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Lithuania
Energy Sector Review

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Country Department IV
Europe and Central Asia Region

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CURRENCY EQUIVALENTS

Currency unit = Litas
US$1 = 4.0 Litai (as of April 1994)

WEIGHTS AND MEASURES

atm	atmosphere (unit of pressure)	kWh	kilowatt-hour
bcm	billion cubic meters	m^3	cubic meters
Btu	British thermal unit	Mt	million tons
Gcal	gigacalorie (10^9 cal)	MW	megawatt (10^6 W)
GWh	gigawatt-hour (million kWh)	MVA	megavolt-ampere
GW	gigawatt	PJ	petajoule (10^{15} joule)
GJ	gigajoule (10^9 joules)	TJ	terajoule (10^{12} joule)
kg	kilogram	TWh	terawatt-hour (10^{12} Wh or one billion kWh)
km^2	square kilometer		
koe	kilograms oil equivalent	t	ton (metric, 1000 kg)
kW	kilowatt	tcm	thousand cubic meters
kV	kilovolt		

FUEL HEAT CONTENTS (Calorific Value)

Fuel	Gcal	GJ
Coal (per ton)	5.0	21.0
Wood (per ton)	2.0	8.4
Natural gas (per tcm)	8.5	35.6
Mazout (per ton)	9.7	40.6
Diesel (per ton)	10.2	42.7
Gasoline (per ton)	10.5	44.0
Kerosene (per ton)	10.3	43.1
Liquified Petroleum Gas (LPG) (per ton)	10.8	45.2
Crude oil (per ton)	10.0	41.9

CONVERSION FACTORS

- 1 Gcal = 4.187 GJ = 3.968 million Btu = 1,163 kWh (of heat)
- 1 kWh of electricity requires (depending on conversion efficiency) 2,520 kcal or 10.5 MJ or 10,000 Btu of fuel heat.
- 1 kWh of hydro and nuclear energy output is converted to an equivalent primary fuel at a conversion factor of 250 grams of oil equivalent per kWh.

CHEMICAL COMPOUNDS

NO_x	Nitrogen Oxides	SO_2	Sulfur Dioxide

ABBREVIATIONS

AFBC	Atmospheric Fluidized Bed Combustion
ATC	Actual Thermal Capacity
CCGT	Combined Cycle Gas Turbine
CEE	Central and Eastern Europe
CHP	Combined Heat and Power (Plant)
CMEA	Council for Mutual Economic Assistance
DHE	District Heating Enterprises
EBRD	European Bank for Reconstruction and Development
EC PHARE	European Commission Technical Assistance Program for Central Europe (including the Baltic Countries)
EEC	European Economic Commission
FSU	Former Soviet Union
GDP	Gross Domestic Product
GTCC	Gas Turbine Combined Cycle
HOB	Heat-Only Boilers
HVDC	High-Voltage Direct Current
IAEA	International Atomic Energy Agency
IDC	Interest During Construction
IEA	International Energy Agency
IGCC	Integrated Gasification Combined Cycle
INPO	Institute for Nuclear Power Operations
IPS	Interconnected Power System (of the FSU)
LEI	Lithuania Energy Institute
LF	Lithuania Fuels Company
LG	Lithuania Gas Company
LSPS	Lithuania State Power System
LTPP	Lithuania Thermal Power Plant
MoE	Ministry of Energy
O&M	Operations & Maintenance
OSART	Operational Safety Assessment Review Team
PNDI	Power Network Design Institute
RPM	Rotations Per Minute
UCPTE	Union for the Coordination of Production and Transmission of Electricity
USNRC	U.S. Nuclear Regulatory Commission
USTDA	U.S. Trade Development Agency
VATESI	State Nuclear Power Inspectorate
WANO	World Organization of Nuclear Operators

FISCAL YEAR

January 1 - December 31

ACKNOWLEDGEMENTS

This Energy Sector Review (ESR) is the product of collaboration between the Bank and numerous energy agencies and institutes of Lithuania. It is based on information collected during a Bank mission to Lithuania in October 1992 supplemented during missions in April and June 1993 and February 1994. The mission consisted of Achilles G. Adamantiades (mission leader), Bjorn Hamso (energy economist), N.C. Krishnamurthy (petroleum refining), Shigeru Kubota (oil and gas), Charles Smith (power system and hydro consultant), Harold Falkenberry (thermal power consultant), Bo Andersson (high-voltage transmission consultant), Jens Brandt Sorensen (district heating consultant), and Scott Vicary (financial analyst consultant). The report also contains information obtained and analyses performed by a concurrent joint World Bank/International Energy Agency (IEA) mission for a "Power Demand and Supply Options" requested by the Group of Seven industrialized countries (G-7) in which the IEA was represented by David Rubin (IEA team leader/energy efficiency and demand management) and Panos Coroyannakis (system planner). William Onorato (legal expert) and Jose M. Bakovic (restructuring specialist) also joined the April Mission. John Besant-Jones and Roy Pepper were the two World Bank reviewers.

Prof. Leonas Asmantas, Minister of Power (until March '93), provided overall support and guidance while Mr. Kazys Zilys, Director of Research and Development in the Ministry of Energy, was the main coordinator of the mission on the Lithuanian side and provided invaluable assistance in facilitating the contacts and activities of the mission. The Ministry of Energy, Ministry of Economy, Lithuanian State Power System (LSPS), State Nuclear Power Inspectorate (VATESI), Lithuanian Gas Company, Lithuanian Fuel, Mazeikiai Refinery, Siluma District Heating Company, Academy of Sciences, and the staff of several other energy sector institutes and enterprises, especially the Lithuanian Energy Institute (LEI) and the Power Network Design Institute actively participated in the work of the mission. Prof. Jurgis Vilemas, LEI Director, deserves special credit for giving many useful insights and making important contributions to the work of the mission.

The report was discussed with Lithuanian Authorities at a conference in November 1993. Comments received at the conference were taken into account for the final version.

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ENERGY SECTOR REVIEW

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EXECUTIVE SUMMARY

1. Lithuania's highly energy-intensive economy is challenged by four major problems in its energy sector. These are its: (1) inefficient energy fuel production and consumption; (2) almost total dependence on imported fuels; (3) vulnerability to serious supply disruptions from the Former Soviet Union (FSU); and (4) over-reliance on a nuclear plant considered unsafe by Western standards. These problems are aggravated by the drastic political transformation that the country has undergone in recent years, the serious economic situation and the major disruption of trade and economic relations with Lithuania's main trading partner, the FSU.

2. Faced with these challenges, the Government of Lithuania (GoL) announced that it would seek to develop an energy strategy based on cost recovery, energy conservation, and the development of indigenous resources. It also requested technical assistance from international bilateral and multilateral donors in formulating the strategy. This study was prepared in response to that request. Among the study's most important findings are that in the energy sector the Government will need to: (1) target its limited investment resources to improve production efficiency; (2) set price incentives to promote conservation; (3) improve the security of fuel supplies; and (4) quickly make a decision on how to improve safety at its nuclear power plant while minimizing economic damage to the country.

3. The principal analyses and conclusions of this study are summarized below.

A. ENERGY DEMAND AND CONSERVATION

4. The energy intensity of the Lithuanian economy is quite high: at 1.5 kg of oil equivalent per US$ 1 of GDP in 1990, it is several times higher than that in developed western economies, although not as high as in some of the more industrial countries of the FSU. The high energy intensity is due to previously low energy prices, inefficient methods of energy production and use, high losses, obsolete equipment, and inadequate maintenance of facilities.

5. This study finds that <u>an accelerated program of reforms in Lithuania would not only lead to a more rapid recovery in GDP, but also to much lower demand for energy</u>. This conclusion is based on a World Bank structural model that projects energy demand under various economic reform scenarios. The analysis shows that, even under the "slow reforms" (high demand) scenario, demand in the year 2000 will be about 75% of its 1990 level and will grow to 98% in the year 2010. The lower energy demand that occurs under the "accelerated reform" program is largely due to a more rapid move away from energy-intensive industries.

<u>Main Recommendations on Energy Demand and Conservation</u>

- The GoL should adopt an "accelerated reform" program, leading to lower energy demand and higher GDP growth;

- Energy conservation must be an integral part of the country's economic reform program. The GoL should establish an Energy Conservation and Efficiency Agency to help develop and implement conservation measures. Price incentives will be the main vehicle to promote conservation, but the GoL should also pursue a broader program. This should include: (1)

an investigation of energy consumption patterns, (2) energy audits, (3) incentives for investment in conservation and efficiency, (4) building code reforms, (5) information programs, and (6) incentives to utilities to promote energy savings and efficiency among customers.

B. ENERGY SUPPLY AND EXPORTS

Domestic Supply

6. Despite substantial excess capacity in oil refining and electricity generation, Lithuania has very limited primary energy resources. Its indigenous resources supply only 2% of total energy demand; this makes the country extremely dependent on primary energy imports until now supplied almost exclusively from Russia. There is some potential to further develop local resources but not enough to reduce significantly Lithuania's dependence on imports.

7. Nevertheless, renewable resources can play a limited role in the fuel supply mix. Wood chips could become an important fuel for district heating systems since the country has significant forest coverage and a substantial lumber and paper pulp industry. The country also has peat deposits, but exploiting them may have negative environmental consequences and, where warranted, must proceed very carefully. Other renewable sources such as solar and wind power also have some potential for local supply. Geothermal resources have been identified but the low temperatures of the discovered zones limit their exploitation to local district heating applications.

Exports

8. Until recently, Lithuania was a major exporter of refined petroleum products and electricity. However, exports declined dramatically in 1992 and 1993 owing to the economic contraction in the region, competition from Russian producers, and payment disputes. Over the near term, this decline is expected to continue.

Energy Imports and Security of Supply

9. Almost all of Lithuania's fuel needs are imported. In 1991, the country imported 18 million tons of oil equivalent (Mtoe) (consisting mainly of about 12 million tons of crude oil and 6 billion cubic meters (bcm) of gas). Economic contraction and supply disruptions reduced imports to about 8.8 Mtoe in 1993. The country's vulnerability because of its excessive dependence on imports was dramatized by severe fuel shortages in 1992 and a gas cut-off in June 1993. With no harbors for alternative deliveries and only Russian-controlled gas connections, supply disruptions became critical. Much of the disruption was due to the inability to pay the asking price and to make payments in hard currency. Lithuania is also dependent on imported nuclear fuel to operate its nuclear plant at Ignalina. However, because of nuclear fuel's high energy density, it is much less susceptible to sudden supply disruptions than fossil fuels and is therefore considered a more secure source of energy.

10. Since Lithuania has major interconnections with the energy networks of the FSU, it is expected that Russia will remain Lithuania's main supplier of oil and gas at least in the short to medium term. In view of this, it is critical that steps be taken to increase the security of supply.

Main Recommendations to Increase Security of Supply

- Negotiate long-term contracts to secure of oil and gas at the most favorable terms. To facilitate the resumption of normal trade relations with Russia, questions of pricing, terms and currency of payment must be settled.

- Investigate alternative crude oil unloading points. The case for the proposed oil terminal on the Baltic Sea coast (at Klaipeda or Butinge) must be carefully considered, along with other least-cost options, including upgrading the existing oil terminal at Ventspils, Latvia. Such a facility should be limited in capacity, providing for only a minimum level of emergency supply, most likely using a low-cost, single-point mooring.

- Increase the security of gas supply through additional gas storage capability. The most immediate and economic way to do this it to cooperate with Latvia on extending the capacity of the existing Incukalns reservoir. The planned development of underground storage in Lithuania (at Sirvintos) is unlikely to be economical.

- Negotiate long-term contracts with the Russian suppliers of nuclear fuel, possibly tying them to exports of electricity to Kaliningrad.

C. REGIONAL COOPERATION

11. Cooperation among the Baltic countries -- such as in utilizing gas storage facilities in Latvia, upgrading the Mazeikiai oil refinery, and developing or expanding oil port facilities and pipelines -- is an important way to maximize the use of scarce resources and strengthen the economy of the whole region. The benefits would be significant: higher returns on existing installed capacity, economies of scale, greater efficiency and reliability, lower environmental impacts, higher viability of new projects, and hence greater ability to attract foreign investments.

12. Setting a suitable framework for regional cooperation will require strong and persistent regional consultations, a political will to seek regional rather than national solutions, as well as investment, financing and ownership schemes that would allow the three Baltic countries to participate with a financial stake in the projects.

Main Recommendations on Regional Cooperation

- Agree with Estonia and Latvia to enhance the role of the Baltics Energy Cooperation Council to tackle all regional energy issues and formulate economically viable regional projects. Plan investments that will service the Baltic region and are based on each country's comparative advantage. Seek consensus on project definition, utilization, and financing with appropriate shares for each country.

D. ENERGY PRICES AND SUBSIDIES

13. Although Lithuania's imported fuel prices are currently at or close to world market levels, its retail and wholesale energy prices are still controlled. When imported fuel prices were raised dramatically in 1992, the GoL responded by raising prices to industrial customers to at least cover the import cost. In the second half of 1992, electricity and gas prices to the residential sector were also increased to the same level as those for industrial customers, but prices for district heating and heating oil continued to be heavily subsidized. After a series of price lags through the end of 1992 and beginning of 1993, the GoL began to make regular price adjustments in the second quarter of 1993 to take into account changing import costs and inflation. In some cases, prices are still below cost-recovery levels.

