the Government of Denmark (US $2.5 million equivalent) and the European Union (US $120,000 equivalent) comprises about 14.5% of total project costs. The local counterpart contribution of LT 10.4 million or US $2.6 million equivalent would be provided by the GOL. A breakdown of costs and the financing plan are shown in Schedule A. Amounts and methods of procurement and disbursements and the disbursement schedule are shown in Schedule B. A timetable of key project processing events and the status of Bank Group operations in Lithuania are given in Schedules C and D, respectively. A map is also attached (No. 27165). The Staff Appraisal Report, No. 14584 LT, dated September 1995, is being distributed separately.

12. Rationale for GEF Financing. The involvement of the GEF (and the World Bank) in the proposed project would provide an opportunity to support Lithuanian efforts to reduce dependence on imported fossil fuels for heating, and improve national environmental quality through the reduction of greenhouse gases and SO_2. In the absence of such involvement, it is unlikely that the country would be able to mobilize the technical assistance and financial resources required to implement a demonstration project of this nature.

13. The project would provide a mechanism for the GEF to test the feasibility of low temperature geothermal energy as a means of reducing greenhouse gas emissions, and reduce the dependence on fossil fuels in district heating systems. With successful implementation, the Project could serve as a paradigm for other successor states to the Former Soviet Union, all of which have extensive district heating systems and extensive renewable geothermal energy resources. The project is eligible for GEF funding as it conforms to the Guidance for programming GEF Resources in 1995 in that: (a) it is sustainable; (b) it is a national priority in the National Energy Strategy; (c) it provides the means of abating GHG at a cost below US $25 per ton carbon; (d) it includes an essential transfer of technology; (e) it would develop an indigenous and renewable energy resource; and (f) it would demonstrate that a further extraction of geothermal energy is achievable, when combined with other energy conserving measures in the Klaipeda district heating system.

14. Incremental Cost. The calculation of the incremental cost is described in the Technical Annex. However, to prepare this calculation the investment cost for the geothermal plant was assessed at US $16.3 million, as the ICB-procedures are expected to reduce the actual cost. The NPV at a discount rate of 10% is US -$5.6 million based on this investment cost (without including environmental benefits) and on the provision of 530 TJ/year of heat supply over 25 years through a planned mix of heavy fuel oil and natural gas. The investment cost has, due to changes in the Yen-dollar relationship, been re-assessed at US $17.6 million. The alternative cost is the investment cost of the Project plus annual operations and maintenance charges for the geothermal installation, converted to present value terms at a 10% discount rate. The difference of US $6.9 million (17.6 - 16.3 + 5.6 million) represents the increment to be covered by GEF.

certified by the financial directors of EG and LSPS; (c) submission of a draft "take or pay" contract for the wholesale of geothermal energy to KDHE; and (d) transfer of license for EG to produce energy from the geothermal plant. Conditions for effectiveness would include: (a) submission of satisfactory evidence that all conditions precedent to effectiveness of the grants from cofinanciers have been fulfilled; and (b) execution of subsidiary loan agreement between GOL and EG.

23. Environmental Aspects. The proposed Project would have only positive environmental impacts as *no emissions* would be generated by the Project, and it would also significantly reduce the use of fossil fuels in affected areas. Due to higher price for natural gas compared with HFO with high sulfur content (3.5%), it is anticipated that the geothermal energy from the Project would reduce both oil and gas consumption. The Project would result in annual reductions in emissions of CO_2 and NO_x by 47,800 and 1 ton(s) respectively if natural gas is replaced, and 51,940 and 110 tons respectively if HFO is replaced. In addition the replacement of HFO would result in an additional reduction of SO_2 of about 1160 tons per year. The proposed Project has been placed in environmental screening category "B". An environmental review consistent with the provisions of the World Bank's Operational Directive 4.01, "Environmental Assessment" and the applicable environmental procedures of the GOL is presented in the Technical Annex.

24. Monitoring and Evaluation. The generation of the extracted heat will be continuously monitored on a daily basis, to assure that EG would be paid correctly in regard to delivered heat. Furthermore, parameters such as the amount of extracted geothermal water, and temperature of the geothermal water and in the network return water, would also be monitored on a daily basis to make it possible to evaluate further energy transfer to the DH company. Based on the delivered heat, it would be easy to calculate the replaced amount of fuel and with it linked emission of CO_2, SO_2, NO_x, and particulate matter.

25. Project Benefits. The project would demonstrate whether Lithuania's substantial geothermal resources can be commercially developed, specifically for the purpose of utilizing these relatively low temperature, environmentally benign resources. These resources would be used in existing district heating systems using technology already being employed in other district heating systems (Denmark, Germany, and Sweden). The proposed project would also establish the institutional and policy framework for promoting the further development of geothermal energy. Specific project benefits include: (a) reduction in noxious emissions of CO_2, SO_2, NOx and particulate matter; (b) the cost-effective utilization of an indigenous energy resource (which is also recommended in Lithuania's Energy Development Program); (c) savings in foreign exchange; and (d) more reliable fuel supplies to supplement imported fuel presently used for heating purposes.

26. The project is estimated to have an economic rate of return (ERR) of 9.8% if national environmental benefits are included (4.7% if national environmental benefits are excluded). The ERR increases to 11.7% if the global benefits of CO_2 reduction are also included in the analysis. A GEF grant of US $6.9 million, approved for the project, would allow the project to remain financially sustainable (that is, to cover its operating and capital costs). Any subsequent geothermal plant would draw on the lessons learned from this demonstration project and would be justified on its own economic and technical merits.

27. Project Risks. Underscoring the demonstration character of the Project, the main risks include:

- Technical Risks: lower than expected supply of geothermal energy (amount of water and water temperature); and

SCHEDULE A

REPUBLIC OF LITHUANIA

KLAIPEDA GEOTHERMAL DEMONSTRATION PROJECT

ESTIMATED COSTS AND FINANCING PLAN

	US $ Million			%
	Local	Foreign	Total	Foreign
Estimated Project Cost /a				
Drilling Operation	0.18	1.73	1.91	91%
Completion of Wells	0.00	0.69	0.69	100%
Control and Evaluation of Drilling Operations	0.00	0.15	0.15	100%
Building and Civil Works	0.36	0.16	0.52	31%
Connection to Boiler House and External Pipeline	0.54	0.19	0.73	26%
Heat Exchangers	0.04	0.67	0.71	94%
Absorption Heat Pumps	0.30	6.04	6.34	95%
Filters, Valves and Internal Piping	0.08	0.74	0.82	90%
Power, Control and Regulation	0.09	0.63	0.72	88%
Project Implementation Support	0.12	0.12	0.24	50%
Training, Technical Assistance, & Supervision	0.16	2.10	2.26	93%
Base Cost for Geothermal Demonstration Plant	1.87	13.22	15.09	88%
Physical Contingencies	0.09	0.66	0.75	88%
Price Contingencies	1.05	0.73	1.78	41%
TOTAL PROJECT COST	**3.01**	**14.61**	**17.62**	**83%**
Interest During Construction		0.40	0.40	100%
TOTAL FINANCING	**3.01**	**15.01**	**18.02**	**83%**

Financing Plan

	Local	Foreign	Total
	US $ Million		
IBRD (loan)	0.21	5.69	5.90
GEF (grant)		6.90	6.90
Ministry of Environment, Denmark (grant)	0.20	2.30	2.50
European Union - Phare (grant)		0.12	0.12
Government of Lithuania	2.60		2.60
Total	**3.01**	**15.01**	**18.02**

a/ Excluding taxes and duties

SCHEDULE B

REPUBLIC OF LITHUANIA

KLAIPEDA GEOTHERMAL DEMONSTRATION PROJECT

SUMMARY OF PROPOSED PROCUREMENT ARRANGEMENTS

Project Element	ICB–WB	ICB–GEF	Other	N.B.F.	Total Cost
Civil Works and Larger Equipment					
Drilling Operation		2.12 1.87 **			2.12 1.87 **
Building and Civil Works	0.75 0.23 *				0.75 0.23 *
Connection to Boiler House and External Pipeline	1.09 0.22 *				1.09 0.22 *
Heat Exchangers		0.82 0.75 **			0.82 0.75 **
Absorption Heat Pumps	3.63 1) 3.37 *	3.63 1) 3.37 **			7.25 3.37 * 3.37 **
Smaller Equipment					
Completion of Wells		0.75 0.75 **			0.75 0.75 **
Filters, Valves and Internal Piping	0.96 0.82 *				0.96 0.82 *
Power, Control and Regulation	0.86 0.86 *				0.86 0.86 *
Project Implementation Support					
Office Equipment				0.09	0.09
Consultant Services					
Control and Evaluation of Drilling Operations			0.16 *** 0.16 **		0.16 0.16 **
Project Implementation Support					
Staffing				0.22	0.22
Training, Technical Assistance, & Supervision				2.55	2.55
Total Procurement					
Total	7.28	7.32	0.16	2.86	17.62
The Bank	5.50 *				5.50 *
The GEF		6.74 **	0.16 **		6.90 **
Loan Service During Construction					
Interest and Commitment Fee					0.40 *
Total Financing					18.02
The Bank					5.90 *
The GEF					6.90 **

N.B.F. = Not Bank Financed

* Bank Loan Financed Procurement

** GEF Financed Procurement

*** According to Bank Guidelines for Use of Consultants" (August 1981) = US $0.16 million

1) The investment cost for absorption heat pumps is equally shared between WB and GEF, as their financial contribution is identical.

REPUBLIC OF LITHUANIA

KLAIPEDA GEOTHERMAL DEMONSTRATION PROJECT

TIMETABLE OF KEY PROJECT PROCESSING EVENTS

(a)	Time taken to prepare the Project:	21 months (Feb. 1994 - Oct. 1995)
(b)	Proposed by:	Ministry of Energy, Lithuanian State Power System, Klaipeda District Heating Enterprise, and Enterprise-Geoterma (using consultants financed by the Danish Government) with Bank assistance.
(c)	First Bank Mission:	February 1994
(d)	Appraisal Mission:	March 1995
(e)	Negotiations:	October 1995
(f)	Planned Date of Effectiveness:	January 1996
(g)	List of Relevant PCRs and PPARs:	None

The Project was prepared by Anders Halldin (EC4NR), Task Manager. The Department Director is Basil Kavalsky, and the Division Chief is Geoffrey Fox.

PART II: TECHNICAL ANNEXES

I. BACKGROUND

A. Country Context

1.1. Lithuania is the southernmost Baltic country. It covers an area of 65,200 km^2, with a population of about 3.8 million. During the Soviet period, Lithuania had a strong economy, based on specialized industries and agriculture, which was fully integrated into the larger Soviet system. Since the restoration of Lithuanian independence in 1991, the country has undertaken a major program of political and economic reforms, which has brought it from a centrally planned economy to a transitional market economy. In this process, it has experienced adjustment shocks common to many economies in transition, characterized by a significant decline in economic productivity and high inflation rates. The gross domestic product (GDP) also declined sharply as a result of the collapse of trading relations with Russia and other former Soviet Republics.

1.2. The Government of Lithuania (GOL) has been pursuing economic reform and stabilization, including price and trade liberalization. A formal macro-economic program was launched in 1991, supported by two IMF standby arrangements (in October 1991 and October 1993). Since then, Lithuania has been successful in containing monetary expansion and fiscal deficits. Lithuania introduced the national currency, the Litas (in July 1993), which has been tied to the US Dollar since April 1994 (4 Litas (LT) = US $1). Inflation has been reduced from an annual rate of 1,020% in 1992 to an estimated rate of 69% in 1994, and is expected to be 25% in 1995, 18% in 1996, and projected to decline further thereafter. The introduction of a currency board system in April 1994 is expected to be very effective in ensuring continued macroeconomic stability. The estimated per capita income level was US $1,350 in 1994. The Bank expects the Lithuanian economy to recover from its current economic recession and projects a GDP growth rate of 5% in 1995, 4.8% in 1996 and 4.5% per year thereafter.

1.3. The Bank's overall strategy in Lithuania is to support the country's efforts to accelerate structural reforms leading to a full transition to a market-based economy and, at the same time, to support efficient investments in high priority sectors to facilitate a return to economic growth. To date the Bank has provided the GOL with a Rehabilitation Loan (No. 3737-LT) of US $60 million in October 1992 (which is being successfully implemented), a Power Rehabilitation Loan (No. 3524-LT) of US $26.4 million in January 1995, the Klaipeda Environment Loan (No. 6401-LT) of US $7 million, and the Enterprise and Financial Sector Assistance Loan (No. 3866-LT) of US $25 million in April 1995.

1.4. The recently completed Public Expenditure Review, jointly prepared by the GOL and the Bank, highlights the need to support priority investments in energy, transport and environmental services. *The proposed Project is regarded as a priority by the GOL, in line with the National Energy Strategy*, which supports the development of indigenous and renewable energy sources.

