Proposal for Review

Project Title:	**Lithuania: Klaipeda Geothermal Demonstration Project**
GEF Focal Area:	Global Warming
Country Eligibility:	Lithuania ratified the IFCC on March 24, 1995 IBRD Eligible (1992 GNP/capita of $1310)
Total Project Costs:	$25.72 million
GEF Financing:	$6.9 million
Government Counterpart Financing of GEF Component:	$3.8 million
Cofinancing/ Parallel Financing:	IBRD US $4.3 million JEXIM US $8.0 million Government of Denmark US $2.6 million European Union (Phare) US $0.12 million
Associated Project:	Modification of Network Connections in Klaipeda District Heating System, World Bank, $8 million (included in Total Project Costs)
GEF Implementing Agency:	World Bank
Executing Agency:	World Bank
Local Counterpart Agency:	Ministry of Energy Lithuanian State Power System (LSPS)
Estimated Starting Date (Effectiveness):	November 9, 1995
Project Duration:	3 years
GEF Preparation Costs:	Funded by Danish Environmental Protection Agency

LITHUANIA: KLAIPEDA GEOTHERMAL DEMONSTRATION PROJECT

COUNTRY BACKGROUND

1. 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 in order to facilitate a return to economic growth. The Government of Lithuania (GOL) ratified the framework Convention on Climate Change in March 1995. The recently completed Public Expenditure Review, jointly prepared by the Government of Lithuania and the Bank, highlights 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. The main reason for the study was to assess the potential of utilizing geothermal energy to replace the currently used fossil fuel for heat generation. The study also determined that the largest and most promising storage areas are located in Lithuania, where the geothermal energy can be utilized by at least 18 identified municipalities.

3. The GOL encouraged the Danish EPA to continue the study through the preparation of a feasibility study focusing on the construction of a geothermal demonstration plant in Klaipeda, which was identified as being the best location for a demonstration. The feasibility study also showed that future utilization of geothermal energy is the least cost alternative of all indigenous energy resources when compared to peat and wood chips. Furthermore, the study showed that a reduction of the temperature regime in the district heating network, through modifying the network connections, enables an increase of the extraction of energy from the geothermal water by about 25%. Compared with the current level of heat demand for Klaipeda, the proposed Project would reduce consumption of fossil fuels more than 20%, resulting in an equivalent reduction of greenhouse gases (GHG) and sulfur dioxide (SO_2) from the boiler houses in Klaipeda. The available geothermal resource in Klaipeda is estimated to have a lifetime of more than 100 years.

4. The proposed project would be the first geothermal project for supply of heat to a district heating system in the Baltic States, and it would be the first geothermal project financed by the Bank where the geothermal energy is transferred to a district heating system using heat pump technology. The best use of the geothermal low temperature water is in connection with a large energy consumer, such as district heating systems. Due to similar geological formations in the East European countries and the Former Soviet Union republics, and extensive use of district heating systems for heat supply, the future utilization of geothermal resources must be considered as very likely. Furthermore, the resources in these countries are regarded as even being of a higher quality, that is, larger resources at a higher temperature. It is foreseen that the extraction of the geothermal energy can be obtained with lower investments, as the transfer technology might be based on heat exchanger instead of heat

pump technology. In Ukraine and Georgia the temperature is high enough to produce electricity from the geothermal resource in some locations. The Project could therefore become a reference for further development of similar geothermal energy resources in the region and worldwide.

PROJECT OBJECTIVES

5. The Project would demonstrate the feasibility of developing the indigenous Lithuanian geothermal energy resources, thereby decreasing the dependence on imported fossil fuel for heating purposes, which in turn would reduce emission of greenhouse gases and SO_2. The Project also seeks to provide energy security, highlighted as a priority in the National Energy Strategy, and improve the quality, reliability, and cost efficiency of heat distribution in Klaipeda.