14. It is important, both for fiscal sustainability and economic efficiency, that all consumers pay the actual costs of producing and distributing energy. Over the long term, the Ministry of Energy (MoE) should introduce metering and control equipment, as well as competitive pricing wherever possible. A detailed pricing study, carried out by consultants under the UK Know-How Fund (August 1993), provides a good framework for a future pricing policy. In the interim, a transitional system needs to be established, particularly since households cannot afford the costs of producing heat from the inefficient district heating system.

Main Recommendations on Transitional Pricing System

- Pending the rehabilitation of the district heating system, implement a consumption tax on electricity to provide a cross subsidy for district heating.
- Raise all other retail energy prices to levels that cover operating expenses and maintenance.
- Liberalize prices on tradeable energy products (LPG, coal, petroleum products, etc).
- Set firm budget restraints on distribution companies by establishing fixed or negotiated wholesale prices between transmission and the distribution companies.
- Establish a pricing formula that is linked to the exchange rate (import costs) and the inflation rate (local costs).
- Eliminate all other direct and indirect energy subsidies.

E. INSTITUTIONAL STRUCTURE AND REGULATORY FRAMEWORK

Structure of the Energy Sector

15. The energy sector is in need of fundamental restructuring. It is still predominantly state-owned. Although the individual enterprises in the energy sector are largely autonomous in day-to-day operations, MoE appoints the general directors and is instrumental in establishing policy, administering subsidies, and negotiating with the GoL on pricing.

16. With help from the World Bank and the Danish Energy Agency, the GoL and the MoE have revised a draft Energy Law, now under consideration by a Committee of the Sejmas, intended to set a

general policy framework for the whole sector. They have also adopted an initial Plan of Action for restructuring the electricity subsector (see Annex 5.1).

17. The Action Plan addresses the specific structural, regulatory, and pricing reforms for the electricity subsector in a five-phase program that can serve as a model for restructuring the other energy subsectors. The Action Plan's main principles include: (1) the separation of the Government's policy making, ownership, operating and regulatory functions; (2) the commercialization of the subsectors; (3) the introduction of competition and the promotion of private sector participation (where appropriate); (4) the transfer of ownership of the distribution and district heating companies to the districts or municipalities; and (5) reform of the pricing system.

18. The prospects for competition in the Lithuanian energy sector are limited because of the small size of the market and the dominance of the Ignalina nuclear power plant in the power generation market. However, Lithuania must commercialize and corporatize those companies that will remain state-owned, and GoL should consider privatization in areas where competition can be fostered.

Main Recommendations for Restructuring the Energy Sector

- Transfer any regulatory, supervisory, and policy-making functions still under the energy enterprises to the Government or regulatory agency (e.g., technical inspection).
- Privatize services which do not fall under the core activities of the energy enterprises (e.g., construction, manufacturing, research).
- Separate the heat, electricity and gas distribution companies from the generation and transmission companies, allowing these companies to recover their local distribution costs.
- Complete the privatization of retail fuel stations.

Regulatory Framework

19. Lithuania is in the process of setting up a regulatory framework for the energy sector, and the draft Energy Law calls for the establishment of an Independent Regulatory Agency (IRA) to oversee both pricing and technical standards in the energy sector. The specific regulations for the IRA will be determined once the body is legally established.

Main Recommendations on an Independent Regulatory Agency

- Ensure that the IRA not only protects the consumer but also determines a fair price at which utilities can maintain their plant and equipment, raise funds in the capital markets, and self-finance necessary expansions.
- Establish a simple and transparent pricing formula for monopolies. In the transition period, price capping may be the most appropriate system of price regulation because it does not require a costly review of asset values, it can be quickly and periodically adjusted, and it provides incentive for the utilities to improve efficiency and plan for long-term investments.

- Where competitive markets can be fostered (e.g., the petroleum products market), the GoL will have to back regulation with anti-trust legislation to prevent collusion and other forms of anti-competitive behavior.

F. THE ELECTRICITY AND DISTRICT HEATING SUBSECTORS

20. The major issues dominating the Lithuanian electricity and district heating subsectors are: (1) the safety concerns about the Ignalina nuclear power plant and hence its future role in the electricity system; (2) the cost and supply of fossil fuels (heavy fuel and natural gas) for electricity and heat production, and (3) the old age and poor condition of a number of generating units.

Electricity Subsector

21. The Ignalina nuclear power plant, consisting of two (RBMK) reactors of the same design as the Chernobyl units, but of a later vintage, does not comply with internationally accepted standards of safety. The Group of Seven industrialized countries (G-7) have asked for immediate safety upgrades and the retirement of these "unsafe" units, as soon as possible. Meanwhile, the Ignalina plant produces more than 90% of the country's electricity because the production cost of electricity is much lower than that of fossil-fired units. The energy sector's dependence on a single nuclear plant with inadequate safety provisions constitutes a dangerous situation for the country. At the request of the G-7, the GoL and LSPS have been negotiating with the European Bank of Reconstruction and Development (EBRD) the terms of a grant of about ECU 33 million from the Nuclear Safety Account to upgrade the Ignalina units and agree on a program to retire the units on an accelerated schedule. The World Bank, although it does not lend for nuclear power projects, has stated that its lending will take into account nuclear safety issues.

22. A number of thermal units burning oil and gas are old and unreliable. In addition, they lack adequate control equipment, creating safety hazards for the operating staff and causing inefficiency. Moreover, their lack of emission control and use of high-sulfur fuel oil make them major polluters. Since most of these units produce little power at the present time, there is little justification for their extensive rehabilitation. However, some of these thermal units are combined-heat-and-power (CHP) producers; as such, they are indispensable for a certain number of hours a year in providing heat to the towns connected to District Heating (DH) systems. Rehabilitating CHP units is therefore a higher priority than rehabilitating power-only units.

District Heating Subsector

23. Heat-only boilers (HOB) supply 70% of the heat in district heating systems; only 30% comes from combined-heat-and-power (CHP) plants. Lithuania's local heat distribution networks suffer from high heat and water losses because of poor design, poor construction and maintenance, and inefficient operation.

<u>Main Recommendations on Electricity and District Heating Subsectors</u>

- Implement safety upgrades as soon as possible at Ignalina, following the conclusion of international agencies and using the funds earmarked by EBRD's NSA. The ECU 38 million currently being negotiated for the first phase of the upgrading for the project will be insufficient for adequate safety upgrading. Therefore, the Lithuanian authorities should seek additional funding from EBRD's NSA or other sources.

- Establish priorities to rehabilitate the fossil-fuel plants and upgrade the electricity system to meet present urgent requirements, giving due weight to the CHP units in major towns and maintaining flexibility to enhance the program after a decision on Ignalina is made.

- Seek an agreement with Poland to establish a high-voltage interconnection to allow economic energy exchanges and improved system reliability.

- Pursue cooperation with neighboring states to analyze least-cost, long-term alternatives for electricity supply and negotiate supply contracts as needed.

- Give high priority to a DH rehabilitation program to bring about energy savings (projected at about 25%) and service improvements. To reduce the country's foreign exchange bill for heavy fuel oil, examine the extent to which indigenous fuels (wood chips and peat) could be used in small, dispersed DH systems or local industries in the country to reduce the foreign exchange bill for heavy fuel oil.

G. THE PETROLEUM AND GAS SUBSECTORS

Petroleum Subsector

24. The main issues in the petroleum subsector, in addition to the heavy dependence on Russian imports mentioned above, are the uncompetitive position of the Mazeikiai refinery, and the still regulated market in petroleum products.

<u>Main Recommendations on Petroleum Subsector</u>

- Address the refinery rehabilitation and planned port terminal and pipeline projects as a regional program based on consultants' studies. Projects justified only on grounds of supply security should be limited to the minimum capacity required to provide the country with energy in case of emergencies;

- View the complex of petroleum projects in a broader regional context, inviting participation of the private sector, possibly including Russian suppliers.

- In the petroleum products subsector, actively encourage private sector participation by liberalizing refined product prices and establish a legal framework for competition.

Natural Gas Subsector

25. The principal gas sector problems are: (1) the poor condition of the gas pipeline network, (2) inadequate maintenance, and (3) an inadequate tariff structure.

Main Recommendations on Gas Subsector

- Begin a phased program of system rehabilitation, including the installation of improved leak detection, better maintenance systems, and metering stations at the borders to more accurately measure gas quantities transmitted.

- Introduce seasonal gas tariffs and connection charges to help the gas company finance the necessary expansion projects and maintain the network.

H. INVESTMENT PLANS AND FINANCING OPTIONS

Investment Needs

26. Owing to the economic contraction of the Lithuanian economy and the expected long-term reduction in energy intensity through conservation and efficiency improvements, there is little need for new capacity in energy generation and transmission. Instead, all efforts should be concentrated on rehabilitating existing facilities and retiring, in a planned manner, those that are not needed, inefficient, obsolete or unsafe. The GoL estimates total energy sector investment needs in the period 1993-95 at about US$ 650 million or about US$ 215 million per year; and in the period 1996-2000, about US$ 1.2 billion or about US$ 240 million per year. These estimates are too high considering the rapid fall in energy demand and the high debt burden that this would represent for the country. An investment program focussed on the rehabilitation of viable units would amount to about 50% of the GoL estimates and would be more realistic.

Financing Options

27. With appropriate energy sector restructuring and price liberalization, most expenditures discussed above should be financed without direct budgetary support over the long term. However, in the short term, Government support is likely to be required in a number of subsectors because of the current weak financial situation of energy institutions, inadequate tariffs, and consumers' limited ability to absorb substantial tariff increases.

28. In the petroleum subsector, the investments to modernize the refinery are expected to be commercially viable. Under proper conditions, commercial loan and equity investors could be attracted to finance the modernization projects.

29. In the gas subsector, investments will depend on the Government's pricing policies. As long as prices to households continue to be subsidized, the investment costs will have to be borne partly by the Government.

30. In the electricity subsector, availability of funding will depend largely on setting electricity

tariffs that cover costs of generation, transmission and distribution[1]. Financing hard-currency investments in the electricity sector without access to foreign loans will lead to severe foreign exchange shortages in other sectors of the economy and will jeopardize the Government's stabilization program. If an appropriate tariff structure and an appropriate legal and regulatory framework are established, both domestic and foreign lenders could be attracted to the subsector.

31. In the district heating subsector where household tariffs are very low, only local government budgets and direct support of the central Government are possible sources of financing.

Main Recommendations on Overall Investment Program

- Since there is little need for new capacity, plan to invest in rehabilitating existing facilities and retiring, in a planned manner, those that are not needed, inefficient, obsolete or unsafe.
- Concentrate government efforts on non-commercial investments designed to increase security of oil supply, upgrade safety of the nuclear plants, and provide technical assistance.
- Accelerate legislation, especially in the petroleum subsector, to provide a legal framework to attract local and foreign capital.
- Taking into consideration the recommendations of the G-7, decide on the future of the nuclear plant at Ignalina; this is critical to allow for a timely decision on other investments needed in the electricity subsector.
- Accelerate introduction of tariffs designed to enable energy enterprises to become financially viable.

ACTION PLAN

32. The Action Plan below collates the main recommendations of this study, based on its analyses of the overall energy sector as well as individual subsectors.

[1] This excludes the safety upgrades for Ignalina, for which grant financing is being planned by EBRD.