B. Sectoral Context

Energy Sector

1.5. Overview. Lithuania's economy is challenged by six major problems in the energy sector: (a) high energy intensity and the need for energy efficiency and conservation; (b) limited domestic energy resources, which currently supply only 2% of total energy demand; (c) almost total dependence on imported fuels from Russia and thus a vulnerability to serious supply disruptions; (d)

receive shares of LSPS totalling 15% of authorized capital. The privatization process is expected to be finished by September 1995, which opens the door for corporatization of the LSPS branches into legal entities in accordance with Lithuanian law. However, an earlier corporatization of EG has been discussed with the GOL, which has indicated that EG can be corporatized in the near future without awaiting the privatization process. EG would then be separated from LSPS and established as a State Enterprise. Corporatization of EG as an open joint stock company would be a condition for Board Presentation, and prior to that, the GOL would provide the Bank with a timetable and action plan for EG corporatization.

1.12. Lithuania is in the process of establishing regulatory bodies concurrently with commercialization of the energy sector. An interim body, the Energy Pricing Council, has been established to submit pricing proposals to the Cabinet. An Energy Agency has been created to help collect data and draft policy for the Government.

1.13. District heating systems supply a major part of residential areas and industries with heat. Residential areas (26 million m^2 of housing) obtain hot water at a maximum temperature of 150° C, and many industries are supplied with steam. The annual heat production delivered to the district heating systems is approximately 100 PJ, of which about 25 PJ are produced as steam for industry. The residential heat consumption of 2.4 GJ/m^2 is more than double that of Western Europe, as a result of poorly insulated buildings and the poor condition of the district heating systems. In 1993, the total fuel consumed in district heating systems had fallen to 0.74 bcm of gas and 0.9 million tons of heavy fuel oil (HFO)--a drop of 0.3 bcm and 0.3 million tons respectively from 1991. This decrease reflects significantly lower industrial consumption, and constrained supply to residential consumers. The share of DH in final energy consumption actually rose from 22% to 24% between 1991 and 1993, however, due to a drastic decline in electricity production. The vast majority of this heat was produced in heat-only boilers.

1.14. District Heating. The principal problems in the district heating systems are: (a) heat production plants rely on heat-only boilers (HOB), fueled by natural gas or HFO, to provide 70% of annual heat production, which is substantially less efficient than using heat from combined heat and power plants; (b) the systems are run in "constant-flow operation mode", making load dispatching and consumer heat regulation (and therefore metering) impossible, and leading to excessively high power consumption of water pumps; and (c) the pipe systems suffer from a monthly loss of 100-400% of total network water volume, whereas a 5-15% monthly loss is the norm in modern, pre-insulated pipe systems. Based on a 200% monthly water loss, heat loss from a network can be estimated as 8 $GJ/year/m^3$ of network volume. In general, measures such as the modification of network connections would enable a reduced network temperature, resulting in significant energy savings, and it has been agreed with the MOE (in March 1995) that such network modifications are a priority in Klaipeda.

1.15. The GOL has been subsidizing district heating consumption through a combination of cross subsidies from electricity and direct operating subsidies. Residential consumers are also partially compensated for that part of their heat bill which exceeds 15% of the household income. This direct subsidy, through LSPS, is capped at an estimated average consumption level based on the cost to heat 15 square meters per resident and an extra 15 square meters per dwelling. In addition, the GOL announced in late 1993 that it would enforce payment of the heating bills by linking it to electricity supply. There are still several inherent problems with this system of subsidization: there is no guarantee that cross subsidies will meet expected targets, and the consumer compensation scheme is designed for a certain level of heat use which may not be possible to provide in all areas. Given the different subsidies, the system is administratively complex, and is subsidized even at full tariff level before

allow a t· ·ough evaluation of the current situation and available resources, and provide a program of short- anc. ıong-term actions. An important part of this strategy would be the identification of actions to reduce the generation of pollution at source. This study will be completed by September 1995. As mentioned in **para. 1.7**, there is a trend toward replacing natural gas with HFO, based on slightly higher prices for natural gas than for HFO. This trend is definitely a negative one from an environmental standpoint as HFO emits much higher levels of CO_2, NO_x, SO_2, and TPM (**Table 1.1**).

Table 1.1: Emissions from Burning Fuel

		Emission (kg/GJ)			
		CO_2	NO_x	SO_2	TPM
Natural Gas	34GJ/ton	71.18	0.1	-	-
HFO	40GJ/ton	78.4	0.4	1.8	0.1

Geothermal Sector

1.22. Background. Geothermal water constitutes an enormous potential reserve of energy, which varies in temperature depending on the geological formation and depth. In the Baltic region, access to geothermal water is quite easy, as the drilling depth can be limited to about 800-1200 m in the Devon stratum, where the temperatures are between 25-50°C. Temperatures between 75-85°C can be found at a depth of about 2000 m (in the Cambrium stratum), but the availability of sufficient amounts of water is questionable; that stratum is not recommended for extensive use until further data can be developed.

1.23. The resource for the proposed Project is situated in a series of Lower Devonian aquifer sands underlying the district of Klaipeda, at a depth of about 1,200 meters. These sands are extensive and their properties (thickness, porosity, permeability, sand consolidation, etc.) in the Klaipeda area (based on well tests, core samples and other data) appear to be good to excellent. Being of a sedimentary origin, the properties of the aquifer sands are predictable and may be extrapolated over a large area, thus the heat reserves can be determined with a good degree of confidence.

1.24. During 1989-1993 a Danish consultant group financed by the Danish EPA carried out a comprehensive study (Baltic Geothermal Energy Study) to determine the size and quality of geothermal resources in Latvia and Lithuania and to assess the potential for utilizing geothermal energy to replace currently used fossil fuel for heat generation. With the temperature of the water resources being between 30-95°C, the energy could only be utilized economically for heating requiring access to a district heating system.

1.25. The study confirmed that substantial geothermal aquifers occur within the Devonian and Cambrian strata, and it identified a number of cities, where the use of geothermal energy could substitute for fossil fuel for up to 50% of energy consumption. The study also determined that the largest and most promising storage areas are located in Lithuania.

has been identified, as well as two projects in Zyrardow outside Warsaw (US $60 million) and in Szczecin (US $120 million). In Slovakia, a project in Kosice (US $120 million) has been identified. All projects would use geothermal water at a temperature of 85 - 95°C (higher temperatures than would be used in the Klaipeda Geothermal Demonstration Project), and the heat would be transferred using existing district heating networks through the use of heat exchangers.

1.31. The Bank's experience in implementing geothermal projects is currently limited in regard to power producing plants such as Olkaria in Kenya (US $59.9 million) for generation up to 45 MW of electricity, and the recently approved project in the Philippines (US $305 million) partly financed by GEF, for generating up to 700 MW of steam to be produced at Leyte and transported to Cebu and Luzon.

1.32. The involvement of the Bank and the Global Environmental Facility (GEF) in the proposed Project would provide an opportunity to support Lithuanian efforts to reduce dependence on imported fossil fuels for heating and improve national environmental quality through the reduction of localized air pollution (particulates and SO_2) and improve the global environment through the reduction of greenhouse gases. In the absence of Bank and GEF involvement, it is unlikely that the country would be able to mobilize the technical assistance and financial resources required to implement a demonstration project of this nature.

1.33 This involvement has already resulted in actions in establishing the implementing company as a separate legal entity under Lithuanian law, developing a business plan for the company's engagement in the future development of the Lithuanian geothermal resources, and contractual arrangements for long-term supply of geothermal energy to a district heating company as well as eventual future private sector participation.

II. THE PROJECT

A. Project Origins and Formulation

2. 1 The GOL requested the Danish EPA to extend the Baltic Geothermal Energy Study (**para. 1.24**) to include the preparation of a feasibility study for the construction of a geothermal demonstration plant in Klaipeda, which was identified as being the best location for a demonstration project. The city of Klaipeda is situated on the Baltic Coast on the mouth of the Kursiu Lagoon. With its population of 204,000, Klaipeda is Lithuania's third largest city. The town has an existing district heating network with a related annual heat demand (1994) of 5,600 Terajoules (TJ).

2.2 The study indicated that a suitable size of the demonstration plant could provide about 10% of the heat demand to the Klaipeda District Heating System. Energy could be extracted from the geothermal water by using heat pump technology based on absorption heat pumps. The feasibility study also determined that by reducing the temperature regime in the district heating network, an additional 24% of geothermal energy could be extracted without any additional investments in the geothermal plant. The proposed geothermal plant would produce 530 TJ annually without reduction of the network temperature. This energy amount corresponds to about 16,500 tons of oil or 19.5 million m^3 of natural gas.

2.3 Preparation of the proposed Project included an identification mission in February 1994, a pre-appraisal mission in September 1994 and an appraisal mission in March 1995. In between, a number of preparatory field visits were made to review specific issues in combination with other missions to the Region. These missions and visits have also included the participation of representatives of the Ministry of Environment of Denmark.

B. Project Rationale

2.4 The proposed Project would be the first geothermal project to supply heat to a district heating system in the Baltic States. It is also the first geothermal project financed by the Bank, where the geothermal energy is extracted from an aquifer with a temperature as low as 42-50^{0}C, and transferred to a district heating system by use of heat pump technology.

2.5 The Project is considered a national priority, and is in compliance with the National Energy Strategy's stated aim of developing indigenous energy resources. It also limits the environmental impacts, both localized air pollution (particulates and sulfur dioxide) and those with broader impacts, such as the emissions of greenhouse gases (GHG) and sulfur dioxide (SO_2) which are covered by international agreements ratified by the GOL, the Montreal Protocol, and the Framework of Climate Changes Convention. The Project would initially reduce the emission of greenhouse gases from the boiler houses in Klaipeda by about 10%.

2.6 The feasibility study, supported by the Danish EPA (**para. 2.1**), shows that the geothermal energy, compared to other indigenous energy resources such as peat and wood chips, has a much larger development potential, and a lower heat generation cost based on a production capacity of

- to promote sustainable management and the development of environmentally sound and non-polluting geothermal resources both in a national and regional perspective.

E. Project Components and Description

2.10 Project Description. The proposed Project would be developed as an environmental/energy management project in the city of Klaipeda. The Project has two complementary components:

(a) Technical Assistance and Training Component for:

- design of the geothermal loop including all necessary equipment for extracting the heat from the geothermal water and transferring it to the district heating system;
- preparation of detailed drilling, testing, and completion programs;
- management support for project implementation, including support in preparing tender documents, and construction supervision; and
- training of Lithuanian staff and management in the operation of a similar geothermal plant in Thisted, Denmark to optimize the transfer of technology.

(b) Investment Component for:

- establishment of two production wells and one injection well;
- above ground facilities including building and necessary equipment such as absorption heat pumps, heat exchanger, and auxiliary equipment for control and regulation of the plant and the heat transfer to the district heating system; and
- piping between production wells and geothermal plant, and between the geothermal plant to the injection well, and piping between the geothermal plant and the district heating network.

A summary of the elements of the proposed Project is provided in **Chart 1** and further details concerning the TA component are given in **Annex 2.**

2.11 Technology. The proposed geothermal project involves the circulation of 600 m^3/h of 42°C geothermal water from about 1,200 meters depth via a closed geothermal loop, utilizing a heat exchanger and heat pumps for the retrieval and subsequent supply of heat into the existing district heating network in Klaipeda. The geothermal water would be extracted from two production wells and returned with reduced temperatures to the same depth to maintain formation pressure and to avoid creating water pollution problems. The technology proposed for utilization of the available low temperature geothermal heat in existing district heating networks is well developed and is being employed in several European towns and cities. A more detailed description of the proposed geothermal plant is presented in **Annex 3.**

2.12 The region was intensively investigated and explored in search of gas and oil fields. The geological and petrophysical information from more than 400 boreholes have been compiled and evaluated, and the predicted findings are described in para 1.26. The geotechnical and geothermal information linked to the actual locations of the demonstration plant indicate that up to 850 m^3/h could possibly be extracted from the two production wells and the temperature of the geothermal water could be as high as 48°C. An increase in temperature would give an additional 20 TJ/°C, and increased water extractions would result in an additional 85 TJ/100m^3/h. Furthermore, if the network temperature regime were to be discarded as a result of expected network modifications, a larger amount of energy could be extracted from the geothermal water.

2.13 Drilling will be undertaken using traditional drilling mud (water based bentonitic mud). The risk of severe drilling fluid loss to the aquifer zone and drilling "blindly" is not anticipated. Such problems are encountered in highly fractured geothermal zones associated with faults and volcanic activity, and not in the zone under consideration. Due to its sedimentary origin and the total absence of organic material, the aquifer water is unlikely to contain H_2S CO, or hydrocarbons.