6. Implementation of the proposed Project would have positive environmental benefits as no emissions would be generated, and in fact, through replacing heavy fuel oil with high sulfur content (mazut at 3.5% sulfur content) with geothermal energy, project implementation would lead to annual reductions in emissions of CO_2 and SO_2 by 56,200 tons and 1,200 tons respectively, as well as reductions of NO_x and TPM. The energy savings generated as a result of the network modifications, in addition to cost savings, would generate a further nearly twofold environmental benefit in terms of reduced emissions of pollutants. The project also will result in the cost-effective utilization of an indigenous energy resource (as recommended in the Lithuanian Energy Development Program), and savings in foreign exchange used to import fossil fuel for heating purposes.

PROJECT DESCRIPTION

7. The project would consist of two complementary components to optimize use of the available geothermal energy resources in Klaipeda: (a) the Klaipeda Geothermal Demonstration Plant (US $17.6 million); and (b) modification of network connections in the Klaipeda District Heating System (US $8.0 million). The *Klaipeda Geothermal Demonstration Plant Component* (KGDPC) includes **Technical Assistance and Training** provided under a Danish grant; and implementation of a **Geothermal Demonstration Plant**, financed partly by a GEF grant, as well as loans from the Bank and JEXIM. The TA component would include design of the necessary equipment for extraction and transfer of geothermal energy for district heating systems; preparation of a detailed drilling program; management support to the PIU; training of local personnel; and supervision of project implementation. The Demonstration Plant sub-component would include establishment of production and injection wells; above ground facilities; and piping for the entire extraction and distribution system. The *Modification of Network Connections Component* (MNCC) includes the replacement of obsolete equipment, including the installation of new thermostats and circulation pumps; and the establishment of a workshop for assembly of the sub-stations, as well as technical assistance for technology transfer and supervision of equipment installation.

8. The proposed geothermal project involves the circulation of 42^0 C geothermal water from 1,200 meters depth via a closed geothermal loop, utilizing heat exchangers 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 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.

9. Background documents include several feasibility studies financed by the Danish Government, and a detailed technical annex (white cover). These are available from ENVGC, fax: 522-3256.

IMPLEMENTATION

10. The construction of the geothermal plant is estimated to take a maximum of three years, during which time district heating network modifications, which will take two years, can be made. The Lithuanian State Power System (LSPS) will have overall supervising responsibility, while its subsidiaries, Enterprise Geoterma (EG) and Klaipeda District Heating Enterprise (KDHE), will be responsible for implementation of the two components. LSPS would be turned into a joint stock company during 1995, which also includes all the subsidiaries, such as KDHE and EG. EG was established during 1993 in order to develop existing geothermal resources. Procurement of the investment component and any TA financed by the loan will be in accordance with WB guidelines, and handled by LSPS.

11. The Project would be implemented under the general supervision of the Ministry of Energy (MOE). A Project Steering Committee (PSC), chaired by the MOE, would be established to provide overall guidance for the proposed Project and to facilitate national and local government coordination issues. Management of the proposed Project would be the responsibility of a Project Coordinator within the LSPS, who would be formally appointed by the Minister. The implementation of the KGDPC would be delegated to EG and the implementation of the MNCC would be delegated to the KDHE on behalf of the GOL. In order to effectively implement these activities, a Lithuanian staffed Project Implementation Unit (PIU) would be established within EG. EG would be provided technical assistance and training from a Danish consultant group through proposed technical assistance covered by the Danish EPA grant. This group would provide expertise to guarantee the quality control during implementation, start-up, and return. Project implementation would receive frequent supervision, including support by Bank staff from the Regional Office for the Baltic Countries in Riga and the local office in Vilnius. Performance indicators for each Project objective, to guide supervision, will be developed during appraisal.

RATIONALE FOR BANK AND GEF INVOLVEMENT

12. The involvement of the Bank/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 greenhouse gases and SO_2. In the absence of Bank 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, which all 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.