LITHUANIA
Energy Sector Action Plan

No.	Text Para. Ref.	Area/Issue (Priority)	Action	Responsible Party	TA (Aid Agency)	Implementation				
						93	94	95	96	97
1.0		SECTOR MANAGEMENT AND REGULATION								
1.1	5.21	Lack of clear legal basis for competition and restructuring in the energy sector. (A)	Complete the draft Energy Law for adoption by Parliament including clear provisions for the development of competition	Government of Lithuania	Yes	x				
1.2	5.25 - 5.32	Energy subsectors depend on centralized planning and subsidies and have weak management and financial positions. (A)	Restructure and commercialize the electricity subsector according to plan of action adopted by the LSPS. Develop similar plans for other subsectors based on experience with electricity subsector	Government of Lithuania//LSPS/Energy Agencies	Yes		x			
1.3	5.35 and Annex 5.1	Regulation of energy prices is not transparent or independent. (B)	Create a Regulation Working Group to prepare regulatory functions	Government of Lithuania	Yes		x			
2.0		ENERGY PRICES								
2.1	4.26	Energy prices to end users do not cover costs, and in the district heating sector contain a large cross subsidy to the benefit of households	Increase prices to cover costs for all energy except district heating. Replace direct district heating subsidies with a cross subsidy from electricity tax. Eliminate all other subsidies.	Cabinet of Ministers/Ministry of Economy	Yes	x				
2.2	4.26	Wholesale energy prices in the electricity and gas sectors do not cover costs of the wholesale company and contain cross subsidies between downstream companies	Establish fixed wholesale prices which distribution companies must pay for delivered energy. Increase prices to cover costs, and remove cross subsidies.			x				

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No.	Text Para. Ref.	Area/Issue (Priority)	Action	Responsible Party	TA (Aid Agency)	Implementation 93	94	95	96	97
3.0		ENERGY CONSERVATION								
3.1	3.20	There is no agency in the Government responsible for the coordination of energy conservation efforts on a nationwide, cross-sectional basis (A)	Set up an Energy Conservation and Efficiency Unit to coordinate conservation efforts		Yes	x	x			
3.2	3.21	No or few companies/organizations exist which can carry out industrial energy audits and assist enterprises to develop energy conservation strategies (A)	Continue to obtain foreign technical assistance with the purpose of acquiring domestic know-how in energy conservation		Yes (USAID, CEC-THERMIS)	x	x	x	x	
3.3	3.19 5.37	Electricity, district heating and gas utilities have no incentives to promote consumer energy efficiency improvements (B)	Design and implement regulatory mechanisms which offer incentives to energy utilities to promote energy-saving measures among customers		Yes		x			

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No.	Text Para. Ref.	Area/Issue (Priority)	Action	Responsible Party	TA (Aid Agency)	Implementation 93	94	95	96	97
4.0		**OIL SUBSECTOR**								
4.1	8.5	Oil Supply Security (A)	Encourage the refinery to sign direct contracts with Russian oil producers. Provide an alternative least-cost crude oil receiving facility for imports from the international market. Promote 1-2 year tolling contracts with Russia/Western European oil trading/marketing companies.	MoE/KSOT		x	x	x	x	x
4.2	8.25-8.27	Competitiveness of the Refinery (A)	Complete ongoing integrated study on current and potential future competitiveness of the refinery. Agree on priorities for justified investments based on study outcome. In the meantime, hold off any major investment plans in the port, infrastructure and refinery areas.	MoE/Mazeikiai Refinery/ USTDA	Yes (USTDA study due for completion in July 1993, by consultant Foster-Wheeler, USA).	x	x	x		
4.3	8.29	Rehabilitate and modernization of storage and distribution network for refined products (A)	Carry out a study on the extent of storage capacity expansion and modernization required for supply assurance, including pollution abatement to ensure efficient operations. Accepted study recommendations to be implemented in medium to longer term.	MoE/Lithuania Fuels	Yes, to be initiated and completed in 1993, cost: about $200,000. Bank will review TOR's	x	x	x		
4.4	8.16	Marketing of products and import/export trade institutional arrangements are not on commercial lines. Refinery management capabilities are deficient. (A)	(a) Corporatize Lithuanian Fuels to facilitate petroleum trade on commercial lines, with minimum direct Govt. intervention; (b) privatize retail stations through sale to domestic and foreign investors, and use proceeds to modernize wholesale storage, transport, and marketing infrastructures, strengthen institutions and training programs.	MoE/Lithuania Fuels/Refinery	Yes	x	x			

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						Implementation				
No.	Text Para. Ref.	Area/Issue (Priority)	Action	Responsible Party	TA (Aid Agency)	93	94	95	96	97
4.5	8.3	Lack of capital for development of indigenous oil fields. (B)	Attract western partners' investment by establishing a sound legal framework and providing incentives. Capitalize on already expressed interest.	SGS			x	x	x	x
4.6	8.18-8.23	Environmental pollution controls at refinery and at storage/marketing facilities are inadequate. (B)	Initiate and support program for development of pollution control standards; audit of existing facilities/systems for control and methods for improvement to conform to standards; and training of operating and management personnel.	MoE/Refinery and environment agencies.	Yes		x	x		
5.0		GAS SUBSECTOR								
5.1	9.6 9.7 9.8	Gas Supply Security (A)	Negotiate intergovernmental agreements with Russia, seeking a longer term gas import agreement. Apply a regional approach together with other Baltic and neighboring CIS states.	MoE/Lithuania Gas	No	x	x			
5.2	9.10 9.14	Inefficient use of gas (A)	Promote extensive energy conservation measures together with gas pricing reform.	MoE/Lithuania Gas		x	x	x		
5.3	9.21	Lack of gas meters for households (A)	Develop and implement a phased program for installing gas meters in the residential market.	Lithuania Gas		x	x	x	x	x
5.5	9.16	Lack of a comprehensive gas subsector regulatory framework (B)	Establish a rational regulatory framework based on the gas sector development study which is under implementation with Danish consultants.		Yes (Danish Oil & Natural Gas Co. - DONG)		x	x		
6.0		ELECTRICITY								
6.1	7.18	The Ignalina nuclear power units are considered "unsafe" by international standards. (A)	Decide on a retirement plan with nuclear safety upgrade program, in agreement with G-7 requests and with their financial support.	MoE/INPP	Yes	x	x	x	x	
6.2	6.32 - 6.35 and Annex 6.9	Ignalina is running out of space for spent fuel storage. (A)	Consider alternatives. Choose least-cost solution.	MoE/INPP	Yes (Swiss grant agency)	x	x	x		

LITHUANIA
Energy Sector Action Plan

						Implementation				
No.	**Text Para. Ref.**	**Area/Issue (Priority)**	**Action**	**Responsible Party**	**TA (Aid Agency)**	**93**	**94**	**95**	**96**	**97**
6.3	6.9-6.17	Thermal Power Plants are getting old. Electricity transmission system is based on obsolete, unreliable and unsafe equipment. (A)	Choose economically justified, least-cost rehabilitation and upgrade program.	LSPS	Yes (USTDA, studies by Stone & Webster Co. and USAID/Electro-tek/EPIC)	x	x	x	x	x
6.4	3.15	Electricity exports and price are uncertain. (A)	Conclude commercial contracts on amounts and prices with importers (Belarus, Kaliningrad, and Latvia).	MoE/LSPS	TA (USAID)	x	x			
6.5	6.48-6.49	Line to Poland and to UCPTE does not exist. (B)	Conclude interconnection agreement with Poland. Plan interconnection project	LSPS	No		x	x		
6.6	6.25-6.28	Pumped Hydro Plant Kruonis is important but has reduced role. (B)	Consider completion of fourth unit only if current study demonstrates economic justification under reduced demand conditions.	LSPS	No	x	x			
7.0		DISTRICT HEATING								
7.1	6.60-6.62	Excessive use of heavy fuel oil in heat-only boilers. (A)	Plan conversion of small DH boilers to wood chips with environmental assessment.	LSPS/Siluma	Yes (CEC, Swedish BITS)	x	x	x		
7.2	6.66	DH Systems are wasteful of energy and improperly designed. (A)	Make master plans to improve DH systems in major cities.	LSPS/Siluma	Yes (Danish Energy Agency)	x	x	x		

I. INTRODUCTION

Country Profile

1.1 Lithuania is situated in the center of Europe (the geometric center of the continent is in eastern Lithuania). The country lies on the south-eastern corner of the Baltic Sea, which borders the country on its western side with a coastline of 99 km. Lithuania is also bordered by Latvia on the north (610 km), Belarus on the east and south (724 km), and Poland (110 km) and the Kaliningrad region of Russia (303 km) on the southwest. The country's area of 65,200 sq. km is larger than that of Belgium, Denmark, the Netherlands, and Switzerland.

1.2 Lithuania has a population of about 3.8 million with a per capita GDP estimated at about US$ 1,310 in 1993. About 84% of its people are ethnically Lithuanian, with 9% Russian and 7% of Polish origin. The country is about 70% urban and 30% rural. The country's capital, Vilnius, has a population of about 600,000 people, making it the largest city in Lithuania. Its other major cities are Kaunas (pop. 430,000), Klaipeda (pop. 206,000), Siauliai (pop. 150,000), and Panevezys (pop. 130,000).

1.3 Lithuania underwent drastic political transformations in recent years. It became independent from the Former Soviet Union (FSU) on March 11, 1990. The governments that have taken power since independence have followed a policy of economic reform and closer relations with the West. Recent parliamentary and presidential elections (October 1992 and February 1993 respectively) have confirmed the country's commitment to economic reforms and an opening to the West.

1.4 After 1940, Lithuania became integrated in the economic system of the FSU and subsequently in the Council of Mutual Economic Assistance (CMEA). About 90% of its trade was with the countries of the FSU. The severe disruption of trade with the FSU has led to acute domestic shortages of a variety of consumption commodities, including vital primary energy supplies. By the beginning of 1992, the lack of supplies was so grave that many industries had to curtail output. As a result, real GDP was halved between 1989 and 1992.

Energy Sector

1.5 The energy sector is of primary concern to the country not only because of the importance of energy for economic development but also because of the country's large potential to export processed energy in the form of refined petroleum products from the Mazeikiai refinery and electricity, mainly from its nuclear plant at Ignalina. The country's energy sector is characterized by almost total dependence on imports, until recently from the FSU and now Russia. The local resources are a limited hydroelectric potential (about 100 MW of which is exploited), geothermal fields of low temperature, and a modest potential resource of hydrocarbons. Essentially all fuels, including nuclear fuel to operate the nuclear power plant at Ignalina, have been and are likely to continue to be imported from Russia.

1.6 Since the country was completely integrated in the FSU and all planning and even operational decisions were made at central ministries in Moscow, local capacity for planning, project evaluation, and decision making in general was and still is limited. In addition, the massive price distortions and state control over resource allocation that characterized the centrally planned economic system led to a very high energy intensity of the economy, with attendant environmental degradation.

1.7 Energy supplies to Lithuania, as well as to Estonia and Latvia have been severely disrupted owing to production difficulties in Russia, technical problems in transmission facilities, and the transition to hard currency payment at world market prices for energy trade. The difficulties have been exacerbated by strained political relations, including disputes on the treatment of minorities, between the Baltic countries and Russia.

1.8 Since independence, the Government of Lithuania (GOL) has embarked on an intensive effort to break its exclusive ties with the FSU; this effort has focused on diversifying fuel supplies, developing trade with Western countries, and most importantly, raising energy prices to levels that at least cover the cost of imported fuels. The GOL that was formed in October of 1992 quickly announced that electricity, and to a lesser degree, heat tariffs would rise to allow recovery of costs; lower-income families were to be partially compensated through direct payments to consumers. The GOL also announced that a new energy strategy would be based on the following basic principles: (a) higher prices to allow at least recovery of production costs, (b) diversification of supply, whenever possible; (c) efficiency improvement in energy production and use, and elimination of energy waste; (d) development and increased use of indigenous resources; and (e) optimal utilization of existing facilities. The GOL also requested the assistance of bilateral and multilateral donors, including the World Bank, in performing a thorough review of the energy sector leading to the formulation of an energy strategy.

1.9 The Energy Sector Review (ESR) presented in this report is the product of close cooperation between the Bank and staff of the Ministry of Energy (MoE) energy research institutions, and the energy entities of Lithuania. The information was collected by the main Bank mission in October-November 1992 and supplemented by the missions of March and June 1993. The work was conducted in parallel with the "Alternative Power Sources (G-7) Study" (May 1993), which examined the cost implications of retiring the Ignalina nuclear power plant. Owing to the importance of Ignalina to the energy sector (about 90% of electricity production now comes from this one plant), the two reports must be considered together. A summary of the G-7 study is presented in this report. The ESR reflects the analyses of the Bank as well as many views, comments, and recommendations of Lithuanian energy experts and Government officials.

1.10 Based on the findings of the ESR, a more detailed energy strategy can be developed. Such a strategy should take into account available options and their priorities, existing limits in financial resources, the technical and institutional capabilities of the country, and the environmental impact of each element of the program. Political and public support will also be needed to implement the program.

1.11 Chapter II (immediately following this section) examines the role of the energy sector in the economy of Lithuania. Chapter III presents an overview of energy supply, trade, and demand, including demand projections developed at the Bank using a macroeconomic energy model. Chapter IV discusses energy price developments and policy issues. Chapter V reviews the structure and institutions of the sector. Chapter VI discusses the electricity and district heating subsectors. Chapter VII addresses the more specialized "Alternative Power Sources (G-7) Study" on possible replacement of the nuclear units at Ignalina. Chapters VIII and IX examine, respectively, the petroleum and natural gas subsectors. Chapter X examines costs estimates for the investments required in the energy sector.

II. ENERGY AND THE ECONOMY

A. Introduction

2.1 Lithuania is an energy-poor nation with an energy industry designed to supply a region substantially larger than itself. The central planners of the former Soviet Union located energy industries in Lithuania partly because of the technical competence in the country. The energy industry is dominated by an oil refinery, a nuclear power plant and a large thermal power plant. Prior to Lithuania's independence and recent economic slowdown, the Lithuanian energy industry had a capacity to export approximately 7 million tons of oil equivalent (Mtoe). This amounted to nearly 40% of the sector's total potential output. Today an even larger share of nominal capacity is available for exports, but the energy requirements and purchasing power of neighboring countries has declined. The Lithuanian energy sector was, and still is, dependent on raw material imports from Russia (oil, gas and nuclear fuel). Lithuania's own energy resources are not substantial and have been left largely unexplored. The country has limited oil and gas reserves, as well as about 400 MW of hydroelectric potential (of which 100 MW has been developed).