2.14 There are technical risks, however, which justify starting first with a demonstration plant. They are: (a) the sustainable level of geothermal water that can be extracted; and (b) the temperature of the geothermal water. Even if the plant design is very conservative and robust, these risks would result in a lower than expected amount of geothermal heat being extracted. To reduce the impact of these risks the feasibility study is based on an energy extraction which is about 30% less than anticipated maximum output.

2.15 Implementation Schedule. Project implementation would be expected to begin January 1996 and would be carried out over a three-year period.

F. Cost Estimates

2.16 The total cost of the Project is estimated to be US $18.02 million or LT 72.08 million equivalent, including contingencies, but excluding taxes. The estimated cost distributed among project subcomponents is shown in Table 2.1.

2.17 The total base cost is estimated at US $15.09 million. Physical contingencies are estimated at US $0.75 million. Price contingencies between January 1, 1995 and December 1998 would amount to approximately US $1.78 million or 11.2% of base cost plus physical contingencies. Total contingencies represent 16.8% of the base cost. The foreign exchange component is estimated at approximately US $15.01 million including contingencies, or about 83% of the total project cost.

G. Project Financing Arrangements

2.18 Financing Plan. The proposed IBRD loan of US $5.9 million would finance about 32.7% of total Project costs. The loan would be repaid by the GOL over 20 years including 5 years grace at the Bank's standard variable rate of interest.

Table 2.2: Financing Plan by Financier

Financiers	Local US $ million	%	Foreign US $ million	%	Total US $ million	%
IBRD (loan)	0.21	7	5.69	38	5.90	33
GEF (grant)			6.90	46	6.90	38
Danish Ministry of Environment (grant)	0.20	6	2.30	15	2.50	14
EU-Phare (grant)			0.12	1	0.12	1
Government of Lithuania	2.60	87			2.60	14
Total	3.01	100	15.01	100	18.02	100

Table 2.3: Financing Plan by Fiscal Year (US $ million)

Financiers	1996	1997	1998	1999	Total
IBRD (loan)	0.02	0.23	3.92	1.73	5.90
GEF (grant)	2.78		4.12	0.00	6.90
Danish Ministry of Environment (grant)	0.51	0.99	0.71	0.29	2.50
EU-Phare (grant)	0.05	0.05	0.02	0.00	0.12
Government of Lithuania	0.33	0.74	1.37	0.16	2.60
Total	3.69	2.01	10.14	2.18	18.02

2.20 Onlending Arrangements. The Government would onlend proceeds of the Bank loan for EG, under terms and conditions satisfactory to the Bank. *As a condition of effectiveness of the GEF grant, subsidiary grant agreements have to have been executed between the Government and EG.* The Government would furthermore channel the GEF grant to EG without adding any charges to the grant.

H. Procurement

2.21 Procurement under parallel cofinancing arrangements (US $2.62 million) would be carried out through tied procurement in accordance with procurement regulations of the Government of Denmark, and the EU-PHARE Program. All goods and works to be financed from the GEF grant proceeds would be procured in accordance with the Bank's *Procurement Guidelines* (January 1995), including amendments as of the loan signing date, using standard Bank bidding documents. Procurement would be undertaken in the following manner:

Table 2.4: Procurement Arrangements

Project Element	ICB–WB	ICB–GEF	Other	N.B.F.	Total Cost
Civil Works and Larger Equipment					
Drilling Operation		2.12			2.12
		1.87 **			1.87 **
Building and Civil Works	0.75				0.75
	0.23 *				0.23 *
Connection to Boiler House and External Pipeline	1.09				1.09
	0.22 *				0.22 *
Heat Exchangers		0.82			0.82
		0.75 **			0.75 **
Absorption Heat Pumps	3.63	3.63 1)			7.25
	3.37 *				3.37 *
		3.37 **			3.37 **
Smaller Equipment					
Completion of Wells		0.75			0.75
		0.75 **			0.75 **
Filters, Valves and Internal Piping	0.96				0.96
	0.82 *				0.82 *
Power, Control and Regulation	0.86				0.86
	0.86 *				0.86 *
Project Implementation Support					
Office Equipment				0.09	0.09
Consultant Services					
Control and Evaluation of Drilling Operations			0.16 **		0.16
			0.16 **		0.16 **
Project Implementation Support					
Staffing				0.22	0.22
Training, Technical Assistance, & Supervision				2.55	2.55
Total Procurement					
Total	7.28	7.32 1)	0.16 **	2.86	17.62
The Bank	5.50 *				5.50 *
The GEF		6.74 **	0.16 **		6.90 **
Interest During Construction					0.40 *
Total					18.02
The Bank					5.90 *
The GEF					6.90 **

N.B.F. = Not Bank Financed

* Bank Loan Financed Procurement

** GEF Financed Procurement

According to Bank Guidelines for Use of Consultants" (August 1981) = US $0.16 million

The investment cost for absorption heat pumps is equally shared between WB and GEF, as their financial contribution is identical.

I. Disbursements

2.26 The proposed Project is expected to be disbursed over a period of four (Bank) fiscal years (1996-1999) with an estimated closing date on December 31, 1998. Disbursements per year are shown in **Table 2.6**. **Table 2.7** shows the disbursement, per fiscal year, of all the financier's contributions for the project. Descriptions of all the Bank loan and GEF grant proceeds and forecasts of expenditure and disbursement for the proposed Project are shown in **Table 2.8**. The disbursement schedule is shown in **Table 2.9**.

Table 2.6: Disbursement by Year (US $ Million)

Bank Fiscal Year	1996	1997	1998	1999
Annual	3.69	2.00	10.15	2.17
Cumulative	3.69	5.70	15.85	18.02
Cumulative % of Total	20.48	31.63	87.95	100.00

Table 2.7: Financing Plan by Disbursement Category

Project Element	IBRD Amount	IBRD %	GEF Amount	GEF %	Local Contribution Amount	Local Contribution %
Civil Works and Larger Equipment						
Drilling Operation			1.87	27.12	0.25	10.62
Building and Civil Works	0.23	3.91			0.52	22.06
Connection to Boiler House and External Pipeline	0.22	3.73			0.87	36.63
Heat Exchangers			0.75	10.90	0.07	3.04
Absorption Heat Pumps	3.37	57.10			0.52	21.98
			3.37	48.81		
Smaller Equipment						
Completion of Wells			0.75	10.82		
Filters, Valves and Internal Piping	0.82	13.93			0.13	5.67
Power, Control and Regulation	0.86	14.55				
Consultant Services						
Control and Evaluation of Drilling Operations			0.16	2.35		
Loan Service Cost During Construction	0.40					
Total Disbursement	**5.90**	**100.00**	**6.90**	**100.00**	**2.36**	**100.00**

months of average expenditures made through the Special Account. During the early stages of the Project, the initial allocation to the Special Account would be limited to US $250,000. However, when the aggregate disbursement under Loan has reached the level of US $2,000,000, the initial allocation may be increased to the authorized allocation of US $500,000 by submitting the relevant application for withdrawal. Applications for replenishment of the Special Account would be submitted monthly or when one-third of the amount has been withdrawn, whichever occurs earlier. Documentation requirements for replenishment would follow the standard Bank procedure as described in the Disbursement Handbook, Chapter 6. In addition, monthly bank statements of the Special Account which have been reconciled by the Borrower would accompany all replenishment requests. *The terms and conditions of the establishment and operation of the Special Account would be set forth during negotiations.*

J. Environmental Aspects

2.31 Preparation of the proposed Project has included an environmental review consistent with the applicable procedures of the GOL and the provisions of World Bank Operational Directive 4.01, "Environmental Assessment" for a category "B" project. As the Project would not generate waste or any emissions to either air or water, the review has been based on gathered information about environmental benefits as a result of reduced consumption of fossil fuels. Implementation of the Project would result in improvement of ambient air quality through annual reductions in emissions of CO_2 and NO_x to the amount of 47,800 and 310 tons respectively if natural gas is replaced, and 51,940 and 265 tons respectively if HFO is replaced. In addition, the replacement of HFO would result in an additional reduction of SO_2 of about 1160 tons per year. The reduction of SO_2 and NO_x would result in an improvement of the ambient air quality at the national level, while the reduction of CO_2 is regarded as a global benefit, thereby also making the project eligible for GEF funding. **Annex 4** summarizes the findings of the environmental review. Attached as **Annex 5** is the Bank's Environmental Data Sheet.

2.32 EG has received all routine approvals for construction of the geothermal plant, including the local electricity company and the water and sewage company. EG has also received a formal environmental impact clearance from the Ministry of the Environment. The Ministry of Construction and Urban Development, will issue the permission to start construction.

III. PROJECT IMPLEMENTATION

A. Organization and Management

3.1 The implementing agency for the Project will be Enterprise Geoterma (EG). Until recently, EG was a branch of the Lithuania State Power System (LSPS), in which it constituted a unit entrusted with the promotion of geothermal energy. *The separation of EG from LSPS and its corporatization are conditions for Board Presentation of the Project.* In this respect, EG has tried to promote a geothermal project in the vicinity of Klaipeda (Vidmantai), where two wells were drilled.[1] It has also been active in the preparation of a geothermal atlas of Lithuania.

3.2 EG has a staff of five, and is headed by a General Manager with a solid background in geothermal energy. In order to prepare EG for the Project, technical assistance would be arranged in the form of two advisers who will: (a) help corporatize EG and prepare a corporate business plan; and (b) promote the commercial aspects of geothermal energy development, by *inter alia* elaborating a framework enabling private sector participation in the Klaipeda Geothermal Demonstration Project and drafting a take or pay contract which will secure the revenues underlying the Project.

3.3 [*Description of the Statutes, Board will be inserted here*]

3.4 [*Description of the Business Plan will be inserted here*]

3.5 Interest has been expressed by the private sector in participating in the Project. Should a positive decision to do so be made, EG and its partners might create a joint venture to implement the Project and operate it. One could anticipate that, unless the involvement of the private sector was very substantial, EG would remain the operator of the Project. Private involvement would be a positive development as it will: (a) bring additional risk capital to Lithuania; (b) strengthen EG's management during project implementation and operation; and (c) facilitate the introduction of private capital for future geothermal projects.

3.6 Project Implementation. EG will be responsible for Project implementation. EG will be assisted, as required, by international consultants to support the preparation of technical specifications, bidding documents, tendering, bid evaluation, contract awards, supervision of civil works and equipment installation, and follow-up activities.

3.7 Other specific responsibilities of the EG under supervision as an open joint stock company are the following:

(a) improve and finalize TORs, preparation of short-lists, and technical evaluation of TA proposals received;

(b) preparation of detailed specifications and procurement documents for approved equipment lists, review of bid packages and evaluation of offers received;

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1 This project is held in abeyance as the original heat market (greenhouses) was never established.

B. Project Supervision

3.9 The proposed Project would be supervised by Bank personnel from both headquarters and the Riga and Vilnius offices of the Regional Mission for the Baltic Countries. In addition, representatives of the Danish EPA would also participate in supervision missions. A proposed supervision plan is presented in **Chart 2.**

3.10 Recognizing that the proposed Project would be the first Bank project in Lithuania involving installation of sophisticated mechanical and electrical equipment for transferring geothermal energy to a district heating system, it is anticipated that it would require significant supervision (about 20 sw/year). This supervision would be particularly intensive during the first two years when considerable input would be required for engineering and procurement aspects. In later years, supervision would be reduced to about 15 sw/year.

3.11 A mid-term review would be conducted to evaluate project progress and assess the status of actions to be undertaken to ascertain a successful Project implementation and to strengthen EG's managerial capacity for further developing the geothermal resources of Lithuania. The loan agreement would include provisions which allow the Bank, in consultation with the Borrower, to make adjustments in the details of these items and the schedule for their implementation.

3.12 Given the essential role program monitoring and evaluation play in determining the impact of a given intervention on development objectives, a number of indicators will be used to monitor and evaluate progress during the implementation of the Klaipeda Geothermal Demonstration Project. However, the progress of these indicators would be evaluated in relative, not absolute, terms. During supervision, a selected number of commercial, operational, financial and environmental indicators would be monitored in accordance with Project objectives. These indicators were identified during appraisal, and are described in detail in **Annex 7.**

C. Reports, Accounts and Audits

3.13 EG, would prepare semi-annual progress reports on each project component, estimated and revised costs, schedule, objective, and activity (starting from Loan Effectiveness).

3.14 To monitor the financial performance of EG assurances should be obtained during negotiations that: (a) it will submit not later than October 31 of each year its operating and capital budget, as well as the budget of the Project for Bank approval; (b) it will submit on a semi-annual basis financial progress reports in which the actual results would be compared with the Budgets; and (c) it will appoint independent auditors satisfactory to the Bank to audit its accounts, as well as its Project accounts on an annual basis, and the audit reports will be submitted to the Bank within six months of the end of the fiscal year; the audit reports will contain a separate opinion on compliance with the financial covenants under the Loan.