PROJECT SUSTAINABILITY AND PARTICIPATION

14. Important elements in assuring sustainability of the KGDPC include: (a) timely implementation of an Action Plan for further development of identified geothermal resources by LSPS/EG, which would promote the establishment of an autonomous and efficient company; and (b) development of a realistic tariff structure for transferring extracted energy to district heating companies on a wholesale basis. The sustainability of the MNCC will be determined by the development of a detailed plan and time schedule for exchanging the sub-stations in the district heating system, and the agreements of all concerned housing associations to proposed network modifications.

15. The project has received broad television and print media coverage because of its innovative aspects. The Municipality of Klaipeda has been involved in the discussions and analyses undertaken thus far. It is expected that the Municipality will hold additional consultations prior to and during project appraisal with local NGOs and users of the heating system, both to determine user receptiveness to the change and as a way of explaining the new heating system.

LESSONS FROM PREVIOUS BANK INVOLVEMENT AND TECHNICAL REVIEW

16. Bank experience in the implementation of geothermal energy projects in Central and Eastern Europe is limited to ongoing work in Poland and Slovakia. In Poland, a project in Zakopane (US $130 million) 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. The heat production cost based on geothermal energy is estimated to about 70% of the heat production cost based on natural gas. The Bank has recently approved a geothermal development project in the Philippines, to generate up to 700 MW of steam for Leyte-Cebu and Leyte-Luzon. (It should be noted that the proposed project will not emit air- or water-borne pollutants. The project would reduce the current emissions from heat generation plants in Klaipeda by a factor of over 20%.)

17. The project was reviewed by a geothermal engineer/energy planner from the STAP roster in February, 1995. His comments were supportive of the project, especially with regard to its potential demonstration impact in the region (see Annex 2).

PROJECT FINANCING AND BUDGET

18. The total project cost is estimated at US $25.72 million and the specific costs for each sub component are described in Annex 1. Sixty-nine percent of this is for the KGDPC (US $17.72 million), which is the component supported by GEF, and 31% for the MNCC (US $8 million). It is proposed that a Bank loan of about US $4.3 million, a loan from JEXIM of US $8 million, and grant financing of US $9.62 million from a number of donors (GEF, Denmark, and European Union [Phare]) would finance the foreign exchange requirements of the project and up to 85% of total project cost. A US $6.9 million GEF grant to cover the incremental costs is requested. The remaining 15%, US $3.8 million equivalent, would be covered by the GOL. The Government of Denmark, through the Ministry of Environment, would provide a grant of approximately US $2.6 million equivalent. The European Union would provide a grant of approximately US $0.12 million for supporting the establishment of the PIU. Other donors have declared an interest in participating in the project.

INCREMENTAL COST

19. The calculation of the incremental cost is described in Annex 2. However, to prepare this calculation the investment cost for the Geothermal Plant was reassessed to US $15.6 million, as the ICB-procedures are expected to reduce the actual cost. The baseline cost is the discounted present cost of providing 500 TJ/year heat supply over 25 years through a planned mix of heavy fuel oil and natural gas. The alternative cost is the investment cost of the GEF 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 represents the increment to be covered by GEF.

ISSUES, ACTIONS AND RISKS

20. The project would demonstrate utilization of low temperature geothermal water as an efficient energy resource for district heating through the use of established heat pump technology successfully used in several European countries (Denmark, Germany, and Sweden). The main risks underscoring the demonstration character of the project are as follows: (a) **Technical Risks**: (i) lower than expected supply of geothermal energy (amount of water and water temperature); (ii) fluctuations in the temperature of return water in the district heating system (as this water is the water to be heated by the geothermal water); (b) **Implementation Risks**: (i) a longer implementation period due to limited implementation capacity; and (ii) a limited administrative capacity in Lithuania for future development of the geothermal resources. These risks would be reduced by: (a) careful monitoring during drilling of production wells; (b) hydraulic analysis, currently under preparation, of the actual district heating system; (c) ensuring that appropriate project management arrangements are in place in a timely manner; and (d) preparing an Action Plan for development of the Enterprise Geoterma (EG). Furthermore, there is an **Economic Risk** that the price of available low priced HFO would fall to the point where its use would be competitive with geothermal resources. Given the global outlook for fuel oil prices this is unlikely. Moreover it is doubtful that the Lithuanian Ministry of Environmental Protection will continue to sanction the use of the available HFO of relatively high sulfur content. It is therefore anticipated that the cost of current fossil fuel-based production will surpass the cost of geothermal energy within a relatively short time.