2.2 Lithuania has recently been faced with a dramatic downturn in economic activity, partly as a result of the difficulties experienced in its transition to a market economy. Owing to the export-oriented structure of its economy and the shortage of domestic mineral and energy resources, Lithuania belongs to the group of FSU-states that was most severely affected by the upheaval of the union's economic system and the precipitous decline in purchasing power throughout the region. The rapid increase in energy import prices has caused a sharp deterioration in its terms of trade. Lithuania has also suffered from energy shortages caused by serious trade disputes with Russia. These disputes have centered mostly on exchange rates and payment of arrears.

2.3 Lithuania faces a number of priority issues in the energy sector, including:

- Restoration and improvement of trading relations with neighboring states, in particular with Russia
- Adoption of an acceptable solution to the safety problem of the Ignalina nuclear power plant
- Diversification of its sources of energy imports
- Rehabilitation of substantial parts of its energy industry
- Reorganization of its energy institutions
- Regional cooperation to solve energy supply problems.

B. Macroeconomic Performance

2.4 The Lithuanian Gross Domestic Product (GDP) increased on average by 4.6% per year from 1980 to 1989, although at an uneven rate (see Figure 2.1) However, in 1990 and 1991, GDP declined 5% and 15% respectively. During 1992, GDP is estimated to have declined a further 36%, leaving per capita GDP at about US$ 1,700. GDP began to stabilize toward the end of 1993, but the country still experienced a 16% decline for the whole year. Key economic data for 1990-1993 are contained in Table 2.1.

2.5 As a small country whose economy was tightly integrated with that of the FSU, Lithuania depends heavily on trade, particularly with the FSU. The severe disruption of trade with the FSU has led to domestic shortages of a wide range of essential inputs into production and of many consumption commodities. In 1992, the energy shortage in Lithuania clearly exacerbated the decline in output. Industrial output in December 1992 was less than 30% of the level in December 1991 (see Figure 2.2). Industrial output showed signs of stabilizing through 1993, albeit at very low levels. Lithuania, like most of the FSU, has substantial overcapacity in the industrial sector compared to demand in its own market. Since the economy cannot easily adjust much of its export-oriented industrial capacity to serve Western markets, the restructuring process will inevitably cause a decline in production. Labor will need to be reallocated, particularly to the previously neglected service sector[1].

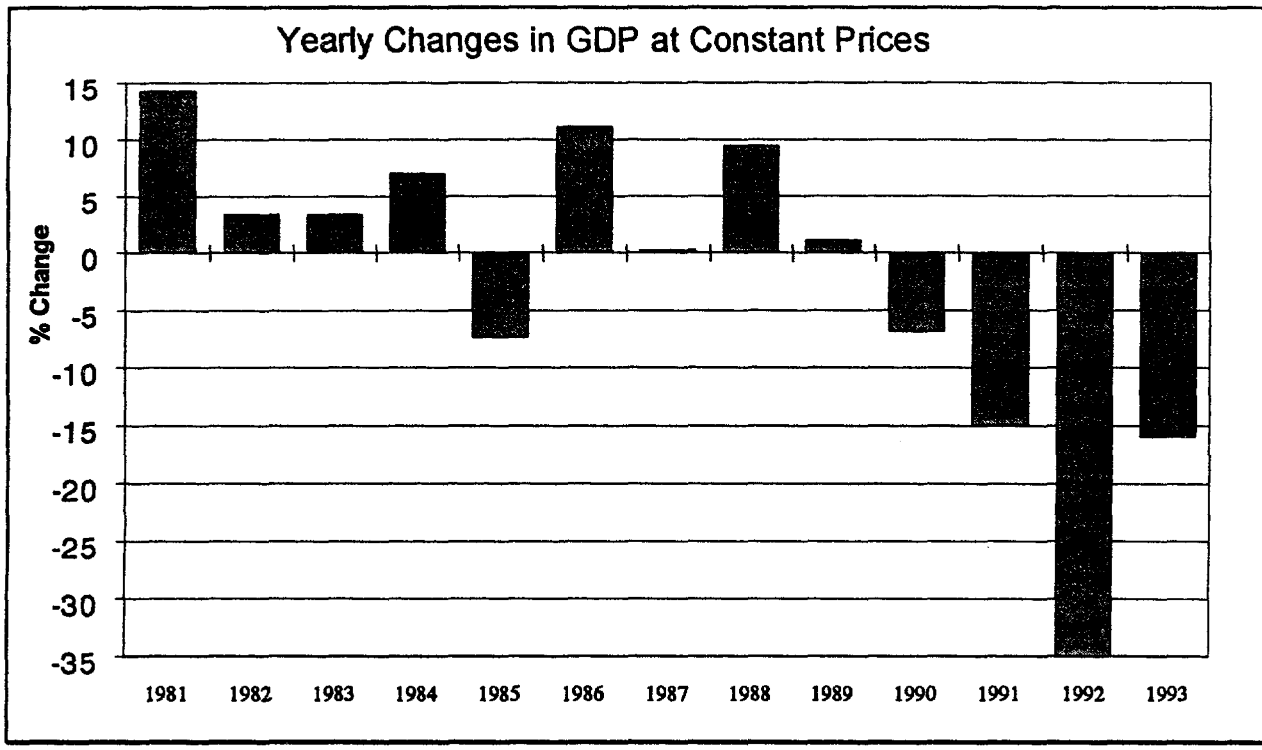

Figure 2.1

2.6 The timing of a recovery for the Lithuanian economy will depend on a number of internal and external factors, including (a) the consistency and speed of reforms, (b) the normalization of trade with the FSU, and (c) the availability of foreign financing. The energy demand model described in Chapter III uses three scenarios for GDP development -- a high, low, and medium case -- for the period 1993-2010 (see Figure 3.6). In the base scenario, GDP is expected to grow by 5.6% per year in the second half of this decade, followed by 4.4% yearly growth in the first decade of next century.

1 For comparison, the number of shops in Italy is nine times higher per capita than in the FSU.

2.7 The energy sector plays an important role in the Lithuanian economy. In 1990, the ruble value of its production was about 9% of total industrial production. This made it the fourth largest industry in Lithuania, after the food processing industry (25%), the machine tool and metal working industry (24%) and the textile industry (16%). Prior to independence, the energy sector was largely fiscally neutral, that is, transfers from the state budget to the energy enterprises were balanced by tax revenues from these industries. However, the prices of imported energy products from Russia were artificially low, effectively subsidized by Russia. Following independence, the energy sector has required significant budget transfers, mostly in the form of subsidies (see Chapter IV). In 1991, refined energy products constituted 7% of Lithuanian exports, (evenly split between electricity and oil products exports), while oil, gas and coal constituted 15% of Lithuanian imports. However, real energy import prices increased 6 to 10 times over 1991-1992, substantially more than prices for manufactured products. Energy exports have grown in value terms relative to Lithuania's other exports, but they have not grown as fast as primary energy imports[2].

Table 2.1: Key Economic Data

	1990	1991	1992	1993
GDP, constant 1990 prices (Rb billion)	13	11	7	6
GDP, nominal prices (Litai equivalent)	129	381	3,269	13,318
Inflation (CPI growth, %)	8	225	1020	410
Average Real Monthly Wage (1990 = 100)	100	80	71	39
Average Exchange Rate (Litai equivalent per US$)	.006	.018	1.8	4.1
Trade Balance (US $ million)		1,846	61	-267

C. Energy Intensity of the Economy

2.8 As is the case in other formerly planned economies, the energy intensity of the Lithuanian economy (1,500 kgoe per 1000 US$ of GDP in 1990) is many times that in Western economies. A comparison of energy intensity for fourteen selected countries is shown in Figure 2.3. Lithuania's industries are relatively less energy intensive than in many former Soviet republics, since very little heavy industry (such as defense) has been located in Lithuania. In 1992 and 1993, the Lithuanian economy declined more than energy consumption, owing to the proportion of fixed consumption in overall energy use. The result has been a temporary increase in energy intensity. This will fall as more fundamental, long-term restructuring takes place.

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[2] The export market has been severely curtailed due to falling demand and uneconomically low Russian exports of processed energy. In most cases, Lithuania has had to cease exporting oil products and electricity because it was unprofitable.

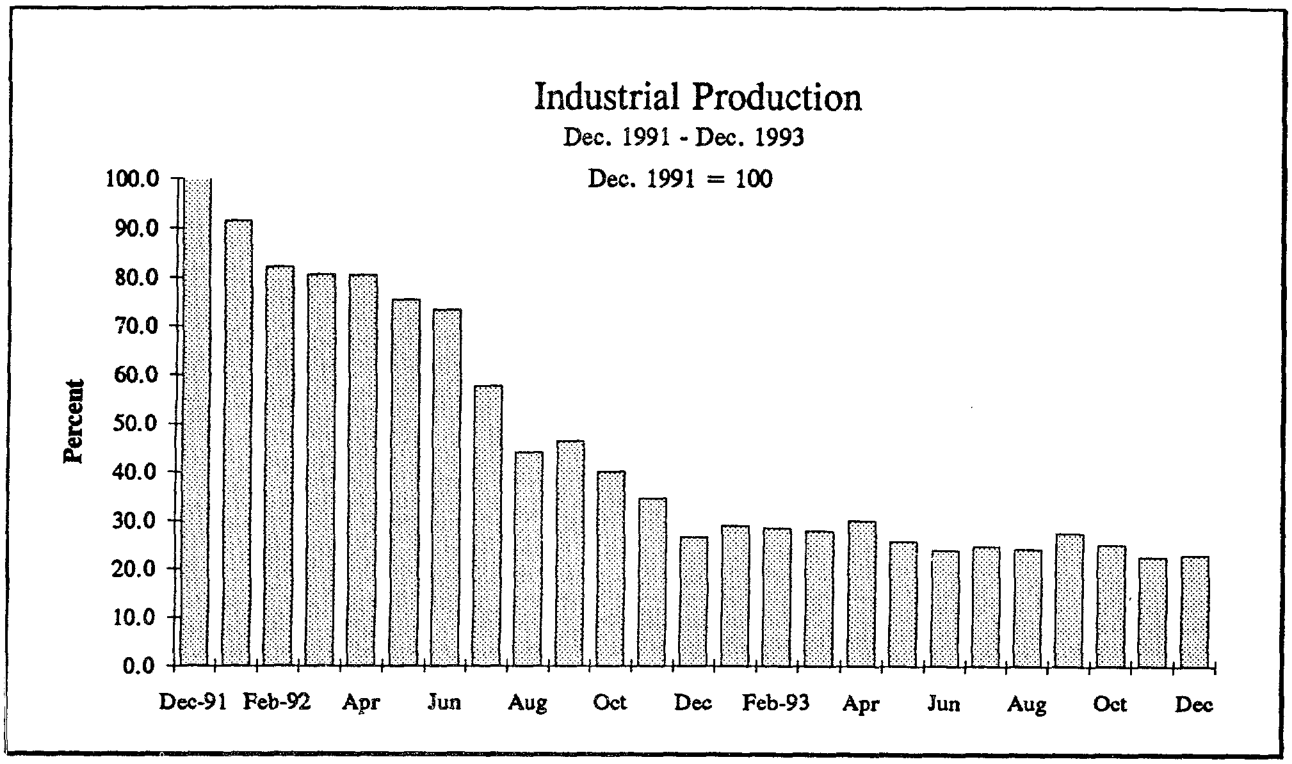

Figure 2.2

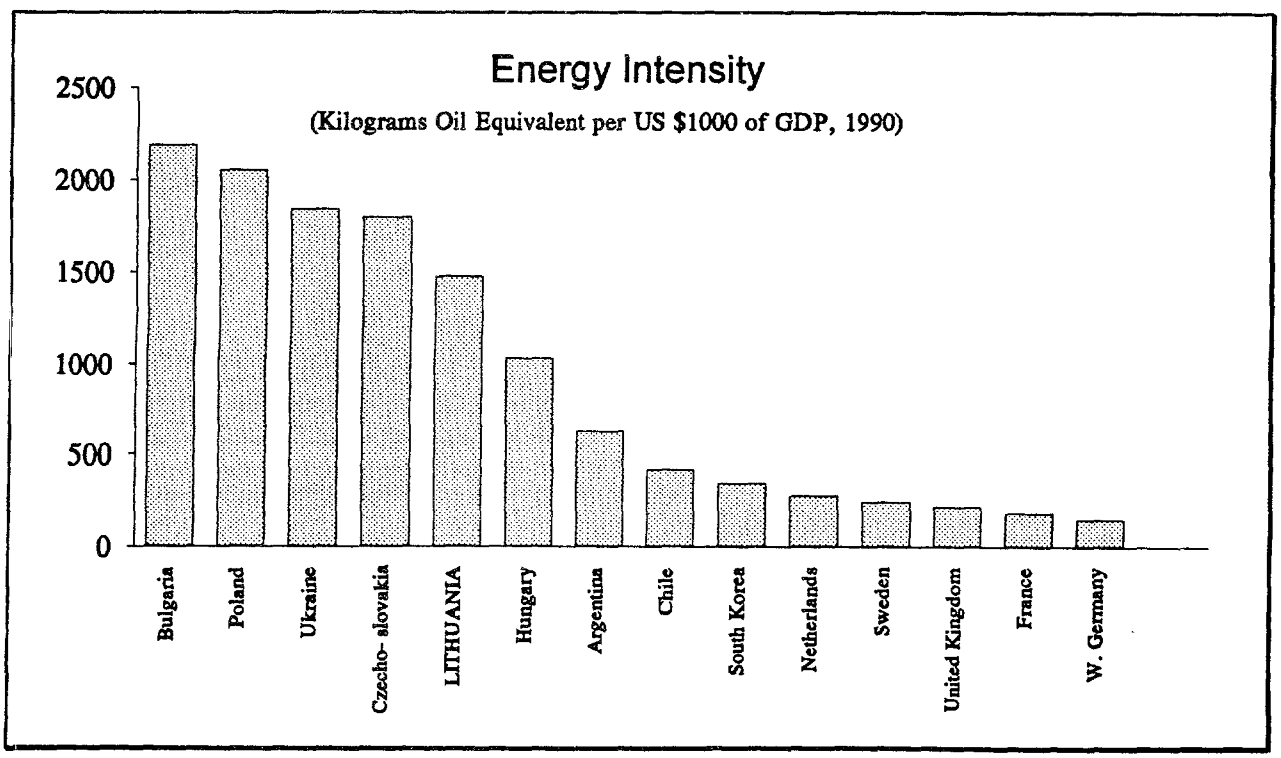

Figure 2.3

2.9 Figure 2.4 shows the relationship between energy consumption and GDP on a per capita basis for 19 countries[3]. Most of the countries selected have climatic conditions similar to Lithuania's. The analysis indicates that in 1990 Lithuania consumed about 40% more than the average predicted value on the basis of its estimated per capita GDP level.