3.15 *To monitor project implementation, during negotiations, agreement will be sought that EG will submit Progress Reports on a quarterly basis and a Completion Report in accordance with Bank Guidelines.*

IV. FINANCIAL ASPECTS

A. Background

4.1 The executing agency for the project will be Enterprise Geoterma (EG) - until recently a branch of the Lithuania State Power System (LSPS).[1] As a branch of LSPS, EG was not a legal person; separate accounts were produced for EG but these did not provide a complete representation of EG's financial standing. Furthermore, the negotiations leading to the separation of EG from LSPS are expected to take place during the fall of 1995 so that at this juncture the assets and liabilities EG will carry are not known with certainty. As a result, *the submission of an independently audited EG balance sheet, certified by the Financial Directors of EG and LSPS is a condition for presenting the Project to the Board.*

4.2 The heat output resulting from the Project will be purchased by the Klaipeda District Heating Enterprise (KDHE), a branch of LSPS. Financial records of the branches are kept partly at the branch level, and partly at headquarters. Available records do not present a full financial picture, as, for instance: (a) services provided by LSPS headquarters are not charged; (b) branches do not have assets registers; and (c) branches do not have their own capital. As long as the branches are kept within LSPS, and not converted to subsidiaries, the usefulness of the financial data will remain limited.

B. Financial Framework for the Geothermal Sector

4.3 While within LSPS separate accounts were prepared for EG which reflected the revenues and costs of EG as a "profit center." These accounts, however, are of limited use given that they did not reflect fully the value of the services received from LSPS. As a result, once separated, one can presume that the operating expenses of EG will increase.

4.4 Aside from the promotion of the Klaipeda Geothermal Demonstration Project, EG, in recent years, has been active in the provision of engineering services related to geothermal energy, and the imports of mechanical equipment. These activities, together with the implicit support received from LSPS, allowed EG broadly to cover its expenses. In order to anticipate the future financial performance of EG, it has been requested to prepare a business plan covering the period 1995-2000. *The submission of a business plan is a condition of negotiations for the proposed Project.*

4.5 Subject to the reviews of EG's opening balance sheet (**para. 4.1**), and of EG's business plan (**para. 4.4**), and the possible addition of private investors to the venture (**para. 3.5**), assurances should be obtained during negotiations that: *(a) the Government will provide an annual grant to EG during project implementation covering all of its direct operating expenses; and (b) EG will not enter into new geothermal ventures, and/or incur new long term debt without the prior agreement of the Bank.*

4.6 Under the assumptions that: (a) in the coming years, EG will be only concerned with the implementation of the proposed Project (to be fully-financed by external sources); (b) EG will not undertake new ventures and/or incur borrowings beyond those contemplated for the Project; (c) the Project will be built within the estimated costs and time frame, and yield the anticipated benefits (530 TJ

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1 The separation of EG from LSPS is a condition of negotiations of the proposed Project.

Table 4.1: Lithuania State Power System 1994 Income Statements (US $ million)[a]

	Electricity	Heat	Consolidated
Sales Volume (TWh)	7.6		
Heat (MGcal)		12.7	
Average Revenue per Unit	US 2.3¢ per Kwh	US 10.7¢ Mcal	
Revenues	172.2	135.8	307.9
Add: Heat Subsidies		21.5	21.5
Expenses			
Fuel	22.1	149.8	171.8
Salaries and Wages	19.5	15.7	35.2
O & M	28.0	47.4	75.5
Ignalina Purchases	93.5	0.0	93.5
Other	1.1	1.0	2.1
Depreciation	12.6	7.5	20.1
	176.8	221.4	398.2
Less Interest	8.9	0.1	9.0
Net Income	(13.4)	(64.3)	(77.7)

[a]At the average exchange rate of 4.00 Litas/US $

4.9 With respect to KDHE, its accounts are partly kept in the branch and partly at headquarters, and do not provide for a full disclosure of its financial standing. Nevertheless, one can assess that in recent years it operated at a loss. Data for 1993-94 are illustrative in this respect (**Table 4.2**). The significant increase in the volume of sales in 1994 is explained by the fact that in 1993 there were disruptions in service on account of fuel shortages. One can see that the increase in revenues (due also to the large increase in residential tariffs) was not sufficient to offset the increase in expenses. The losses were made up by transfers from LSPS (which in essence paid for the fuel oil and natural gas consumed).

4.10 KDHE operates with limited financial autonomy. All its revenues, barring payments for local costs (in essence salaries) are transferred to LSPS. It is facing particular difficulties in timely bill collection, and accounts receivable are now equivalent to 124 days of sales. It should be noted in this respect that individual connections are not metered, and thus cannot be disconnected. In extreme cases, KDHE disconnects power supplies to delinquent heat customers.

[6](...continued)
arising from inadequacy in previous tariffs from future budgetary allocations. The Bank is reviewing these issues and will also review the audit report of LSPS's 1994 accounts (due September 1995). This footnote will be updated when agreement on the Action Plan has been reached and the ongoing audit have been received.

V. PROJECT JUSTIFICATION AND RISKS

5.1 The proposed geothermal demonstration project is aimed at: (a) developing an unutilized indigenous energy resource which would mitigate the emission of green-house gases (GHG); and (b) demonstrating that the resource can be used cost-effectively to partially replace fossil fuels in the district heating (DH) systems in Lithuania. Development of indigenous geothermal resources is an integral part of Lithuania's Energy Development Program as it would reduce the country's dependence on energy imports (over 98% of primary energy is imported) and also mitigate environmentally damaging emissions. In the base case, it is expected that 530 Terajoules (TJ) of geothermal energy can be reliably extracted and delivered to the Klaipeda DH system. Additional amounts of heat could be extracted, without additional investment or operating costs in the geothermal plant, if: (a) the temperature in the geothermal aquifer is at the higher end of the range expected; and (b) the DH system is itself rehabilitated and modified to improve its operating efficiency, thereby lowering the temperature regime in the network and increasing the utilization level of geothermal energy. Under optimal conditions the annual energy yield could reach 650 TJ.

5.2 The replicability of the proposed demonstration plant, from economic, financial and technical points of view, can be fully assessed only after the demonstration plant is operational. However, it is expected that a subsequent plant could be built at a lower capital cost by maximizing local engineering and other technical skills developed through transfer of technology under the demonstration project. The economic analysis has been done for the demonstration plant and for a subsequent plant built at a lower capital cost, assuming the base case scenario of 530 TJ/year heat extraction. Additional scenarios, reflecting both down-side risks and the possible additional benefits, have been incorporated into the sensitivity analysis (**Tables 5.5 and 5.6**).

5.3 The basic conclusions derived from the economic analysis are:

- Demonstration Plant: Without taking into account environmental benefits, the proposed demonstration plant is not economically viable. However, grants from the GEF and the Danish EPA, aimed at promoting GHG mitigating technologies, would allow the project to meet its recurring costs and debt-service obligations under the expected circumstances. In order to yield a real economic rate of return (ERR) of 10%, energy extraction should be raised to 780 TJ/year or the price of the fuel substituted (mazut) would have to be 50% higher than the $100/ton level anticipated. It is estimated that this extraction could be achieved under the "best case" technical scenario under which: (a) geothermal resources were at 48 °C instead of 42 °C assumed in the base case (to be confirmed through the demonstration plant); and (b) priority investments were undertaken to improve the efficiency of the district heating systems to which geothermal heat would be supplied (this is to be implemented under a separate project for which Bank support has been sought by the Government of Lithuania).

- Successor Plant: Based on expected reductions in capital costs and stable fossil fuel prices (US $100/ton of mazut), any successor geothermal plant would need to supply at least 660 TJ/year in order to yield an ERR of 10%. This is within the range of technical possibilities (**Table 5.5**). Modifications to the DH networks, expected to be undertaken in the near future, by themselves are expected to have an ERR above 20%, and would allow this level of geothermal heat extraction. Alternatively, mazut prices would need to be 25% higher than the level anticipated to yield an ERR of 10%. If these heat extraction or fossil fuel price thresholds were not met, specific policy interventions such as environmental taxes on fossil fuels, or direct production

would employ a greater proportion of local engineering and technical inputs based on the transfer of technology achieved through the demonstration project. Investment costs (including physical contingencies) are estimated at US $16.3 million for the demonstration project and US $13.0 million for a subsequent plant. Base costs include engineering and technical assistance, drilling of production and re-injection wells, and plant construction. Past exploration costs are treated as "sunk" costs; additional exploration costs are not expected as the resources are well-documented.

5.7 Operating and Maintenance (O&M) Costs. Costs were supplied by consultants and consist mainly of electricity (for pumping and circulation), maintenance, and salaries. The economic price of electricity has been assumed at US cents 4.0/kWh (this would be higher if nuclear plant retirement costs were included). Annual O&M costs are estimated at about US $0.51 million for the first 2 years during which international TA is required, and US $0.45 million after that.

5.8 Capital and O&M costs per unit of geothermal heat utilized are sensitive to the level of heat extracted from the geothermal water. These costs are compared in **Table 5.2**.

Table 5.2: Cost Comparison - Mazut vs Geothermal Heat

	Cap. Cost	Geothermal, $/GJ			Mazut, $/GJ[b]	
Scenario	MM$	Cap[a]	O&M	Total	w/o Env	w/Env
Demo Only (530 TJ/Y)	16.3	3.40	0.85	4.25	3.08	4.46
Post-Demo (530 TJ/Y)	13.0	2.70	0.85	3.55	3.08	4.46

a Amortized over 25 years at a discount rate of 10%.
b Without and with national environmental costs and a mazut price of US $100/ton.

5.9 Because of the high capital costs per unit of heat extracted (**Table 5.2**), the economic viability of geothermal energy in Lithuania is sensitive to the quantity of heat extracted and the price at which it is sold. As the sales price is linked to the prevailing market price of mazut (or natural gas). Reference prices (excluding environmental costs) are presented in **Table 5.3** for comparison with the costs of geothermal heat production shown in **Table 5.2**.

Table 5.3: Heating Fuel Reference Prices
(excluding environmental costs)

Natural Gas based Heat		Mazut (3.5% S) based Heat	
Price, $/tcm	$/GJ	Price, $/ton	$/GJ
90	3.06	70	2.16
100	3.40	80	2.46
110	3.74	90	2.77
120	4.08	100	3.08
130	4.42	110	3.39

Reference heat-equivalent prices include a boiler efficiency and handling cost factor of 85% for natural gas and 80% for mazut.

C. Economic Rate of Return

5.10 The base case economic rates of return, based on the annual replacement of 530 TJ of mazut by geothermal energy, are presented in **Table 5.4** and the conclusions are presented in **para. 5.16**. The detailed analysis is presented in **Annex 1.4**.

5.15 Sensitivity Analysis: Base case benefits are conservative with respect to the amount of heat that can be extracted from the demonstration and successor plants. Aquifer temperatures are assumed to be at the low end of the range expected, and larger amounts of geothermal water could be obtained. Environmental benefits have been excluded from the sensitivity analysis but, if included, would substantially increase the ERR as seen in Table 5.5. The economic sensitivity of the proposed Project, and any successor plant, has been assessed conservatively by: (a) determining the values for geothermal

Table 5.5: Variation of ERR with Changes in Aquifer and Network Return Temperatures

Geothermal Plants	Network Return Temp. °C	Indoor Temp. °C	Aquifer Temp. Range 42-48°C	Yield TJ/year	Economic Rate of Return (%)		
					w/o Env. Benefit	Nat'l. Env. Benefit	Global Env. Benefit
Demonstration Plant							
Investment US $16.3 million (excl. price contingencies)							
Basic Design (Base Case)	40-50	18	42	530	4.7	9.8	11.7
			45	590	6.2	11.9	14
			48	650	7.5	13.4	15.6
Current Situation	35-55	15	42	570	5.8	11.4	13.5
			45	630	7.1	12.9	15.1
			48	690	8.3	14.4	16.7
MNCC Implemented	30-35	18	42	650	7.5	13.4	15.6
			45	710	8.6	14.8	17.1
			48	710	9.8	16.2	18.6
Subsequent Plant							
Investment US $13 Million (excl. price contingencies)							
Basic Design	40-50	18	42	530	6.8	12.5	14.8
			45	590	8.5	14.9	17.4
			48	650	9.9	16.7	19.2
Current Situation	35-55	15	42	570	8	14.4	16.7
			45	630	9.5	16.1	18.6
			48	690	10.8	17.8	20.4
MNCC implemented	30-35	18	42	650	9.9	16.7	19.2
			45	710	11.3	18.3	21.6
			48	770	12.5	19.9	22.7

expected network modifications. Its achievement could be better defined through the demonstration plant and further facilitated through efficiency-enhancing network modifications. Under the best scenario expected, geothermal heat production would be about 770 TJ/year. The successor plant is sensitive to changes in capital costs and the prices of substitute fossil fuels. A reduction in capital costs by 25% (to US $9.8 million excluding price contingencies) or an increase in substitute fuel (mazut) prices to US $125/ton (in constant 1995 US $) would be needed to yield a 10% ERR. These switching values are not expected to be reached.