Components	Procurement	1995			1996			1997			1998			1999			TOTAL			%	FINANCING				
		L	F	T	L	F	T	L	F	T	L	F	T	L	F	T	L	F	T		WB	GoI	EU-Phar	Denmark	JEXIM
othermal Demonstration nt																									
Drilling Operation	ICB	0.18	0.90	1.08	0.42	0.93	1.35										0.60	1.83	2.43						
Physical Contingencies - 5%		0 01	0 05	0.05	0 02	0.05	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.09	0.12						
Sub Total		0 19	0 95	1.13	0 44	0.98	1.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.63	1.92	2.55						
Price Contingencies %		15 00	2 00		6 00	2 50		5 00	2.70		5.00	2.50		5.00	2.60										
US$		0 03	0.02	0 05	0.10	0 04	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.06	0.19						
TOTAL		0 22	0 96	1 18	0 54	1.02	1.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.75	1.98	2.74						
Completion of Wells	ICB	0.08	0.30	0.38	0.05	0.25	0.30			0.00							0.13	0.55	0.68						
Physical Contingencies - 5%		0 00	0.02	0 02	0 00	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.03						
Sub Total		0 08	0.32	0 40	0.05	0 26	0.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.58	0.71						
Price Contingencies %		15 00	2.00		6.00	2 50		5.00	2.70		5.00	2.50		5.00	2.60										
US$		0 01	0.01	0 02	0 01	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.04						
TOTAL		0 10	0.32	0.42	0.06	0.27	0.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.60	0.76						
Control and Evaluation of lling Operations	SHORT LISTING		0.07	0.07		0.04	0.04										0.00	0.11	0.11						
Physical Contingencies - 5%		0 00	0 00	0 00	0 00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01						
Sub Total		0 00	0.07	0.07	0 00	0.04	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.12						
Price Contingencies %		15 00	2.00		6.00	2 50		5.00	2.70		5.00	2.50		5.00	2.60										
US$		0 00	0 00	0.00	0.00	0 00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0 00	0 00						
TOTAL		0 00	0.07	0 07	0 00	0.04	0 04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.12						
Building and Civil Works	ICB				0.24	0.11	0.35	0.12	0.05	0.17							0.36	0.16	0.52						
Physical Contingencies - 5%		0 00	0.00	0 00	0.01	0.01	0.02	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.03						
Sub Total		0 00	0.00	0.00	0 25	0.12	0.37	0 13	0.05	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.38	0.17	0.55						
Price Contingencies %		15.00	2.00		6 00	2 50		5.00	2.70		5.00	2.50		5.00	2.60										
US$		0 00	0 00	0 00	0 06	0.01	0.06	0.04	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.01	0.10						
TOTAL		0 00	0 00	0.00	0 31	0.12	0.43	0.16	0.06	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.18	0.65						
Connection to Boiler House l External Pipeline	ICB				0.54	0.20	0.74										0.54	0.19	0.74						
Physical Contingencies - 5%		0.00	0.00	0.00	0.03	0.01	0 04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.01	0.04						
Sub Total		0.00	0.00	0.00	0.57	0 21	0.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.57	0.20	0.78						
Price Contingencies %		15 00	2.00		6.00	2 50		5.00	2.70		5.00	2.50		5.00	2.60										
US$		0.00	0.00	0.00	0.12	0.01	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.01	0.13						
TOTAL		0.00	0.00	0.00	0.69	0.22	0.91	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.69	0.21	0.91						
Heat Exchangers	ICB							0.02	0.35	0.37	0.02	0.32	0.34				0.04	0.67	0.71						
Physical Contingencies - 5%		0 00	0 00	0.00	0.00	0 00	0 00	0.00	0.02	0.02	0.00	0.02	0.02	0.00	0.00	0.00	0.00	0.03	0.04						
Sub Total		0 00	0.00	0.00	0.00	0.00	0.00	0.02	0.37	0.39	0.02	0.34	0.36	0.00	0.00	0.00	0.04	0.70	0.75						
Price Contingencies %		15 00	2.00		6.00	2.50		5.00	2.70		5.00	2.50		5.00	2.60										
US$		0 00	0 00	0 00	0 00	0 00	0.00	0.01	0.03	0.03	0.01	0.03	0.04	0.00	0.00	0.00	0.01	0.06	0.07						
TOTAL		0 00	0.00	0.00	0.00	0.00	0.00	0.03	0.39	0.42	0.03	0.37	0.40	0.00	0.00	0.00	0.06	0.76	0.82						
7. Absorption Heat Pumps	ICB				0.10	1.84	1.94	0.15	3.00	3.15	0.05	1.20	1.25			0.00	0.30	6.04	6.34						
Physical Contingencies - 5%		0 00	0.00	0 00	0.01	0.09	0.10	0.01	0.15	0.16	0.00	0.06	0.06	0.00	0.00	0.00	0.02	0.30	0.32						
Sub Total		0 00	0.00	0.00	0 11	1.93	2.04	0.16	3.15	3.31	0.05	1.26	1.31	0.00	0.00	0.00	0.32	6.34	6.66						
Price Contingencies %		15.00	2.00		6.00	2.50		5.00	2.70		5.00	2.50		5.00	2.60										
US$		0 00	0.00	0 00	0.02	0.09	0.11	0.04	0.23	0.28	0.02	0.13	0.14	0.00	0.00	0.00	0.09	0.45	0.53						
TOTAL		0.00	0.00	0.00	0.13	2.02	2.15	0.20	3.38	3.58	0.07	1.39	1.46	0.00	0.00	0.00	0.40	6.79	7.19						
ilters, Valves and Internal ng	ICB				0.05	0.36	0.41	0.04	0.36	0.40							0.09	0.72	0.81						
Physical Contingr %		0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.02	0.02		0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04						
Sub Total		0.00	0.00	0.00	0 05	0.38	0.43	0.04	0.38	0.42	L	0.00	0.00	0.00	0.00	0.00	0.09	0.76	0.85						
Price Contingencies %		15 00	2 00		6.00	2.50		5.00	2.70		5.00	2.50		5.00	2.60										