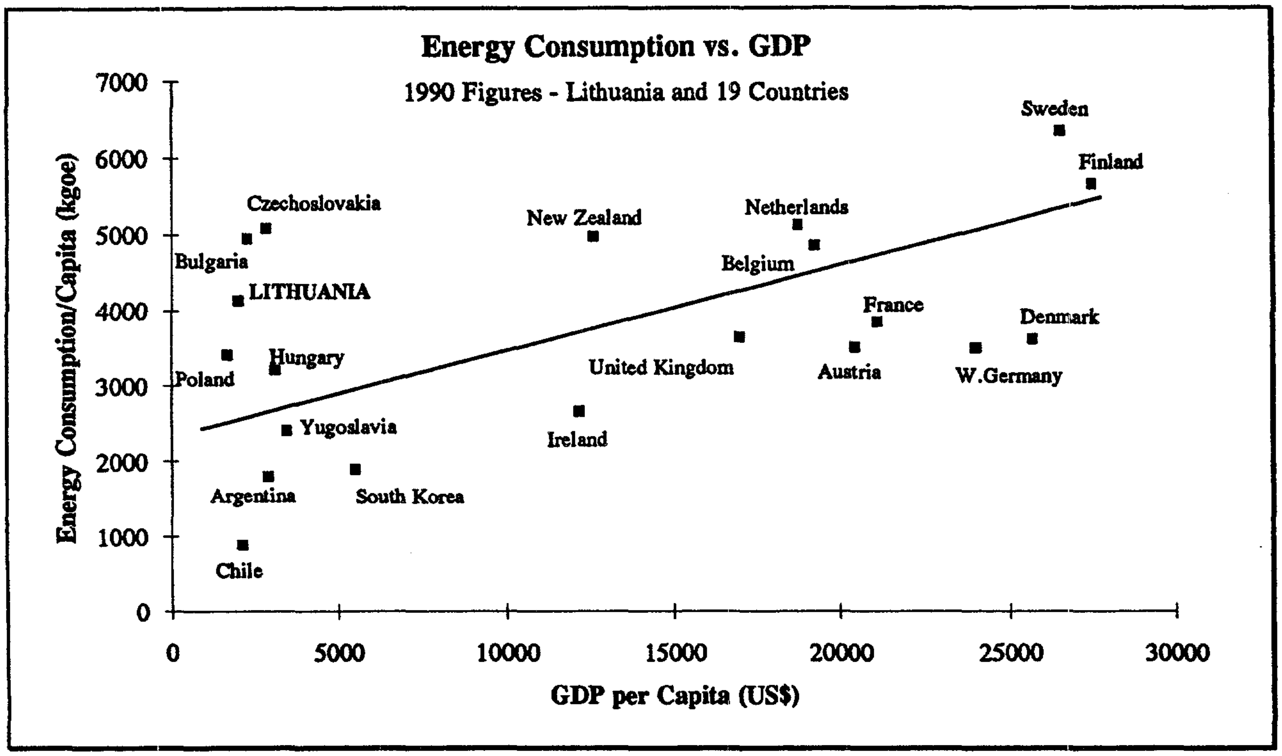

Figure 2.4

D. Energy Sector Overview

Energy Sector Facilities

2.10 Electricity. Lithuania has an installed power production capacity of 5,600 MW. This allows for substantial exports, because less than half the capacity is needed to meet domestic demand. The Ignalina nuclear power station has two units for a total capacity of 2,500 MW, and is one of the largest nuclear plants in the FSU. The other dominant facility in the power subsector is the oil- and gas-fired Elektrenai power station (1,800 MW). The Kruonis hydro pumped storage plant is an important peak capacity facility, developed in anticipation of cheap, off-peak nuclear energy being available for night pumping. Two more units are scheduled to be completed, the first of which is currently undergoing commissioning; owing to the drop in demand and lack of financing, the completion of the final unit is somewhat uncertain.

[3] Data for all countries except Lithuania were taken from the Bank's 1992 World Development Report.

2.11 Petroleum. The Mazeikiai oil refinery is the only refinery in the Baltic region. During the 1980s, it was running close to full capacity (12 to 13 million tons per year). In 1992, only about 50% of its capacity was utilized. This reduction was due to rising crude oil prices that made Mazeikiai uncompetitive against Russian refineries (which received low-priced oil). Another reason was that Mazeikiai had to stop production because of a halt in oil supplies from August to October 1992 which resulted from a price dispute. During 1993, the refinery operated largely on a throughput basis at a much reduced capacity. An oil terminal in the seaport town of Klaipeda handles exports of heavy fuel oil from refineries in the FSU. In 1991 and 1992 shipments from the terminal were about 6 million tons per year; 90% of that is Russian heavy fuel oil. The facilities are obsolete, and the MoE is also planning to invest in a proposed new terminal to allow for crude oil imports to the Mazeikiai refinery.

2.12 Natural Gas. Lithuania has a 1,400 km long high-pressure gas transmission system, as well as a network to supply industries with lower pressure gas. Of the 6 billion cubic meters (bcm) of gas supplied in 1991, more than half was used in heat and electricity production. Two import pipelines through Belarus have much more transportation capacity than Lithuania needs. Up to 2 bcm per year may be transited via Lithuania to Latvia through a reversible-flow pipeline, and 0.5 bcm per year may be transited to Kaliningrad.

2.13 Coal. Lithuania imports coal by rail from the FSU (and previously from Poland) and distributes it by rail or road to end users in the industrial and household sectors. Coal is not used in power generation. Lithuania does not have seaport facilities to import coal. This largely limits the number of its supply sources from the FSU countries and Poland.

Energy Sector Issues

2.14 The main issues that Lithuania faces in the energy sector include the following:

- Need to restore and improve trading relations with neighboring states, particularly with Russia. Lithuania's early move to separate from the Soviet Union severely strained the trading relationships with its most important trading partner, Russia. Lithuanian authorities tend to believe that trade issues with Russia throughout 1992 were negatively affected by political relations. While it is certainly true that Russia supplied member countries of the CIS at lower energy prices than it did to Lithuania, it is also clear that Russian prices to Lithuania have been set largely on a commercial -- as opposed to a political -- basis. Indeed, there may still be some scope for further price rises to Lithuania (see Chapter IV).

- Need to reduce dependence on Russia for energy supplies. Reducing dependence on one dominant energy supplier makes sense in order to improve the security of supply and to increase commercial leverage. In the gas sector this may be impossible in this century, partly due to the great distance to other sources of supply and the prohibitive costs of developing new infrastructure. In the oil sector the physical dependence on Russian crude supplies may be overcome by harbor investments in Lithuania or in Latvia, but this could be prohibitively expensive (see Chapter VIII). Although Lithuania still gets most of its coal supplies from Russia, it has sufficient rail facilities to import coal from a number of other countries, particularly Poland. Although Lithuania could theoretically find another supplier to produce the specialized fuel required for Ignalina, it is unlikely that a Western supplier could compete with Russian suppliers, who enjoy advantages in economies of scale and lower input costs. Lithuania must establish its energy trade with Russia on sound, commercial principles that give *both parties incentives to adhere to their obligations.*

- Need to find acceptable solution to the safety problem at Ignalina Nuclear Plant. Lithuania's two RBMK (Chernobyl type) reactors are generally considered unsafe by Western standards. The severe energy crisis in Lithuania has hardened the Government's resolve to continue to operate these units until the end of their economic life (2010). In compliance with a request from the Group of Seven (G-7) industrialized countries, the World Bank and the IEA have issued a preliminary report on the costs of improving safety through upgrades to the units and/or by retiring one or more units of Ignalina before the end of their economic lives. The findings of this report are summarized in Chapter VII. In February 1994, the GoL signed a grant agreement from the Nuclear Safety Account of the European Bank for Reconstruction and Development (EBRD); according to the agreement, the grant is tied to the retirement of Unit 1 by the middle of 1998 unless the unit can be brought to sufficient standards of safety to warrant relicensing by the Nuclear Inspectorate.

- Need to rehabilitate substantial parts of energy industry, while reorganizing institutional structure. Physical installations in all energy subsectors need rehabilitation, partly because of chronic under-spending on maintenance in the past, and partly because of the need for new technology to improve competitiveness, efficiency, safety and security of supply. In the electricity subsector, rehabilitation of the thermal power stations will be influenced by decisions about the future operation of the Ignalina nuclear plant. In the petroleum subsector, the cost efficiency and international competitiveness of the Mazeikiai oil refinery must be addressed in order to assess benefits of refinery upgrading, investments in pipelines, and export/import facilities. In the district heating subsector, heat losses and inefficient heat-only boilers are crucial issues. In the natural gas subsector, some rehabilitation of the distribution and transmission systems is needed, as well as improvements (and in many cases, the introduction) of control and metering systems. The institutional framework and the organization of the Lithuanian energy industry is, however, not conducive to efficient operations and cost-effective investments. The introduction of commercial principles and hard budget constraints in the energy sector will be a critical first step toward efficient operations.

- Need to seek regional solutions to energy supply issues. It is crucial that the Baltic countries and their neighbors do not replace the centrally planned trading system of the FSU with a strategy of self-sufficiency. Such a strategy in its extreme form may become costly and does not benefit from a reliable, market-based trading system. Lithuania must therefore work for extensive regional cooperation in the energy sector. In particular, the Lithuanian electricity industry and petroleum refining industry may continue to serve a wider region. Lithuania can also benefit from port facilities for energy exports and imports in Latvia, as well as from developing gas storage in Latvia, to mention only a few potential areas of cooperation.

III. ENERGY SUPPLY, DEMAND, AND TRADE

A. Historical Energy Consumption

3.1 Lithuania's primary energy consumption rose at an average annual rate of 4% during the three decades prior to 1988, when it peaked at nearly 16 million tons of oil equivalent (Mtoe). In 1991, consumption leveled off at 15 Mtoe. In 1992 and 1993 it fell steeply to about 9.3 and 7.2 Mtoe respectively largely as a result of economic contraction (which in itself was significantly influenced by large energy price increases)[4]. The situation was exacerbated by payment disputes with Russia that caused a number of disruptions to energy supply. As noted in Chapter II, Lithuanian GDP fell a staggering 54.6% between 1991 and 1993.

3.2 In addition to a 51% reduction in the country's primary energy consumption between 1991 and 1993, the energy mix changed substantially. In particular, the share of natural gas declined from 27% of primary energy consumption in 1991 to less than 17% in 1993 whereas nuclear power increased from 23% to 33%. Compared to western Europe, the share of nuclear power in Lithuania's primary energy mix is high. The share of oil products in the primary energy supply initially fell from 44% to 37% between 1991 and 1992, but it rose to 42% in 1993. The recovery was largely a reflection of a glut of heavy fuel oil in 1993 which pushed prices lower relative to other fuels. The composition of primary energy supply for 1993 is shown in Figure 3.1.