5.17 Impact on Energy Imports. Lithuania's low temperature geothermal resources would be utilized mainly to complement centralized district heating systems by substituting part of the base load supply presently provided by fossil fuels. It is estimated that about 10% of this heat supply in about seven cities could be substituted by geothermal energy. Based on a total production of 51,014 TJ of hot water from centralized heat-only boilers in 1994, geothermal energy could conceivably replace 5,000 TJ (about 120,000 toe) of imported fossil fuels, or about 2% of total 1994 fossil fuel imports.

5.18 Economic Performance Criteria. Specific parameters which will be monitored during project implementation because of their potential impact on the economic viability of the proposed Project (and any subsequent geothermal plants) will include: (a) capital and operating costs; (b) sales price of geothermal energy; (c) quantity of geothermal heat extracted and sold; and (iv) operating conditions of the DH system needed to optimize the use of geothermal energy.

ANNEX 1

CALCULATION OF INCREMENTAL COST

AS BASIS FOR GEF GRANT

LITHUANIA

KLAIPEDA GEOTHERMAL DEMONSTRATION PROJECT

CALCULATION OF THE INCREMENTAL COST TO BE COVERED BY GEF

1. The fundamental basis for estimating the incremental cost is to compare the proposed project with an alternative way for producing the same amount of energy. At an early stage of project preparation the use of other energy resources such as peat, wood chips, coal, gas, and low sulfur oil was compared with the energy (500 TJ) produced from the geothermal water. To also include the issue of sustainability the study included a geothermal plant implemented with Lithuanian planning based on the Technical assistance provided under the project. The result of the study was as follows:

Energy Production Alternative	Investment Cost US $M	Annual O/M Cost US $M	ERR excl. Env. Benefits
HFO (1% sulfur)	0.7	1.68-1.71	14.4
Coal	2.3	1.51-1.55	11.0
Natural Gas	0.6	1.99-2.00	<< 0
Peat	5.6	1.32-1.37	6.3
Wood Chips	7.8	2.43-2.47	<< 0
Geothermal Demo	17.0	0.64-0.78	3.4
Geothermal Sub-sequent	9.6	0.44-0.60	15.2

2. The purpose of the study was not to look into alternative fuels in detail, and therefore the comparison was based on only necessary investments in the existing boiler house, where the geothermal plant will be built, to accommodate other types of fuel. The revenues of heat produced by the different energy sources was based on US $110/ton. The results were only used to justify the subsequent project preparation, because the subsequent plants do have an advantage compared to all the other alternatives.

3. Among the energy sources listed above only peat, wood chips, and geothermal water are indigenous. Peat is not renewable, and furthermore, the sparse peat resources has been allocated for the agricultural sector and should not be regarded as readily available. The amounts of wood chips are limited in Lithuania, and are mainly available in the Eastern part of the country, which results in quite costly transportation costs. Furthermore, to feed the boiler in Klaipeda with wood chips to produce the 500 TJ would require that all Lithuanian forests be included in the thinning operations.

Amount of fuels replaced by geothermal energy

4. The heat demand for Klaipeda is currently 5600 Terajoules (TJ), and is expected to increase to about 7,500 TJ by year 2000. The heat is delivered by the Klaipeda District Heating Enterprise and generated by the use of mazut (Russian heavy fuel oil with a sulfur content of 3.5%), and natural gas.

Assumptions for calculation of IRR without environmental benefits

1) Project lifetime : 25 years
2) Investment cost : US $15.6 million
3) Recurrent cost : US $0.71-0.84 million
4) Revenues are equal to projected cost for fuel saved
5) Recurrent cost includes replacement of certain equipment, to maintain the investments in full operation

10. The IRR of the Geothermal Demonstration Plant is 4.2% based on an investment of US $15.6 million and a reduction of fuels in correspondence with the actual fuel mix. To achieve an IRR of 10% the investment has to be reduced to US $8.6 million.

11. Based on the calculations of IRR without environmental benefits, the increment necessary to make the demonstration plant defendable as an investment reducing the global warming effects of carbon dioxide, is estimated at US $6.9 million. The reduced emission of CO_2 during the lifetime of the project is, as mentioned in paragraph 7, 1,196 million tons. The cost effectiveness of emissions reduction is calculated at cost of US $5.85/ton CO_2 or US $21.45/ton C.

Sustainability

12. The future development of the geothermal resources is dependent on the possibility of implementing similar plants at a lower cost, as it cannot be expected that grant support would be available after the implementation of the demonstration plant.

13. During the preparation of the project it becomes clear that a reduced temperature regime in the district heating network would increase the energy extraction from the geothermal water without any increase in investment and operational costs. In order to maximize utility, the overall World Bank Project includes another component which will finance the modification of network connections (sub-stations).

14. The Modification of Network Connections Component, MNCC, will finance exchange of all sub-stations in the network at a cost of US $8 million, and give an IRR of over 20%. In view of the very high IRR, it must be anticipated that this kind of measures will be implemented in all district heating systems. The resulting reduced temperature regime will enable an increased extraction of energy from the geothermal water with 24%, which means that the amount of energy in future installations will be 620 TJ instead of 500 TJ.

15. The Lithuanian Design Institute has calculated the investment for subsequent plants build entirely in a Lithuanian concept, after having received the training included in this project, at US $9.6 million. This cost will be re-examined in the very near future. However, assuming that the investment may increase by 25% to US $12 million, the investment based on an extraction of 620 TJ is still acceptable. The IRR for investments of US $9.6 million and US $12.0 million is 13.0% and 10.2% respectively.

ANNEX 2

TECHNICAL ASSISTANCE PROVIDED UNDER THE DANISH GRANT

Annex 2

Technical Assistance Provided Under the Danish Grant

Background

1. The Danish Environmental Protection Agency has offered parallel financial support for the implementation of the Klaipeda Geothermal Demonstration Project up to US $2.5 million. The Danish support has been referred to as the technical assistance component (TAC) under the Klaipeda Geothermal Demonstration Project, comprising four major fields of activity. These are:

a) Project steering, coordination, and supervision of the implementation and start-up of the demonstration plant;

b) Engineering and specifications with regard to the aquifer development and surface demonstration plant;

c) Procurement and contracting with regard to required goods and services; and

d) Training of Lithuanian State Power System and Enterprise Geoterma staff for the purpose of sustainable operation and maintenance of the demonstration plant.

An important goal under the Danish Project support is to provide the TAC in a manner which allows continued geothermal development in Lithuania, both in Klaipeda as well as other urban areas in western Lithuania. This requires detailed documentation and thorough reporting procedures in step with plant development.

Organization of Danish Assistance

2. Dansk Olie & Naturgas A/S (DONG) will be project manager for the Danish consulting group providing assistance for the planning, implementation, and start-up of the Klaipeda Geothermal Demonstration Plant. DONG will be assisted by two sub-contracted companies, Petroleum Geology Investigators and Houe & Olsen (see **Box 1**).

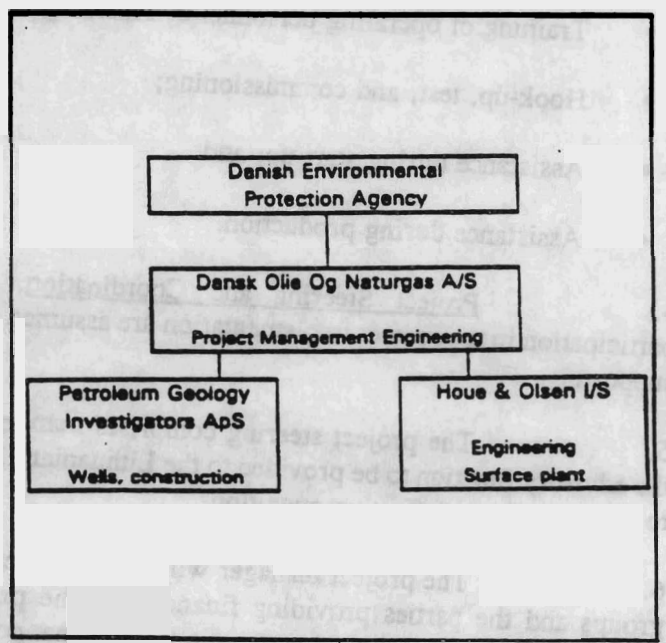


Figure 1

Scope of Work

3. The implementation and start-up phase of the Klaipeda Geothermal Development Plant is expected to take three years subsequent to the Bank's approval of the Project. The Danish project support consists of approximately 25,600 man-hours

with regard to the drilling, testing, and completion of the geothermal wells as well as for the construction and installation activities required for the implementation of the geothermal production and injection plants.

8. Reporting. Adequate documentation with regard to the progress of the project is considered a basic requirement for proper steering and coordination of the project. It is of particular importance for project sustainability and continued geothermal development elsewhere in Lithuania. IN addition to routinely prepared and issued monthly progress reports, a number of completion reports (well completion, construction, and installation) as well as a final project implementation report are required. Based on a manpower requirement of 70 man-hours per month for documentation/reporting activities, the total project support for this component is assessed at 2,000 man-hours.

Table 1: Danish Project Support, Manpower (man-hours) Allocation

	1995	1996	1997	1998	Total
Steering & Coordination	500	1700	1800	1600	5600
Reporting	100	700	700	500	2000
Supervision	0	1800	2100	1700	5600
Engineering	700	4200	3400	500	8800
Procurement	300	800	700	200	2000
Training & Education	0	0	600	1000	1600
Total	1600	9200	9300	5500	25600

9. The manpower requirement under the Danish financial support for the implementation of the Klaipeda Geothermal Demonstration Project is summarized in Table 1, allocated to work category and year of activity.

10. Supervision QA/QC. Based on the Lithuanian estimate with regard to the implementation of the geothermal wells, a total manpower requirement for full-time on-site supervision is estimated at 1600 man-hours. The on-site supervision with regard to construction and installation of the geothermal plants is planned to extend over approximately 18 months and require 4,000 man-hours of work, including the installation and tuning of the absorption heat pumps. The engineering department in DONG is ISO 90001 certified and relevant QA/QC procedures will be applied to the project.

11. Engineering. The detailed engineering and specifications present the most time consuming activity under the Danish project support and comprise 8,000 man-hours that can be divided into two parts:

a) The preparation of the drilling, testing, and completion programs for the two geothermal production wells, the single injection well, and the specifications required for the procurement of pertinent equipment, services, and consumables. The drilling operations are currently planned

gained through the Klaipeda Geothermal Demonstration Project, together with the training and education planned for the Project, is expected to make it possible for Enterprise Geoterma to:

a) Erect the Klaipeda Geothermal Demonstration Plant successfully;

b) Avoid start-up problems;

c) Avoid operation problems such as sand production, pump break downs, corrosion, loss of injectivity, and down time;

d) Obtain an optimized operation of the plant with a maximized geothermal heat production;

e) Plan, design, erect, and operate new geothermal plants with higher Lithuanian content and participation; and

f) Eventually participate in geothermal projects outside Lithuania.

ANNEX 3

DESCRIPTION OF THE GEOTHERMAL RESOURCES

AND

THE GEOTHERMAL LOOP

LITHUANIA

KLAIPEDA GEOTHERMAL DEMONSTRATION PROJECT

DESCRIPTION OF GEOTHERMAL RESOURCES AND THE GEOTHERMAL LOOP

GENERAL

Geothermal energy is natural heat, stored in mobile fluids present in geological strata, at temperature above the annual average values. Low temperature geothermal energy, below 100 degree Celsius '°C', is widespread all over the world and is exploited for district heating, agricultural and industrial use by extracting the heat from the subsurface fluids. The development of such energy is generally connected to several factors: geologic and thermal conditions, climate, industrial and technological development etc.

Low temperature geothermal energy technology is well proven and is operational in several European countries: Iceland; Sweden; Denmark; France; Italy; CIS etc. for a variety of uses but essentially district heating and agriculture. When used for residential or district heating systems, the geothermal source substitute basically for the fuel in the conventional system. Heat is generally extracted from the geothermal water by heat exchangers, but higher efficiency heat pumps become essential for low temperature source to allow recovery of sufficient amount of heat from the geothermal fluid. Development of low temperature geothermal projects is strictly dependent on the proximity of end-users, because long distance transportation is not economical as heat losses and insulation costs would render the project uneconomical. When converting a heating system to geothermal, the additional costs needed are represented by drilling of production and disposal wells to re-inject spent water, heat exchangers and pumps, and modifications to the distribution net work which are often necessary.

The proposed project consists of a pilot "demonstration" plant representing the first phase in the development of relatively extensive geothermal resources for space heating in Klaipeda and other urban areas in Lithuania. It represents an important pilot phase in the more general Power and Heating Rehabilitation Project with an objective to: establish the feasibility and economic viability of exploiting geothermal resources for district heating; reduce the dependence on imported fossil fuels for power generation and heating; and contribute to the mitigation of the environmental impact of carbon, sulfur and nitrogen oxides emissions.