US$		0.00	0.00	0.00	0.01	0.02	0.03	0.01	0.03	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.05	0.07
TOTAL		0.00	0.00	0.00	0.06	0.40	0.46	0.05	0.41	0.46	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.80	0.92
Power, Control and Regulation	ICB				0.03	0.21	0.24	0.04	0.35	0.39	0.02	0.07	0.09				0.09	0.63	0.72
Physical Contingencies - 5%		0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.04
Sub Total		0.00	0.00	0.00	0.03	0.22	0.25	0.04	0.37	0.41	0.02	0.07	0.09	0.00	0.00	0.00	0.09	0.66	0.76
Price Contingencies %		15.00	2.00		6.00	2.50		5.00	2.70		5.00	2.50		5.00	2.60				
US$		0.00	0.00	0.00	0.01	0.01	0.02	0.01	0.03	0.04	0.01	0.01	0.01	0.00	0.00	0.00	0.03	0.04	0.07
TOTAL		0.00	0.00	0.00	0.04	0.23	0.27	0.05	0.39	0.45	0.03	0.08	0.11	0.00	0.00	0.00	0.12	0.71	0.83
10. Project Implementation Unit	NBF	0.03	0.08	0.11	0.03	0.04	0.07	0.03		0.03	0.03		0.03				0.12	0.12	0.24
Price Contingencies %		15.00	2.00		6.00	2.50		5.00	2.70		5.00	2.50		5.00	2.60				
US$		0.00	0.00	0.01	0.01	0.00	0.01	0.01	0.00	0.01	0.01	0.00	0.01	0.00	0.00	0.00	0.03	0.00	0.03
TOTAL		0.03	0.08	0.12	0.04	0.04	0.08	0.04	0.00	0.04	0.04	0.00	0.04	0.00	0.00	0.00	0.15	0.12	0.27
BASE COST		0.29	1.35	1.64	1.46	3.98	5.44	0.40	4.11	4.51	0.12	1.59	1.71	0.00	0.00	0.00	2.27	11.02	13.30
Physical Contingencies - 5%		0.01	0.07	0.08	0.07	0.20	0.27	0.02	0.21	0.23	0.01	0.08	0.09	0.00	0.00	0.00	0.11	0.55	0.67
Subtotal		0.30	1.42	1.72	1.53	4.18	5.71	0.42	4.32	4.74	0.13	1.67	1.80				2.38	11.58	13.97
Price Contingencies %		15.00	2.00		6.00	2.50		5.00	2.70		5.00	2.50		5.00	2.60				
US$		0.05	0.03	0.07	0.34	0.19	0.53	0.12	0.32	0.44	0.04	0.17	0.21	0.00	0.00	0.00	0.54	0.70	1.25
otal Geothermal emonstration Plant		0.35	1.45	1.80	1.87	4.37	6.24	0.54	4.63	5.17	0.17	1.84	2.01	0.00	0.00	0.00	2.93	12.29	15.21
lodification of Network onnections																			