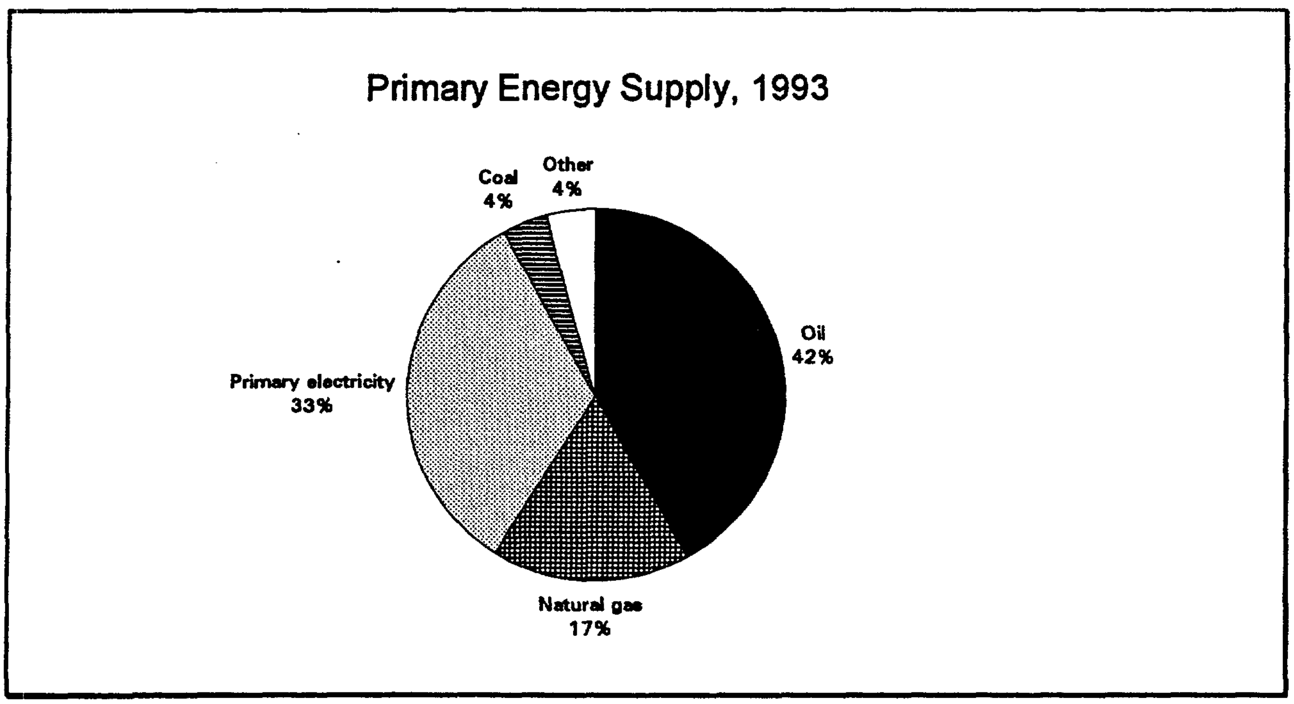

Figure 3.1

[4] Due to differences in methods of preparing energy balances, Lithuanian data on primary energy consumption for 1991-93 are 18.0, 11.4 and 8.8 Mtoe respectively.

3.3 The share of heat in final energy consumption is particularly high in Lithuania and is unlikely to change dramatically in the medium term because of the priority previously given to investments in the district heating infrastructure and the inefficiencies in the country's networks. Lithuania's previous focus on district heating rather than developing natural gas distribution contrasts with western countries, where interest in conservation has reversed these priorities. In 1993, about 0.7 bcm of gas and 0.9 million tons of heavy fuel oil were consumed in the production of district heating (down from 1.8 bcm of gas and 1 million tons of heavy fuel oil in 1992). However, the share of heat in final energy consumption actually rose from 22% to 24% between 1991 and 1993. The vast majority of this heat was produced in heat-only boilers. A breakdown of final energy consumption for 1993 is shown in Figure 3.2.

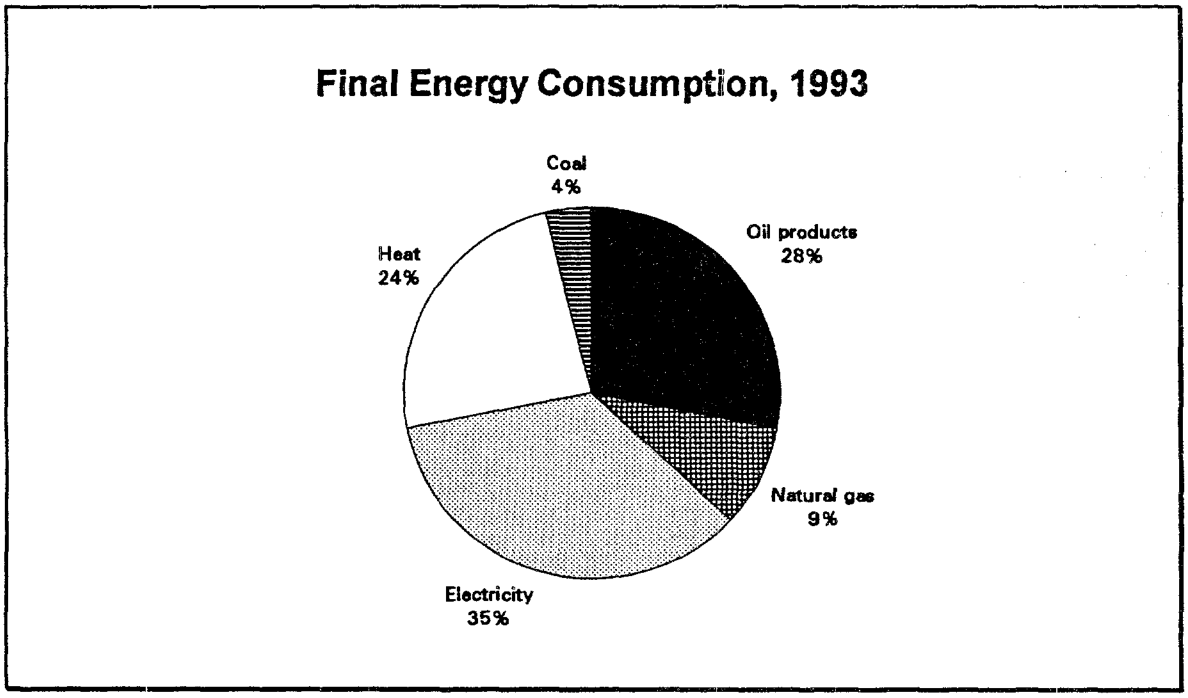

Figure 3.2

3.4 The primary and final energy balance (Annex 3.1) shows that industry, which produced about 35% to 40% of GDP, accounted for about 40% of final energy consumption in Lithuania in 1991. This is somewhat low compared to consumption in other eastern European countries (up to 70% of consumption) and is similar to consumption in western European countries. The country's 25% share of final energy demand in the transport sector was higher than that in other eastern European countries and similar to the level in developed countries.

3.5 Analysis of the energy balance and related statistics reveals a large potential for energy savings. However, by far the most influential force driving energy consumption for the next few years will be the level of economic activity and the speed of economic restructuring.

B. Domestic Energy Resources

3.6 Lithuania's indigenous energy resources supply only about 2% of energy demand. Although there is potential to improve the use of indigenous energy (see Chapters VI-IX), this will have only a limited impact on Lithuania's import dependence.

3.7 Oil and Gas. Lithuania produces 70,000-80,000 tons of oil per year (i.e., less than 1% of its maximum refinery throughput). Typical product characteristics are low gas-to-oil ratio (50 m^3 gas per 1 m^3 of oil), light oil quality (specific gravity 0.81), low sulfur (0.1-0.2%), and low natural flow pressure (2-3 atm at wellhead). No associated gas is used commercially. About 300 exploration and 7 production wells have been drilled since exploration first began in 1963. About 20,000 km of seismic lines have been shot by the former Soviet Ministry of Geology, and 15 fields have been found onshore and 3 offshore. The fields are all small and located in the western part of the country. The Lithuanian State Geological Service (SGS) estimates recoverable reserves at 87 million tons of oil, of which 47 million is onshore and 40 million offshore. Furthermore, SGS predicts that indigenous oil production could reach 1.5 million tons per year. The oil reserves are in Cambrian sand stones and lime stones at depths of 1700 to 2000 meters; the offshore reserves are at a depth of 30 to 50 meters. SGS estimates production costs in the range of US$ 5-8 per barrel of oil, which would make the exploitation of these reserves economic. Three oil concessions were scheduled for tendering in 1993.

3.8 Hydro Power. The Kaunas Hydroelectric Power Station has operated since 1959 with an aggregate capacity of 100.8 MW. Output has averaged 320 GWh per year. Additional, undeveloped hydro power resources in Lithuania are estimated to total 300 MW. Although the economic viability of new hydro capacity has been considered doubtful, it should be re-examined following the recent increases in energy prices.

3.9 Wood Chips and Peat. The country has large forest resources and several wood processing plants. Much of the wood waste could be used for district heating. Wood-chip-burning boilers should be considered where they can be located near pulp and paper companies or near forest waste collection points. Experience from neighboring Scandinavia indicates that this may be an attractive alternative to boilers burning fossil fuel (see Chapter VI). Lithuania has significant amounts of peat, so far unutilized. Peat extraction and burning often has large negative environmental consequences. However, until site-specific economic and environmental costs have been assessed, peat cannot be excluded as a supplemental energy source under harsh economic conditions.

C. Energy Trade

3.10 Lithuanian energy trade was disrupted somewhat in 1990 because of the country's declaration of independence and conflicts with the Soviet Union. In 1991, exports and imports returned to levels of the 1980s. In 1991, Lithuania imported 18 Mtoe of energy, mainly oil and gas. Exports constituted nearly 8 Mtoe[5](more than 40% of imports) but were comprised mainly of refined energy (i.e., petroleum products and electricity). In 1992, Lithuania's vulnerability to unreliable oil and gas deliveries from Russia became increasingly evident. Without harbor facilities for oil imports, and with gas pipeline connections only to the Russian-controlled gas network, energy price disputes with Russia were transformed into energy shortages in the autumn of 1992, as is dramatically illustrated in Figure

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[5] Including electricity trade grossed up to its fossil fuel primary energy equivalent.

3.3 Although gas supply was briefly interupted toward the end of 1993 due to late payments, Lithuania generally had fewer supply problems in 1993 than it had in 1992. .

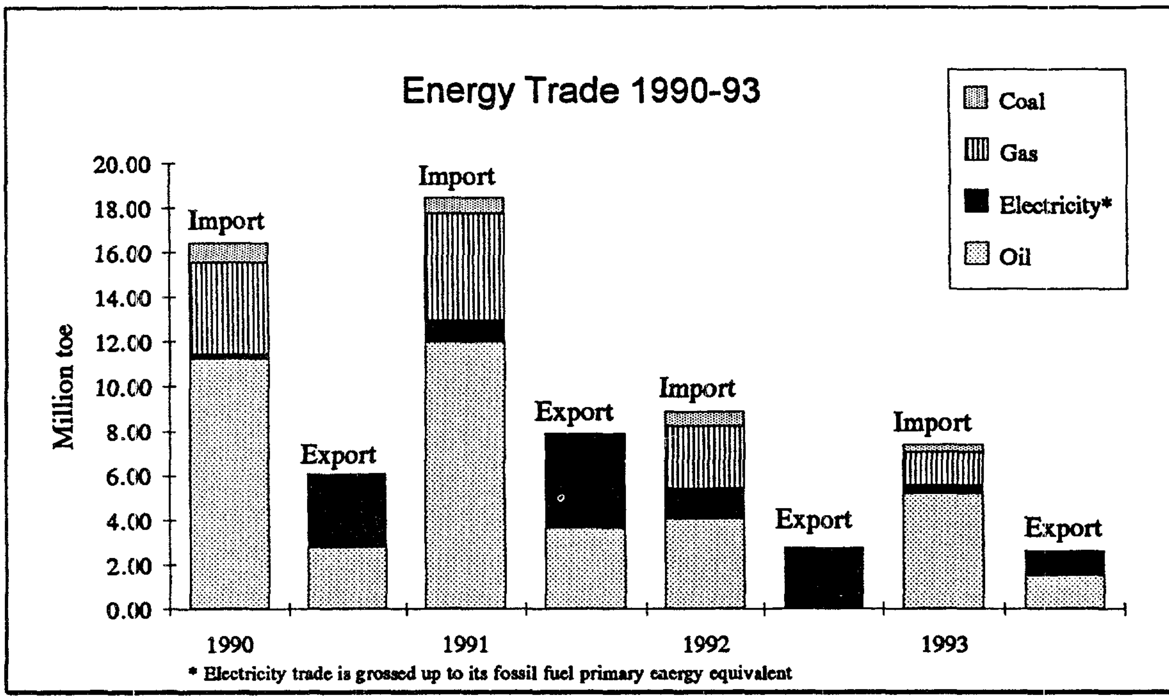

Figure 3.3

3.11 Petroleum. During the 1980s, the Mazeikiai oil refinery operated at or close to full capacity (12-13 million tons per year). Up to 40% of its production was exported; this amounted to more than 5 million tons of refined products in the late 1980s. Latvia has been by far the largest recipient of Lithuanian refined petroleum (particularly white products), although Russia has consumed between 66% and 95% of Mazeikiai's heavy fuel oil exports. Capacity utilization of the refinery dropped to about 70% in 1990 due to the blockade of energy supplies imposed by Russia after Lithuania's declaration of independence. In 1992, only 3.5 million tons of oil were refined at Mazeikiai, and the facility was only used for small volumes of contract refining in the second half of the year. The low capacity utilization in 1992 was due to dramatic increases in real import prices for Russian crude oil, as well as a price dispute. By 1993, production had recovered slightly to about 5 million tons.