RESOURCE ASSESSMENT

In Lithuania, geothermal potential is confined to the Cambrian and Lower Devonian which underlie most of the Lithuanian and Latvian territories, at depth ranging from 2000 to 900 meters. In the Klaipeda area, the above aquifers are encountered at depth of 2000 and 1200 meters respectively. The lower Devonian has far superior supply potential and would be the main resource

The aquifer water is neutral and contains about 96 gram per liter of salt (sea water contains 35 gram per liter), mainly of sodium chloride. The presence of hydrogen sulfide (H_2S) has never been detected while drilling into the geothermal zone or from water samples obtained from the Devonian aquifers in wells drilled in Lithuania. The average composition of the geothermal water in the Klaipeda area is given in the table below:

Aquifer Water Composition - Devonian Aquifer
Klaipeda Area (Well Vilkyciai-3)

Compound	*mgr/liter*
Bicarbonate: $HCO3^-$	81
Chlorine: Cl^-	60350
Sulfate: $SO4^-$	1115
Bromine: Br-	368
Sodium: Na^+	24100
Potassium: K^+	645
Calcium: Ca^{++}	6750
Magnesium: Mg^{++}	2170
Strontium: Sr^{++}	197
Iron: Fe^{++}	1
Total Mineralization	95777
pH	7.1

PROJECT DESCRIPTION

The project consists of recovering heat from hot water produced from the Lower Devonian aquifer sands. The water is then circulated through a closed loop in a doublet, production-injection well, configuration comprising heat absorption pumps and heat exchangers to extract a fraction of the heat carried by the geothermal water. The heat recovered is then injected into the existing district heating network in Klaipeda. In essence, the geothermal loop replaces part of the boiler function in the conventional district heating system.

The project comprises two main components: development and construction of the geothermal loop mentioned above, which entails the drilling of three wells and the construction of heat recovery facilities; and training and technical assistance to guarantee a smooth and timely project implementation, and technical transfer to facilitate the future development of the Lithuanian geothermal resources. The loop is designed based on the same concept used at the Thisted geothermal plant in Denmark which is now in operation since 1984. This design has been chosen because of the close similarities of aquifer parameters (petrophysical properties, depth and water temperature) at Klaipeda and Thisted.

ANNEX 4

ENVIRONMENTAL REVIEW

ANNEX 4

Lithuania

Klaipeda Geothermal Demonstration Project

Environmental Review

A. Overview

1. Introduction. Preparation of the proposed Project has included an environmental review consistent with the applicable procedures of the GOL and the provisions of World Bank Operational Directive 4.01, "Environmental Assessment" for a category "B" project. As the Project would not generate waste or any emissions to either air or water, the review has been based on information about environmental benefits as a result of reduced consumption of fossil fuels.

2. Consultation process. The environmental review for the proposed project was prepared in coordination with Enterprise Geoterma (EG). EG will obtain the routine approvals for construction of the geothermal plant, including approvals from the local electricity company and the water and sewage company. Geoterma is in the process of requesting a formal environmental impact clearance. Upon completion, the Ministry of the Environment will then check whether impacts are correctly assessed, and whether mitigation measures are adequate. Finally, the Ministry of Construction and Urbanistics will issue the permission to start construction once all approvals are in place.

B. Current Environmental Conditions in Klaipeda[1]

3. Environmental quality problems are not as severe in Lithuania as those encountered in other countries of the FSU and eastern Europe. The decline in economic activity over the past five years has corresponded with a drop in industrial activity and energy use, resulting in an overall decline in pollution. However, in smaller cities dominated by a single large manufacturing facility, emissions from these plants are still high enough to result in adverse health impacts. This is, for example, true of Jonava, where a significantly higher incidence of children's respiratory disease and eye disease has been reported. [2]

4. However, it appears that the concentration of most pollutants has dropped, with the exception of NO_2, which has risen in almost all cities since 1991. This can be attributed to an increase in vehicular emissions, which is estimated to cause 70% of air pollution in cities (Lithuania Ministry of Environment).

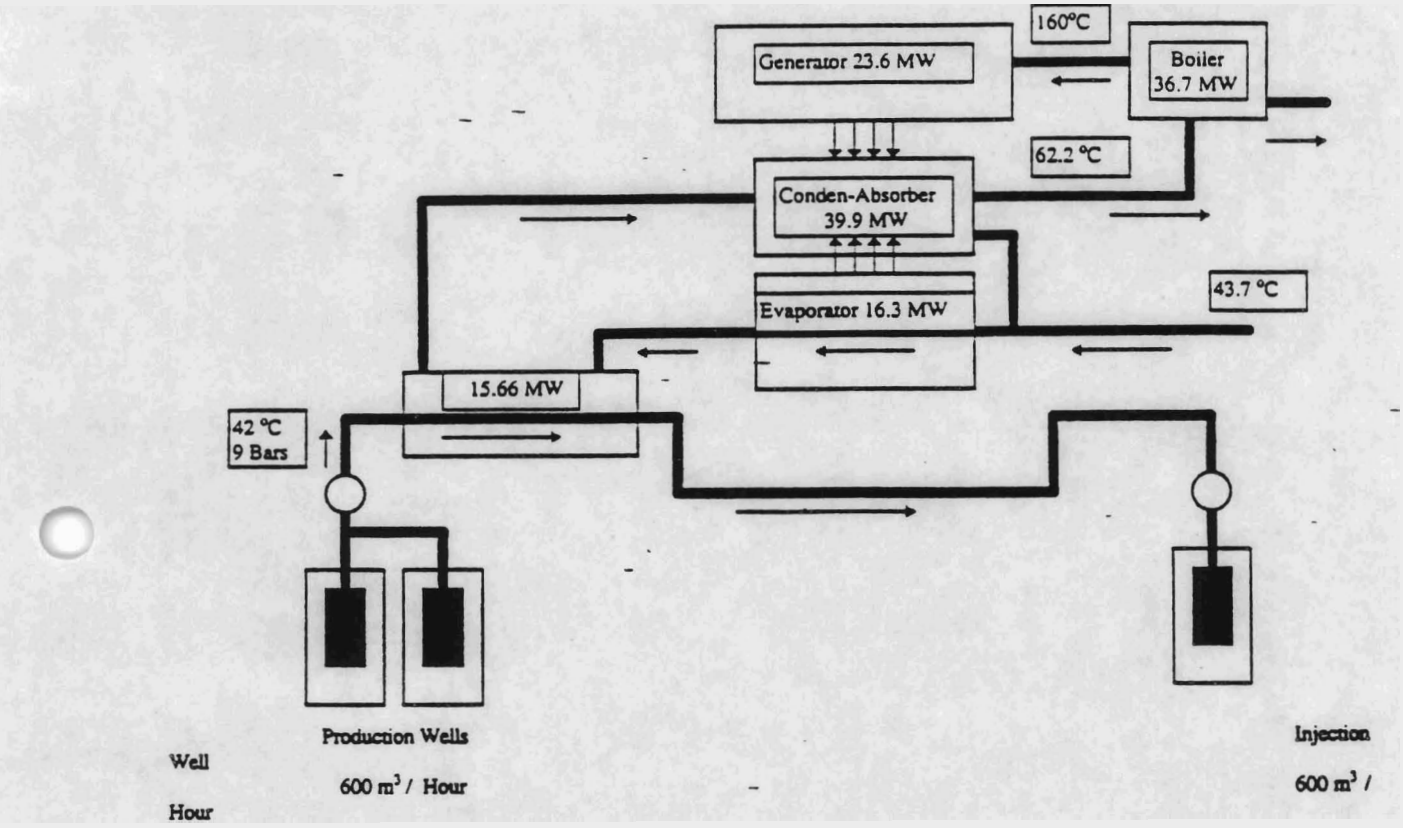
5. Klaipeda's main pollution problem in previous years was caused by an industrial plant that produced batteries. This has been temporarily closed down, due to limitations placed on industrial output. Today whatever air pollution problems exist are principally caused by traffic congestion in the

---

1 Water pollution is not discussed, as it is irrelevant to the use of geothermal energy in this case.

2 *Environmental Action Programme (EAP) for Central and Eastern Europe*, Environment Division, Technical Department, Europe and Central Asia , Middle East and North Africa Region, The World Bank, Washington, D.C., March 31, 1994. Also *Air and Water Quality Permitting in Lithuania*, W. Harrington, Resources for the Future, Washington, D.C., September 1993.

Klaipeda Project: Main Components and Layout of Geothermal Loop
Winter Conditions



10. Regulations. Every industrial enterprise, utility, and heating company must request an emission permit, for which there is no charge. The permit is issued by the regional Department of the Environment. If the permitted amount of emissions is exceeded, in terms of tons/year, a fine is imposed (collection rates are unavailable). The fines differ according to substance, and are indexed to inflation four times a year. Permitted concentrations of pollutants are determined according to the *State Control Regulations on Stationary Sources of Air Pollution*, issued by the Ministry of Environment in 1992, in accordance with Order 97. New HPC standards will be issued on January 1, 1996, and will be applied to all new and rehabilitated boilers. In cases where boilers use two or more different kinds of fuel, standards for complex pollutant emissions will be higher.

C. Project Description

11. The proposed Project will be developed as an environmental/energy management project for the city of Klaipeda. The Project has two components:

(i) Technical Assistance and Training Component:

- design of the geothermal loop including all necessary equipment for extracting the heat from the geothermal water and transferring it to the district heating system;
- preparation of detailed drilling, testing and completion programs;
- management support to the Project implementation for Enterprise Geoterma, including support to LSPS/TENA in the preparation of tender documents;
- training of Lithuanian staff and management in operation of the geothermal plant in Thisted, Denmark to maximize the transfer of technology; and
- supervision of the implementation of the project including installation of the geothermal loop as well as underground work.

(ii) Investment Component:

- establishment of two production wells and one injection well;
- above ground facilities including building and necessary equipment such as absorption heat pumps, heat exchanger, and auxiliary equipment for control and regulation of the plant and the heat transfer to the district heating system; and
- piping between production wells and geothermal plant, as well as piping from the geothermal plant to the injection well, and piping between the geothermal plant and the district heating network.

European Union will facilitate Lithuania's adjustment to the added costs of such a tax, were Lithuania to join the EU.

16. Both from the perspectives of limiting health damage, and from assumed public willingness to comply with future environmental policy, the proposed geothermal project would have beneficial local results. In order to fully assess the benefits in reduced health damage, data for PM_{10}, and information on health and labor costs is necessary. However, it is clear that given high short term concentrations of sulfur dioxide, the reduction of sulfur dioxide emissions (in the case of mazut replacement) could only be benign. Given the tighter standards to be enforced in 1996, and a possible stricter enforcement of the prohibition of the use of mazut with a Sulfur content greater than 2.5%, the use of geothermal energy would make it easier for KDHE to meet standards.

E. Proposed Mitigation Actions

17. Protection of drinking water zones. The consultants have estimated the salinity of the geothermal water in Klaipeda to be 8.8% by weight. Therefore, it is important that the water does not flood farm land or enter groundwater. The use of a closed loop system will avoid such leakages. Geothermal water which is used to clean up the pipe system prior to re-injection will lead to the sea through the sewer system. Drinking water zones will be protected by a cement casing. Basins and pits on the well site will be sealed off, and measures will be taken to avoid residue spills during testing and production. Solid wastes from the drilling operation will be deposited in suitable controlled landfills.

18. Blow out prevention. The likelihood of gas or oil presence in the Devonian aquifer zone is considered very small. Nevertheless, the casing and cementing programs are designed to resist a blow-out from the Devonian aquifer.

19. Prevention of gas release. If necessary, measures will be taken to prevent gases from being released from geothermal water in the sewer. Water destined for the sewer will first be sprayed into a basin in which it slowly runs towards the inlet pipe of the sewer system, in order to release combustible gases, if present. The absorption heat pump does not utilize CFC gas, but a LiBr-water solution, and therefore does not lead to gas leakage to the atmosphere.

F. Environmental Monitoring and Institutional Issues

20. Discussions have been held between the consultants and the Lithuanian Geological Survey, the Lithuanian Energy Agency and the Ministry of the Environment. The Geological Survey expressed its support for the project, and offered assistance as required. The Survey provides government supervision with regard to the exploitation of Lithuanian underground resources. Pending the receipt of an orderly drilling proposal, the Survey will be able to provide clearance within a month. The Ministry of the Environment provides government supervision with regard to an environmentally acceptable drilling operation. The Ministry has expressed concern that installation of the wellhead be adequately performed. It has also stressed that measures be taken to prevent gas entering the sewage system. These concerns have been addressed, and follow-up will be closely monitored.