Equipment for Network lodifications	ICB	0.15	0.25	0.40	0.40	3.20	3.60	0.25	1.95	2.20	0.10	0.74	0.84			0.00	0.90	6.14	7.04
Physical Contingencies - 5%		0.01	0.01	0.02	0.02	0.16	0.18	0.01	0.10	0.11	0.01	0.04	0.04	0.00	0.00	0.00	0.05	0.31	0.35
Sub Total		0.16	0.26	0.42	0.42	3.36	3.78	0.26	2.05	2.31	0.11	0.78	0.88	0.00	0.00	0.00	0.95	6.45	7.39
Price Contingencies %		15.00	2.00		6.00	2.50		5.00	2.70		5.00	2.50		5.00	2.60				
US$		0.02	0.01	0.03	0.09	0.15	0.24	0.07	0.15	0.22	0.04	0.08	0.11	0.00	0.00	0.00	0.23	0.39	0.61
otal Modification of etwork connections		0.18	0.27	0.45	0.51	3.51	4.02	0.34	2.20	2.53	0.14	0.86	1.00	0.00	0.00	0.00	1.17	6.83	8.00
raining, Technical ssistance, Contract oordination & Supervision	N.B.F.	0.04	0.95	0.99	0.04	0.70	0.74	0.04	0.25	0.29	0.04	0.20	0.24				0.16	2.10	2.26
Physical Contingencies - 5%		0.00	0.05	0.05	0.00	0.04	0.04	0.00	0.01	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.01	0.11	0.11
Sub Total		0.04	1.00	1.04	0.04	0.74	0.78	0.04	0.26	0.30	0.04	0.21	0.25	0.00	0.00	0.00	0.17	2.21	2.37
Price Contingencies %		15.00	2.00		6.00	2.50		5.00	2.70		5.00	2.50		5.00	2.60				
US$		0.01	0.02	0.03	0.01	0.03	0.04	0.01	0.02	0.03	0.01	0.02	0.04	0.00	0.00	0.00	0.04	0.09	0.14
TOTAL		0.05	1.02	1.07	0.05	0.77	0.82	0.05	0.28	0.34	0.06	0.23	0.29	0.00	0.00	0.00	0.21	2.30	2.51
OTAL PROJECT COST		0.58	2.73	3.31	2.43	8.66	11.08	0.93	7.11	8.04	0.37	2.92	3.29	0.00	0.00	0.00	4.31	21.42	25.72
otal Physical Contingencies		0.20	0.38	0.58	0.59	0.39	0.49	0.03	0.32	0.35	0.01	0.13	0.14	0.00	0.00	0.00	0.17	0.96	1.13
otal Price Contingencies		0.08	0.05	0.13	0.44	0.38	0.81	0.20	0.49	0.69	0.09	0.27	0.36	0.00	0.00	0.00	0.81	1.19	1.99
otal Contingencies		0.27	0.44	0.71	1.02	0.77	1.30	0.24	0.80	1.04	0.11	0.39	0.50	0.00	0.00	0.00	0.98	2.15	3.12
otal Base Cost		0.31	2.29	2.60	1.41	7.88	9.78	0.69	6.31	7.00	0.26	2.63	2.79	0.00	0.00	0.00	3.33	19.27	22.60