3.12 The future prospects of oil imports and exports are related to a set of issues that are dealt with in more detail in other chapters of this report. These issues include:

- The commercial viability of the refinery after extensive refurbishment (Chapter VIII)
- Access to crude oil from Russia
- Access to crude oil from other sources (port and pipeline investments) (Chapter VIII)
- Developments in oil supply in neighboring countries and the expansion of regional cooperation
- Domestic requirements for refined oil products (Subsection E below).

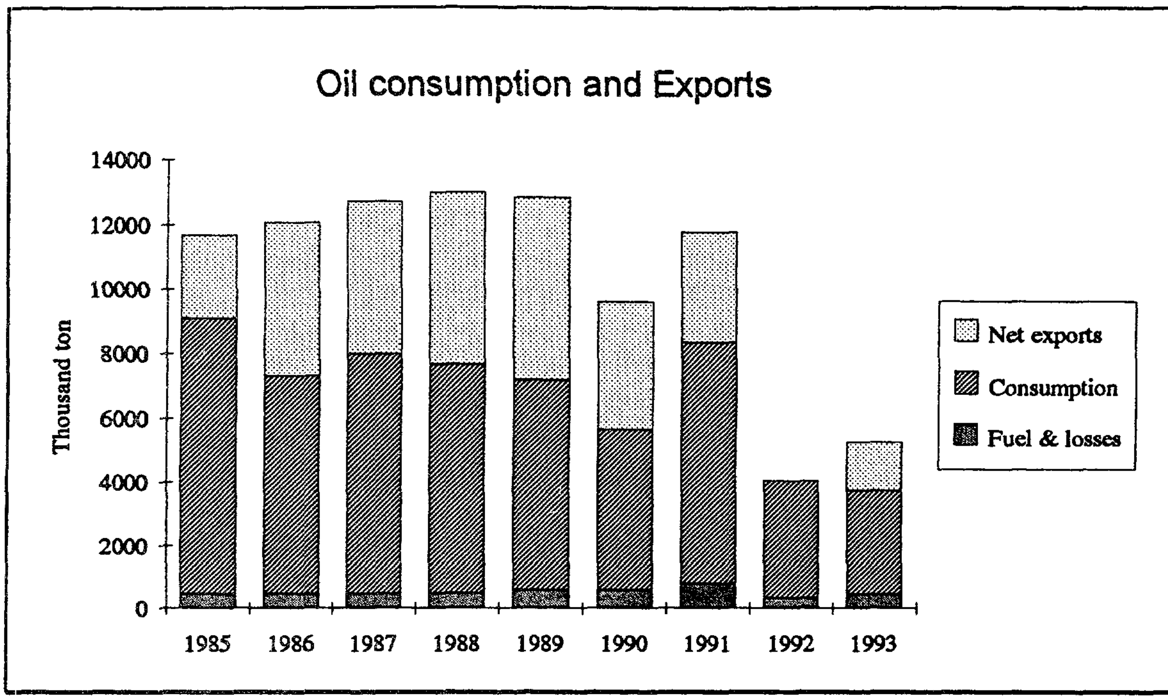

Figure 3.4

3.13 Natural Gas. Lithuania's imports of natural gas rose during the late 1980s from 4.5 bcm to a peak of just under 6 bcm in 1991. Following dramatic price increases on imports and the price dispute that caused periodic reductions in supply during the autumn, Russia agreed to supply only 4 bcm of gas in 1992; approximately 3.2 bcm were actually received. Gas supply fell to 1.7 bcm in 1993, although this was more a reflection of reduced demand for gas for electricity generation and increased use of heavy fuel oil rather than problems with supply. With the possible exception of Turkmenistan gas (which would still have to be transisted through Russia as well as Kazakhstan and Belarus), no other gas sources are likely to be available in this decade. About 2 bcm of Russian gas is transisted through Lithuania to Latvia and Kaliningrad. At present, Lithuania receives no transist fees for such deliveries, although there is some payment in kind.

3.14 Coal. Lithuania consumes about one million tons of coal per year. It relies entirely on imports from external sources, mainly Russia (50-70%), Kazakhstan and the Ukraine. Polish deliveries, which earlier constituted around 800,000 tons per year, were phased out in 1990. Most of the coal is high grade (7,000-8,350 Mcal/ton), used for heating primarily in the household and agriculture sectors. Owing to the general economic downturn and consequent drop in overall energy consumption, coal consumption fell nearly 50% between 1991 and 1993, although coal became significantly cheaper in relative terms compared to oil and gas. In the medium term, it is not likely that coal will replace other energy products to any significant degree. However, coal-based electricity generation may become substantial if, for safety reasons, the Ignalina nuclear plant is retired early (see Chapter VII). Details of coal imports are presented in Annex 3.2.

3.15 Electricity. Production of electricity peaked between 1989 and 1991 when both Ignalina units were running close to full capacity, producing approximately 17 TWh out of a total production of around 29 TWh (Figure 3.5). Net electricity exports were running at around 6 TWh in the mid 1980s, increasing to around 12 TWh from 1989 to 1991. Belarus was by far the most important export market (7-10 TWh/year), but Kaliningrad (a Russian region on the Baltic sea) received large amounts of electricity (2-3 TWh/year) from Lithuania. To optimize system utilization, Latvia and Lithuania have a strong but largely balanced trade in electricity. Further details of electricity trade are included in Annex 3.3. In 1992, net exports fell dramatically to about 5 TWh because of a shortage of fuel for the thermal stations, maintenance work on Ignalina's first unit, and reduced demand in neighboring countries for Lithuania's relatively high-priced electricity. By 1993, net electricity exports had fallen to less than 2.9 TWh, reflecting Lithuania's decision to cut off electricity supplies to Belarus and Kaliningrad due to non-payment. The future of electricity exports from Lithuania depends largely on (1) the retirement schedule for Ignalina, (2) developments in electricity demand and available sources of supply in neighboring countries, and (3) the ability of these countries to pay for imports. Russia has recently completed a 750-kV transmission line to Belarus, which is expected to allow Russia to undercut Lithuanian electricity exports. Lithuania has been engaged in discussions with Russia on paying for electricity exports to Kaliningrad with natural gas imports to Lithuania. If agreement can be reached, this should allow a 2-3 TWh recovery in Lithuanian electricity exports while improving its natural gas supply.

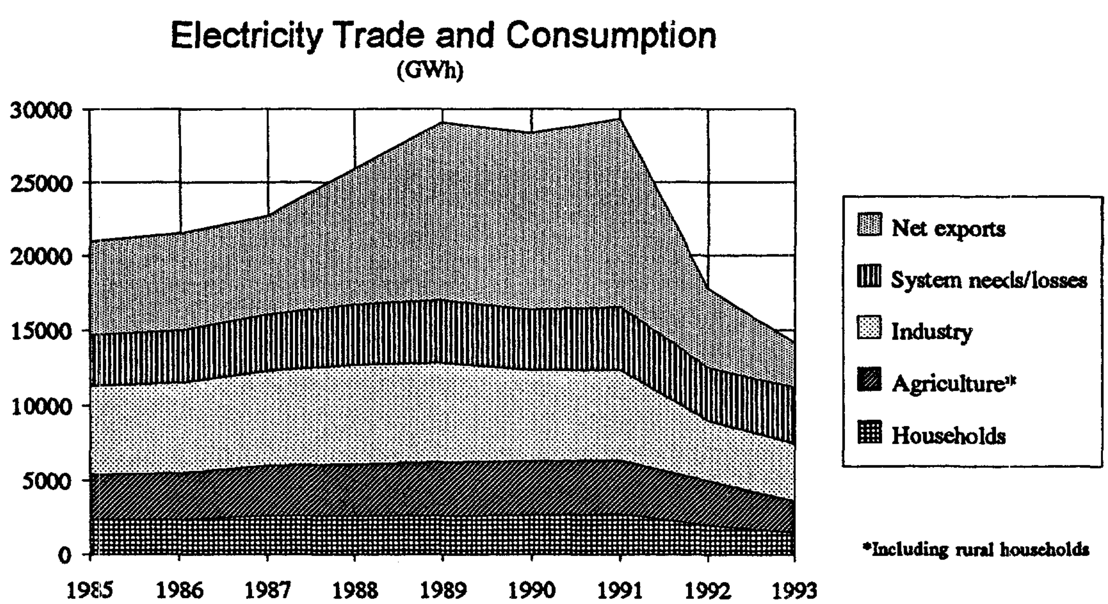

Figure 3.5

3.16 Nuclear Fuel. The fuel for the Ignalina nuclear power plant is imported from Russian producers. The two-unit station requires 1,630 fuel assemblies to operate for one year. After recent large price increases on nuclear fuel, nuclear fuel prices for Lithuania are now only slightly lower than fuel for an equivalent Western-type power station (that is, costs are about US$ 120 million per year for the two units, see details in Chapter VI). Lithuania is interested in diversifying its sources of nuclear fuel by finding a Western supplier that would produce the specialized fuel. However, since Russian manufacturers are producing fuel to the same specifications for several nuclear plants, they will probably be able to maintain a competitive edge over potential Western suppliers. Thus, the Russians are likely to remain the only fuel source for Ignalina.

D. Conservation

3.17 Considering Lithuania's high energy intensity and its almost total dependence on imported fuels, energy conservation is a crucial issue. In the near term, Lithuania's economy is expected to continue to decline, actually increasing energy intensity during the restructuring period due to the high, fixed-energy component in GDP. In the longer run, the energy intensity will decline, partly because of the restructuring of the industrial sector and partly because of a rising share of the service sector in GDP.

3.18 Price liberalization to allow full recovery of costs will have to be the major incentive for conservation (see Chapter IV). Direct social support payments to poorer households are a preferred and less distortive measure than continued subsidized energy prices. Following an agreement with the International Monetary Fund, direct operating subsidies will gradually be phased out.

3.19 Installation of metering equipment is a major priority in order to make customers responsive to prices and thus motivate them to control their energy use. Nearly all electricity customers are now metered. An increasing number of industrial customers are also installing time-of-day meters to take advantage of cheaper off-peak electricity. Installation of gas and heat meters has begun, with financial support from Western grants and loans. However, the effect of metering depends largely on pricing schemes. Price incentives -- not only to reduce energy consumption but also to move consumption away from peak hours -- can have a substantial impact on overall energy costs.

3.20 Western economies have learned that price and market reforms will not in themselves promote all possible cost-effective energy conservation measures. On the other hand, many conservation investments are highly profitable, bring quick results, and have a positive environmental impact. The private sector is not likely to assume an active role in conservation without government leadership, technical assistance, and possibly additional governmental financial incentives. In order to encourage and promote energy conservation, the Government should set up an Energy Conservation Agency to coordinate energy conservation efforts on a nationwide, cross-sectional basis.

3.21 The barriers that prevent market adoption of conservation measures in the absence of government involvement have been recognized in numerous studies conducted in Lithuania. Audits performed with the help of US and European contractors confirm opportunities for low-cost/no-cost measures that can save 10-20% of present energy consumption. The problem is that plant managers and other energy users lack information, experience and incentives to invest in technologies that can reduce demand. Moreover, the transitional period of price and market reform over the next several years will create instability. In such an environment, investments in energy efficiency may get little attention unless GoL shows leadership. In particular, the household, service and agricultural sectors need strong guidance. Lithuanian authorities and companies should continue to seek foreign technical assistance in acquiring know-how in energy conservation.

3.22 The Government's National Energy Efficiency Program identifies several areas that deserve further attention. Estimates are that potential efficiency improvements could produce substantial savings, but, based on experience in the West, these expectations may be optimistic. The quantitative underpinnings of the energy-efficiency impact of certain investments need to be reviewed as to costs of materials and world energy prices. The Government should move ahead aggressively on several of the programs identified, as well as a few others. The need for meters as a first critical step, is indisputable. Targeted information and detailed audits will help energy users identify cost-effective ways to reduce energy use. Financial resources need to be devoted to inducing consumers to invest in energy efficiency. Efficiency standards on buildings and appliances must be reconsidered.

3.23 In OECD countries, energy utilities are often key instruments in promoting energy efficiency among their customers. Efforts should be accelerated to identify and implement mechanisms by which the Lithuanian energy utilities can take on such a role. Towards this goal, energy conservation measures should be thoroughly assessed so as to avoid investing in new capacity where curbing overall demand or shaving peak demand are more cost-effective.

E. Energy Demand Projections

3.24 The major influence on energy demand in Lithuania in the next two decades will be the profound economic changes. These are transforming incentives, institutional arrangements, and economic activity. The transition from central planning to markets will not only improve Lithuania's economic performance in the longer term; it will also improve energy efficiency by penalizing the massive waste of resources that characterized production in the past. Recognizing the true opportunity cost of capital will shift emphasis away from large capital investments towards better utilization of existing capital equipment. Incorporating new technology will also reduce average energy requirements per unit of output. These structural changes will take time, but they will have a big impact on energy demand over the next 10-15 years.