ANNEX 4

ENVIRONMENTAL REVIEW

ANNEX 4

Lithuania

Klaipeda Geothermal Demonstration Project

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ANNEX 5

ENVIRONMENTAL DATA SHEET

ENVIRONMENTAL DATA SHEET FOR PROJECTS
in the IBRD/IDA Lending Program

Country:	LITHUANIA	Project ID No:	36011
Project Name:	Geothermal Demonst.	Total Project Cost:	US$18.0m
Appraisal Date:	March, 1995		
Board Date:	October, 1995	**Task Manager:**	Anders Halldin
Managing Division:	EC4NR	Sector:	Environment
Lending Instruments:	SIL	Status:	Standby
Date (est) for receipt of EA by Bank:			
EA Category (A/B/C):	B	Date Assigned:	August 1, 1994

Date Sheet Prepared/Updated ***June 8, 1995***
(Please do not leave any items blank: use "N/A" or "To be developed" when appropriate)

Major Project Components: (presents description of project components)

(a)Demonstration of use of geothermal energy as an indigenous renewable energy resource to replace imported fossil fuel for heat generation to Klaipeda District Heating System, and to reduce emission of GHG and SO_2.

Major Environmental Issues: (describes major environmental issues identified or suspected in project)

The project has zero emissions to air and water, and does not generate any hazardous waste. Potential for air and water emissions will be examined during the environmental analysis.

Other Environmental Issues: (describes environmental issues of lesser scope associated with project)

Disposal of residues from drilling operations in connection with project implementation. After implementation no waste will be generated.

Proposed Actions: (describes actions proposed to mitigate environmental issues described in project)

Residues from drilling operation would be disposed of at a controlled landfill acceptable to the Regional Environmental Authority.

Justification/Rationale for Environmental Category: (reasons for environmental category selected & explanation of any changes from initial classification)

The residue from drilling operations during project implementation need to be disposed of at a controlled landfill.

Status of Category A Environmental Assessment: (presents EA start-up date, EA first draft, and current status)

N/A

Remarks: (gives status of any other environmental studies, lists local groups and local NGOs consulted, tells whether borrower has given permission to release EA, etc)

N/A

Signed by:	**Signed by:**
Geoffrey Fox, Chief, EC4NR	Seth (EMTEN), Regional Environment Division Chief
	June 9, 1995

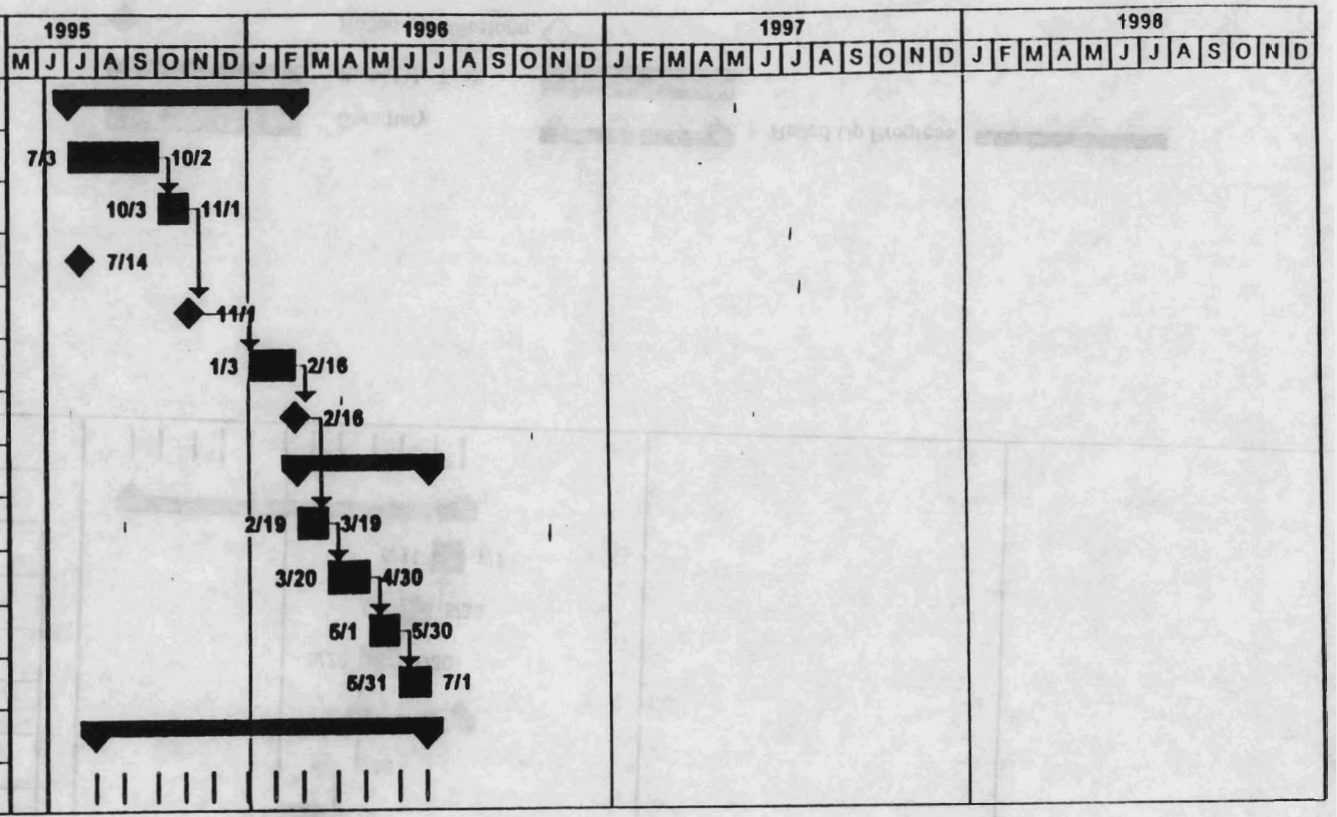
ANNEX 6

DETAILED IMPLEMENTATION SCHEDULES

Appendix 1 - Table A

Lithuania: Klaipeda Geothermal Demonstration Project
Implementation Schedule: Drilling Operation

ID	Task Name
1	Preparation
2	Develop drilling program
3	Develop tender documents
4	Procurement notice in development business
5	Submit tender documents
6	Evaluate bids and negotiate
7	Contract signing
8	Implementation
9	Establishment
10	Drill production well 1
11	Drill production well 2
12	Drill injection well
13	Monitoring
14	Monthly progress reports



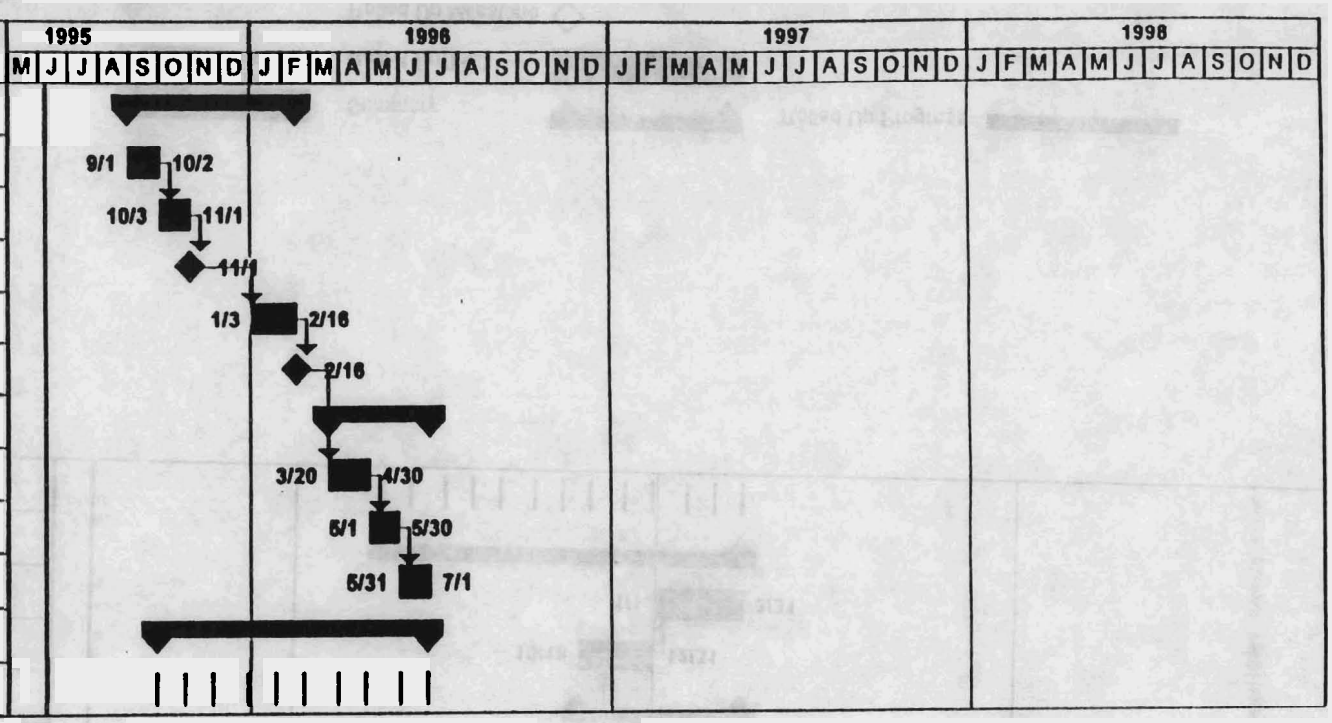
Klaipeda Geothermal Demonstration
Start Date: 7/3/95
Task Manager: Anders Halldin

Task
Progress
Milestone
Summary
Rolled Up Task
Rolled Up Milestone
Rolled Up Progress

Appendix 1 - Table C

Lithuania: Klaipeda Geothermal Demonstration Project
Implementation Schedule: Control & Evaluation of Drilling Operations

ID	Task Name
1	Preparation
2	Develop terms of reference
3	Shortlist and prepare tender documents
4	Submit tender documents
5	Evaluate bids and negotiate
6	Contract signing
7	Implementation
8	Control of production well 1
9	Control of production well 2
10	Control of injection well
11	Monitoring
12	Monthly Progress Reports



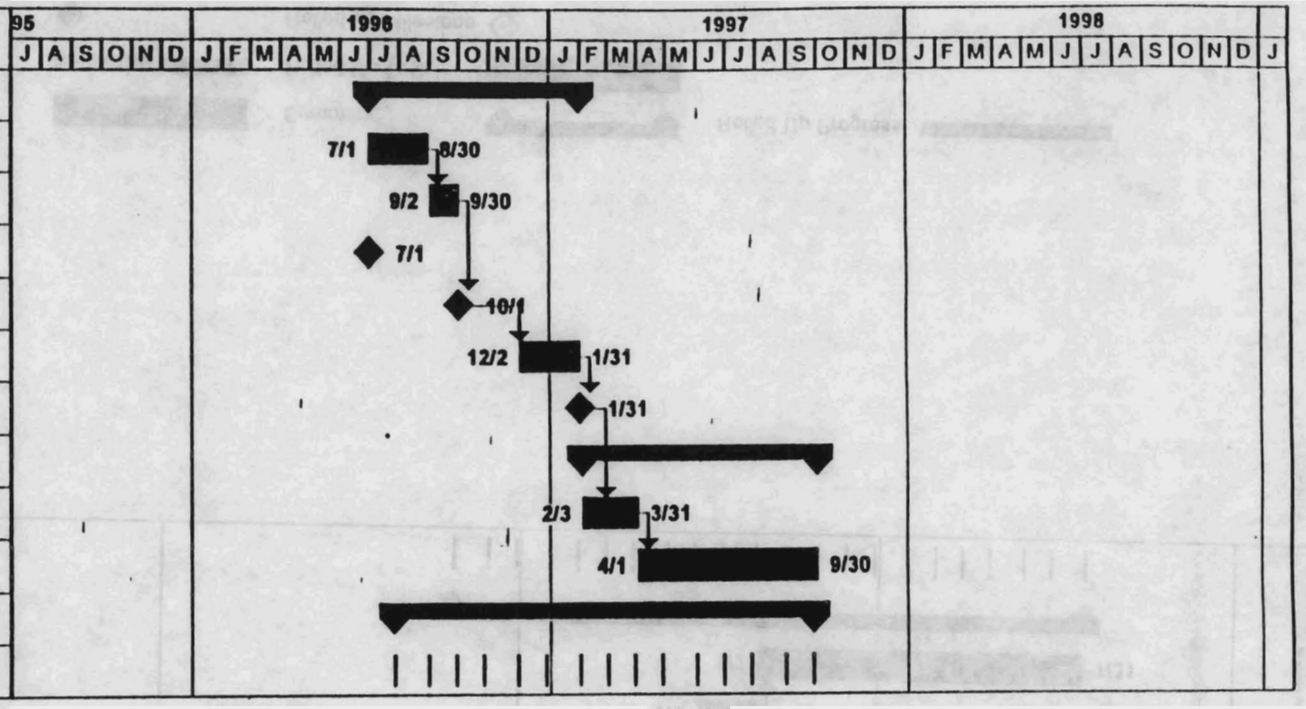
Klaipeda Geothermal Demonstration
Start Date: 9/1/95
Task Manager: Anders Halldin