ANNEX 2

SUMMARY AND OUTCOMES OF TECHNICAL REVIEW

SUMMARY OF TECHNICAL COMMENTS

1. The technical reviewer was supportive of the project, calling it an "innovative and potentially very important project not only for the Government of Lithuania (GOL) but also for other governments of the Former Soviet Union" that operate energy-inefficient district heating systems relying on expensive and often imported fossil fuels. In many cases, these district heating systems are becoming virtually unusable because of fuel costs and must to be converted to indigenous fuel sources to remain operational. By converting such systems to geothermal power sources, governments would not need to make the enormous investments in district heating infrastructure that traditionally render geothermal district heating projects uneconomic under most fuel price scenarios and the most optimistic assumptions regarding the geothermal resource and well technology performance.

2. The reviewer confirmed the project to be reasonably matched in scale to the heating demands, and the geothermal resource to be recoverable at a standard depth with standard technology. The district heating system in question will require only modest infrastructural upgrading for successful conversion to the geothermal resource. The economics of the project also "seem reasonable given the potential long-term benefits to the GOL, both in terms of hard currency savings and environmental benefits". The economics, for Lithuania as well as for other nations of the Former Soviet Union, would be improved when tapping geothermal potential is coupled with energy pricing reforms. This project could spawn an infant industry in the Former Soviet Union to promote geothermal technology. Thus the demonstration value is expected to be large.

RECOMMENDATIONS

3. The reviewer did not have any specific design recommendations. Given the potential demonstration value of the project, efforts will be made to disseminate lessons learned from the project so that future geothermal initiatives can benefit fully from the Klaipeda project.

ANNEX 3

LITHUANIA
KLAIPEDA GEOTHERMAL DEMONSTRATION PROJECT

CALCULATION OF THE INCREMENTAL COST TO BE COVERED BY GEF

1. The basic methodology for estimating the incremental cost of a project is to compare the proposed project with the cost of an alternative way to produce the same amount of energy. In the early stages of preparing this project, 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 this geothermal model, based on the preparatory technical assistance. 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 Subsequent	9.6	0.44-0.60	15.2

2. The purpose of the study was to assess the viability of developing geothermal resources in the region, and not to perform a detailed analysis of alternative fuels. Therefore the comparison was based on only investments in the existing boiler house (where the geothermal plant will be built) that would be needed to accommodate other types of fuel. The revenues of heat produced by the different energy sources was based on a fuel oil price of US $110/ton. The results clearly demonstrated that subsequent geothermal plants did have an advantage compared to the other alternatives examined.