Task
Progress
Milestone
Summary
Rolled Up Task
Rolled Up Milestone
Rolled Up Progress

Appendix 1 - Table E

Lithuania: Klaipeda Geothermal Demonstration Project
Implementation Schedule: Connection to Boiler House and External Pipline

ID	Task Name
1	Preparation
2	Develop standard equipment list & completion pla
3	Develop tender documents
4	Procurement notice in development business
5	Submit tender documents
6	Evaluate bids and negotiate
7	Contract signing
8	Implementation
9	Prepare detailed design
10	Supply and erect
11	Monitoring
12	Monthly Progress Reports



Klaipeda Geothermal Demonstration
Start Date: 7/1/95
Task Manager: Anders Halldin

Task
Progress
Milestone

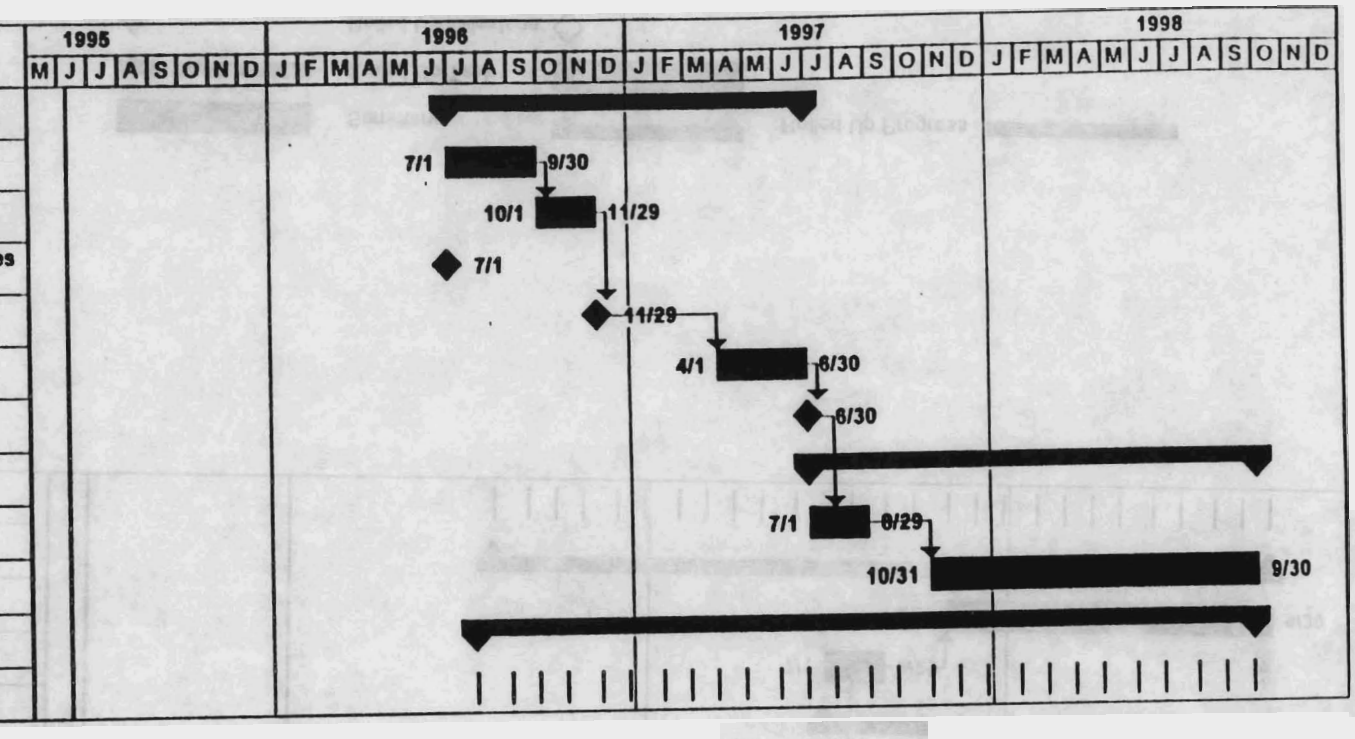
Summary
Rolled Up Task
Rolled Up Milestone

Rolled Up Progress

Appendix 1 - Table G

Lithuania: Klaipeda Geothermal Demonstration Project
Implementation Schedule: Absorption Heat Pumps

ID	Task Name
1	Preparation
2	Develop & specify standard equipment list
3	Develop tender documents
4	Procurement notice in Development Busines
5	Submit tender documents
6	Evaluate bids and negotiate
7	Contract signing
8	Implementation
9	Detailed design
10	Supply and erection
11	Monitoring
12	Monthly progress reports



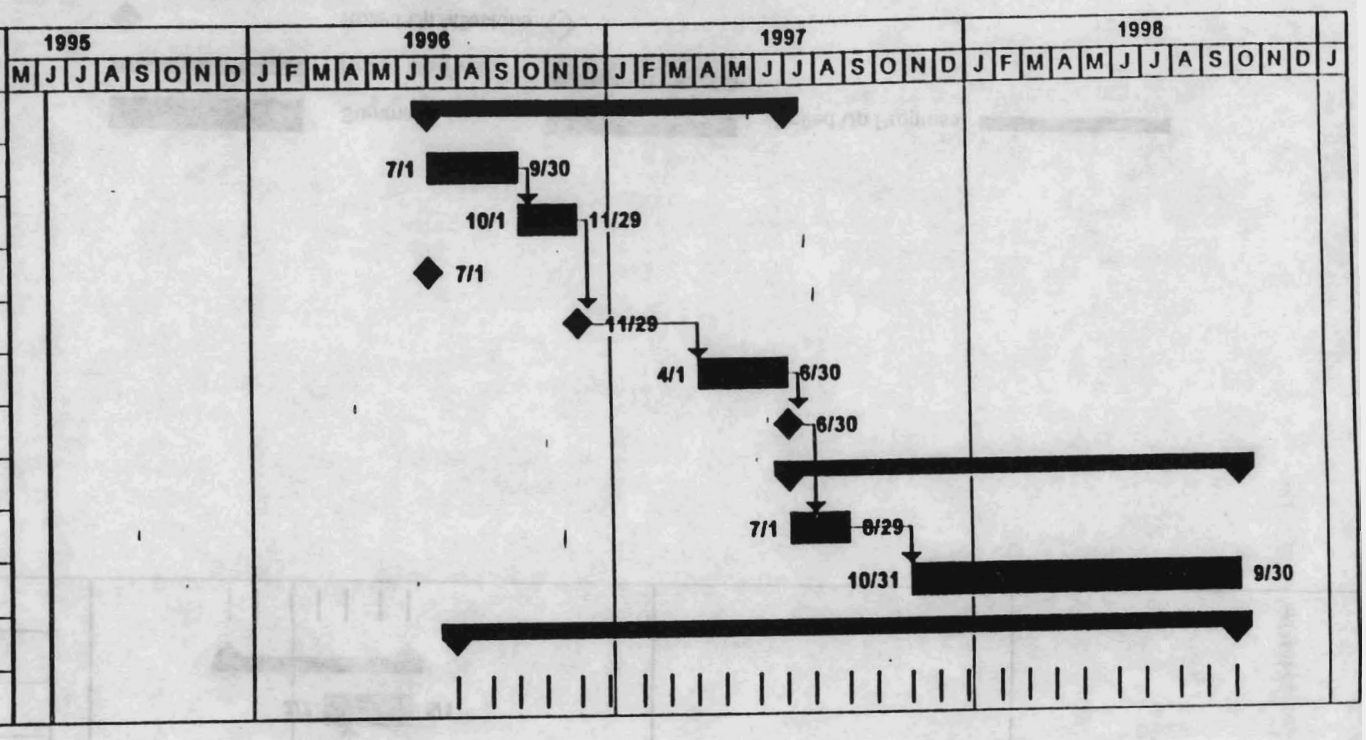
Klaipeda Geothermal Demonstration
Start Date: 7/1/96
Task Manager: Anders Halldin

Task
Progress
Milestone
Summary
Rolled Up Task
Rolled Up Milestone
Rolled Up Progress

Appendix 1 - Table I

Lithuania: Klaipeda Geothermal Demonstration Project
Implementation Schedule: Power, Control and Regulation

ID	Task Name
1	Preparation
2	Develop & specify standard equipment list
3	Develop tender documents
4	Procurement notice in Development Busine
5	Submit tender documents
6	Evaluate bids and negotiate
7	Contract signing
8	Implementation
9	Detailed design
10	Supply and erection
11	Monitoring
12	Monthly progress reports



Klaipeda Geothermal Demonstration
Start Date: 7/1/96
Task Manager: Anders Halldin

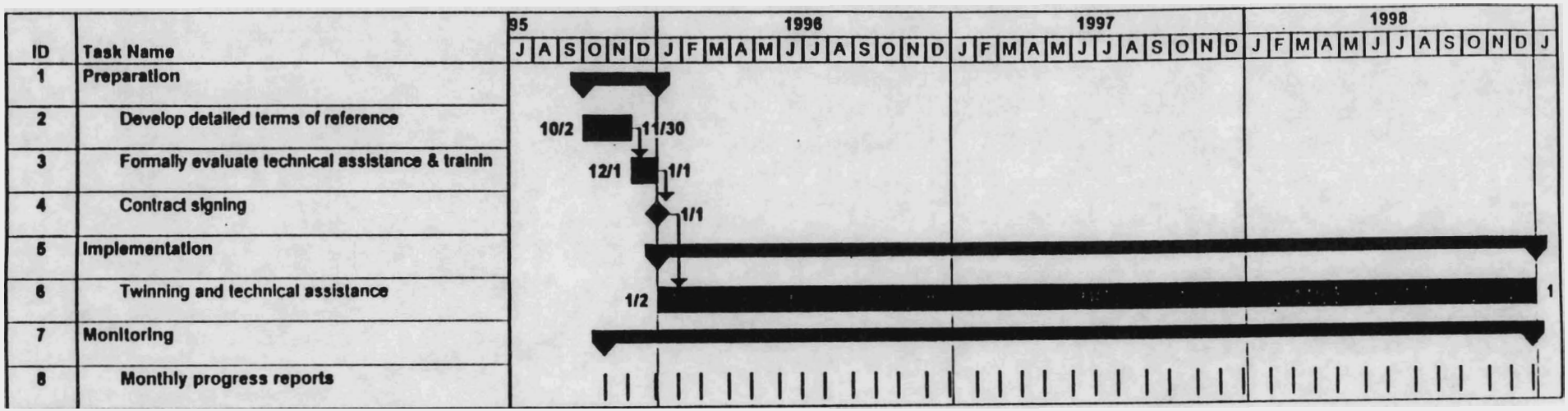
Task
Progress
Milestone

Summary
Rolled Up Task
Rolled Up Milestone

Rolled Up Progress

Appendix 1 - Table K

Lithuania: Klaipeda Geothermal Demonstration Project
Training and Technical Assistance Provided by Danish Ministry of Environment



Klaipeda Geothermal Demonstration
Start Date: 10/2/95
Task Manager: Anders Halldin

Task
Progress
Milestone
Summary
Rolled Up Task
Rolled Up Milestone
Rolled Up Progress

ANNEX 7

MONITORING AND EVALUATION

MONITORING AND EVALUATION

A. Actions to Monitor Development Objectives

1. Project monitoring indicators were developed during appraisal in order to enable tracking of Project inputs on key development objectives throughout the Project cycle. At the mid-term review, the need to fine-tune or restructure the Project design will be based on the data received from these indicators.

B. Project Indicators

2. Given the essential role program monitoring and evaluation play in determining the impact of a given intervention on development objectives, a number of indicators will be used to monitor and evaluate progress during the implementation of the Klaipeda Geothermal Demonstration Project. However, the progress of these indicators would be evaluated in relative, not absolute, terms. During supervision, a selected number of commercial, operational, financial and environmental indicators would be monitored in accordance with Project objectives.

(a) *Commercial indicators*

- Extraction of geothermal energy is expected to be larger than described due to higher temperature in the aquifer, and actions to improve building insulation are expected to reduce the network return temperature. These deviations will be continuously monitored and recorded as they will have a clear impact on the sale of heat.

(b) *Operational indicators*

- Heat extracted from the geothermal water and delivered to the network will be monitored and compared with actual aquifer temperature and temperature of the return network water.

- It should be demonstrated that the use of geothermal energy has resulted in a reduction of use of imported fossil fuels.

(c) *Financial indicators*

- The transfer price for geothermal energy between EG and KDHE would be monitored in accordance with the Loan Agreement.

- The following standard financial indicators, in addition to the internal rate