3. Among the energy sources considered, only peat, wood chips and geothermal water are indigenous. Peat is not renewable, and furthermore, the sparse resources available have been allocated for the agricultural sector. The limited quantity of wood chips available in Lithuania is available mainly in the Eastern part of the country, which would result in quite high transportation costs. Furthermore, to feed the boiler in Klaipeda with wood chips to produce the 500 TJ required would result in the utilization of all Lithuanian forests for thinning operations, and this is not a sustainable option.

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 the 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.

5. The geothermal demonstration plant would produce 500 TJ by extracting this energy from geothermal water by use of absorption heat pump technology. Use of electrical heat pumps is not a competitive alternative because of the high and increasing cost of electricity.

6. The extracted energy will replace an equivalent amount of energy produced from fossil fuels in boilers with an efficiency of 80%. The extracted 500 TJ corresponds to an annual reduction of 15625 tons of mazut or 18.382 million m^3 of natural gas. The current fuel mix for supplying heat is 65% mazut and 35% natural gas, which is used as the basis for calculating the amount of fuel replaced by the geothermal energy.

	Mazut	Natural gas
Demand covered by	325 TJ	175 TJ
Energy content in	40 GJ/ton	34 GJ/1000 m^3
Energy replaced at 80% efficiency	10,156 ton	6,434 M m^3

REDUCTION OF CARBON DIOXIDE EMISSIONS

7. Based on the assumption that the geothermal energy would replace either mazut or natural gas over the (25 year) lifetime of the project, the reduction in carbon dioxide would be 1.225 million tons and 1.132 million tons respectively (reduction is based on 3,136 kg CO_2/ton of mazut, and 2,463 kg CO_2/1000 m^3 of natural gas). The actual fuel mix gives a reduction of 1.196 million tons over the lifetime of the project.

INCREMENTAL COST FINANCED BY GEF

8. The investment cost for the Geothermal Demonstration Plant was **originally estimated at US $17.6 million, which is the investment used in the PID and the white-cover staff appraisal report.** This cost has recently been reassessed, and it is expected that it will be **reduced to US $15.6 million due to procurement under International Competitive Bidding (ICB) and reevaluation of the basic cost estimates.**

9. The investment will include the following sub-components:

		US $M
1)	Drilling Operations and Well Completion	3.00
2)	Control and Evaluation of Drilling Operations	0.12
3)	Building and Civil Works	0.61
4)	Connection to Boiler House and External Pipeline	0.70
5)	Absorption Heat Pumps	7.00

6)	Power Control and Regulation	0.80
7)	Project Implementation Unit	0.27
8)	Design and Technical Assistance	2.50
	TOTAL INVESTMENT COST	**15.60**

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 of replaced fuel
5) Recurrent cost includes replacement of certain equipment, to maintain the investment in full operative capacity.

10. The IRR of the Geothermal Demonstration Plant is 4.2% based on an investment of US$ 15.6 million and a reduction of fuel use in proportion with the actual fuel mix. To achieve an IRR of 10% the investment has to be reduced to US $8.6 million. The calculations for the mentioned IRRs, based on investment cost, operational cost and benefits are described in Annex 1-2 of the detailed staff appraisal report.

11. Based on the calculations of IRR without environmental benefits, the increment necessary to make the demonstration plant viable as an investment reducing global warming from carbon dioxide, is estimated at US $6.9 million. The reduced emission of CO2 during the lifetime of the project is, as mentioned in paragraph 7, 1196 million tons. The cost-effectiveness of emissions reduction is calculated as US $5.85/ton CO2 or US $21.45/ton C.

SUSTAINABILITY

12. The future development of geothermal resources is dependent upon 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 became 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 to 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 these kind of measures would be implemented in all district heating systems. The resulting reduced temperature regime will enable an increased extraction of energy from the geothermal water of 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 cost for subsequent plants built entirely along the lines of the Lithuanian model, 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.