Basic Assumptions

3.25 Economic Transformation and Energy Demand. Attempting to forecast the impact of economic transformation in Lithuania on energy demand is fraught with difficulty. Even short-term predictions about the macroeconomic effects of stabilization programs or the responses of enterprises to the new environment have proved difficult to make. Furthermore, extrapolation of past trends provides little guidance to the future. Without a clear idea of the changes likely to occur over the next decade, resources could be wasted through energy investments that turn out to be redundant. Moreover, the timing of the retirement of the Ignalina Nuclear Plant will have the most significant impact on future energy investments (see Chapter VII).

3.26 Structural Influences on Energy Demand. The scenarios for this report are based on analysis of numerous structural, institutional, and microeconomic changes in Lithuania's economy that are expected to occur over the next two decades. The most important structural influences on the prospects for energy demand in the short and medium term are:

(i) Share of National Income Devoted to Investment. This share has declined dramatically during the recent macroeconomic adjustment. Even as the economy recovers, the investment share will be much lower than in the past because investment resources were used so inefficiently. This implies a permanent drop in the demand for the output of heavy industry relative to national income.

(ii) Composition of Private and Public Consumption. Overall, a smaller fraction of income will be spent on industrial goods, but the shares of expenditures for processed foods, paper and chemical products, and transport equipment will rise. Spending on services will grow rapidly because services were so underprovided in Lithuania's previous centrally planned economy. Growth in industrial output will therefore probably lag far behind aggregate economic growth. Within the industrial sector, there will be a shift toward less energy-intensive activities.

(iii) Past Focus on Meeting Output Targets. This made many industries notoriously wasteful in using non-energy material inputs, labor and capital. Simple changes in organizing production will reduce such waste, eliminate over-staffing and produce more output from the same stock of capital. The country will thus be able to produce more final output for the same volume of resource and other inputs. This will reduce indirect use of energy in material inputs.

(iv) Average Age of Capital Equipment. Because old plant and equipment was rarely scrapped in Lithuania, the country's capital equipment is much older than in market economies. Some industries and plants are at the forefront of their technology, but most are technologically backward. Much of the oldest capital equipment will have to be scrapped as a result of the decline in industrial output and industrial restructuring. New investment, once economic recovery gets underway, will embody modern, more energy-efficient technologies. Even if old capital equipment were simply scrapped at rates typical in market economies, less than half the existing stock would still be operating in its present manner after 10 years.

3.27 Energy Prices. One of the most painful but essential features of the market reforms in Lithuania is to raise energy prices to levels that first recover operating costs and eventually provide enough capital for investment. The response to higher energy prices will have two main effects on energy demand: (1) it will promote energy conservation, significantly decreasing the energy intensity of economic activity over the next decade; and (2) it will shift the composition of fuel use. The real energy price increases of 1992 (see Chapter IV) had a big impact on economic activity and started a significant shift from oil products.

3.28 Scenario Analysis. A detailed structural model has been developed to examine the combined impact of these structural and pricing changes on energy demand. It is based on an input-output framework, using the Lithuanian input-output table for 1987 aggregated to 48 sectors. However, a distinction is drawn between the input-output coefficients for plant and equipment from new investment, and the capital stock inherited from the past. The technical coefficients for new capital are assumed to be the same as those in Western Europe in the mid-1980s, except in the case of a slower approach to reforms (see below). On the other hand, the technical coefficients for old capital change in response to exogenous reductions in over-staffing and in response to material inputs (x-efficiency gains) and changes in relative prices. There is no single energy price elasticity because substitution between energy, labor and materials and between fuels depends upon the initial shares of the factor and fuels in total costs.

3.29 Over the past two decades the share of electricity in industrial use has increased by about 2.5% per year. In Lithuania, this is seen in an increasing share of electricity in the primary energy mix, reflecting a shift to more automated production and increasing use of household appliances. A similar trend is applied to the use of electricity for new capital equipment, while old capital equipment is assumed to shift more slowly towards use of electricity (a trend increase of 1% per year). On the other hand, Western European industries do not rely on heat purchased from external suppliers. Instead, they meet their needs for process heat by operating their own steam plants and buying their primary fuels. Reliance upon district heating for households and the service sector is also much less common in Western Europe. Thus, it has been assumed that: (a) new plants will not use external heat supplies, and (b) old plants, households and services will gradually reduce dependence upon externally supplied heat to one-half of 1990 levels. The net effect of these two adjustments is to increase the overall share of electricity and heat in total final energy use, but much more slowly than implied by the trend in electricity use alone.

Scenario Choices

3.30 Three energy demand scenarios were chosen to give a broad view of possible developments:

(i) The Base Scenario. This is the most plausible outcome over the next 20 years. It assumes a reasonably comprehensive reform program will be pursued, bringing energy prices to world market levels within 5 years.[6]

(ii) The Accelerated Reform Scenario. This assumes the Government will press ahead with radical economic reforms and hard budget constraints on enterprises. These pressures, combined with an active policy to encourage foreign investment, will shorten the period of adjustment to new incentives and higher prices. The immediate decline in employment and output will be greater because more of the old capital stock is scrapped. However, the recovery will be more rapid, with faster economic growth through the decade 2000-2010.

(iii) The Slow Reform Scenario. This assumes that world market energy prices are reached in 1999. The reform proceeds slowly, so incentives to reduce energy consumption and to invest in more efficient capital equipment are much weaker and operate over a longer time period. This scenario implies that any economic recovery after 1995 will be much weaker and that growth in the decade 2000-2010 will also be lower.

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[6] The specification of energy price adjustments is complex in the model because it focuses on changes in the real price of energy relative to other tradable goods. Subject to that qualification, the price assumptions in the base scenario are consistent with the recommendations in the report for level and speed of adjustment, except for electricity. The model anticipates that electricity prices will rise to between 5 and 8 US cents per kWh in the base case, but this is premised on the belief that the Ignalina nuclear power plant may have to be retired early (see Chapters IV and VII).

Scenario Assumptions

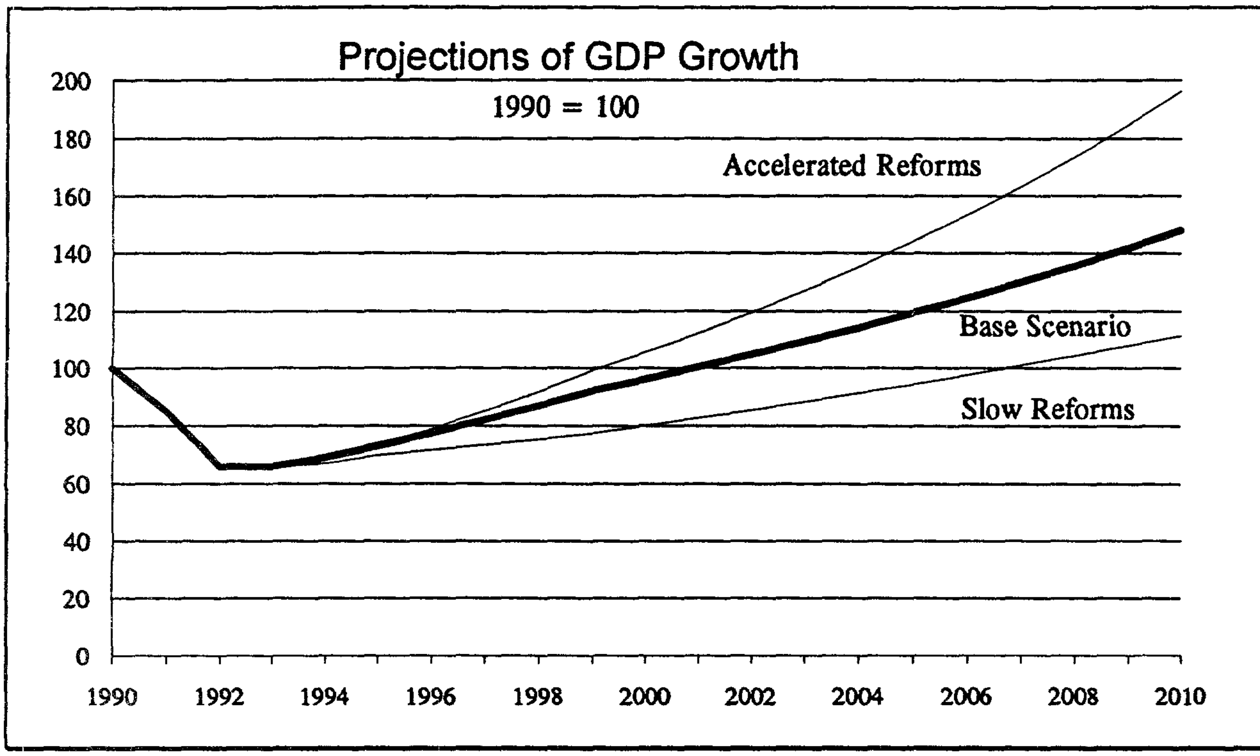

Figure 3.6

Table 3.1: Summary of Parameters for Energy Demand Scenarios

	Base Case	Accelerated Reforms	Slow Reforms
Annual GDP growth 1995-2000	5.6	7.7	2.7
Annual GDP growth 2000-2010	4.4	6.3	3.4
Adjustment period (years)	10	5	20
Average own-price elasticity	-0.5	-0.5	-0.07
Technology replacement	Western	Western	Former Soviet
Achievement of world prices by	1995	1995	1999

3.31 Comments on key assumptions:

- GDP Development. Figure 3.6 shows that GDP is assumed to bottom out in 1993 under all three scenarios at about 65% of its 1990 level. The subsequent growth rates (see Table 3.1) are high, but historical experience suggests they can be achieved if the reforms are implemented. The accelerated growth scenario follows an East Asian pattern. The slow-reform scenario is based on post-1995 growth rates similar to those of the former Soviet Union.

- Investments. The share of investment in GDP falls sharply until 1995 and then recovers to 20% of GDP in 2000 and 25% in 2010. These figures are still well below past levels. Slower or faster growth implies correspondingly lower or higher investment shares.

- Consumption. The composition of private and public consumption gradually shifts by 2010 towards the pattern typical of middle-income countries, with similar incomes measured in terms of purchasing power parity.

- Adjustment Period. Improvements in x-efficiency, as well as the adjustment of energy and other inputs per unit of output using old capital, are phased over 10 years in the base scenario, and over 5 years in the accelerated reform scenario. The adjustment period is 20 years for the slow-reform scenario. For this scenario it is also assumed that new investment has input-output coefficients based on typical Soviet technology rather than Western technology.

- Price Elasticity. The long-run aggregate elasticity of energy use in industry is approximately -0.5 for the base case and accelerated-reform scenario. This is typical of the long-run responses of Western European economies to the two oil shocks. Under the slow reform scenario, it is only -0.075; this is more typical of the response of centrally planned economies to price changes in the past. Note that the short-run price elasticities are much lower because the adjustment to higher prices is phased over 5, 10 and 20 years as appropriate.

- Response Time Lags. Lags have been built into the adjustment process to reflect the slow initial response of industrial energy consumption to changes in output. These lags assume that energy use responds to a weighted average of past and present output levels, and that a proportion of total energy use (40% in the case of electricity) is fixed consumption (overhead, etc.), that can be reduced only gradually over the standard adjustment period.

- Longer-term Focus. It should be noted that the energy demand model is constructed for longer-term assessments rather than short-term predictions. In reality, Lithuanian GDP has contracted more rapidly from 1990 to 1992 than the model suggests. In this period, Lithuanian GDP fell approximately 45%, whereas energy consumption was reduced almost 30%. The model is also incapable of taking into account supply constraints resulting from trade disputes with Russia. In the short term, constrained supply can reduce consumption further than the model predicts, but these supply-driven falls will be reversed as trade relations stabilize.

Demand Projections

3.32 Base Scenario. A projection of total final energy requirements in Lithuania to the year 2010 is shown in Figure 3.7, and Table 3.2 presents a detailed breakdown of relative changes in energy demand by sector. The combined effects of the decline in economic activity in the near term and the impact of the move to world prices are projected to result in a decline in total energy demand. This would bottom out in 2002/2003 at about 5 million tons of oil equivalent (Mtoe) per year or about 46% of the demand in 1990. Thereafter a steady growth is assumed as a consequence of restructuring the economy, adjusting to world market prices, and growth in the GDP. Energy demand is assumed to reach about 58% of the 1990 level in the year 2010.

3.33 Accelerated Reform Scenario. In this scenario (also shown in Figure 3.7), the development in GDP and other parameters have been adjusted as discussed above. The speed of reform leads initially to a steeper fall in energy demand as old, inefficient capital equipment is scrapped more rapidly than in the base case. After bottoming out in 1998 at about 41% of the 1990 level, energy demand increases at a yearly rate of almost 7% to reach about 74% of the 1990 level in 2010.

3.34 Slow Reform Scenario. Figure 3.7 also demonstrates the effect on energy demand if Lithuanian industries are cushioned from the full impact of world market prices and if the industrial component of GDP remains much higher than in developed market economies. The GoL would find it very difficult to sustain this economic policy, not least because imported fuel costs would probably exceed hard-currency revenues. In this scenario, energy demand falls to its lowest point in 1994 at about 72% of the 1990 level, and climbs to a level of about 98% in 2010.

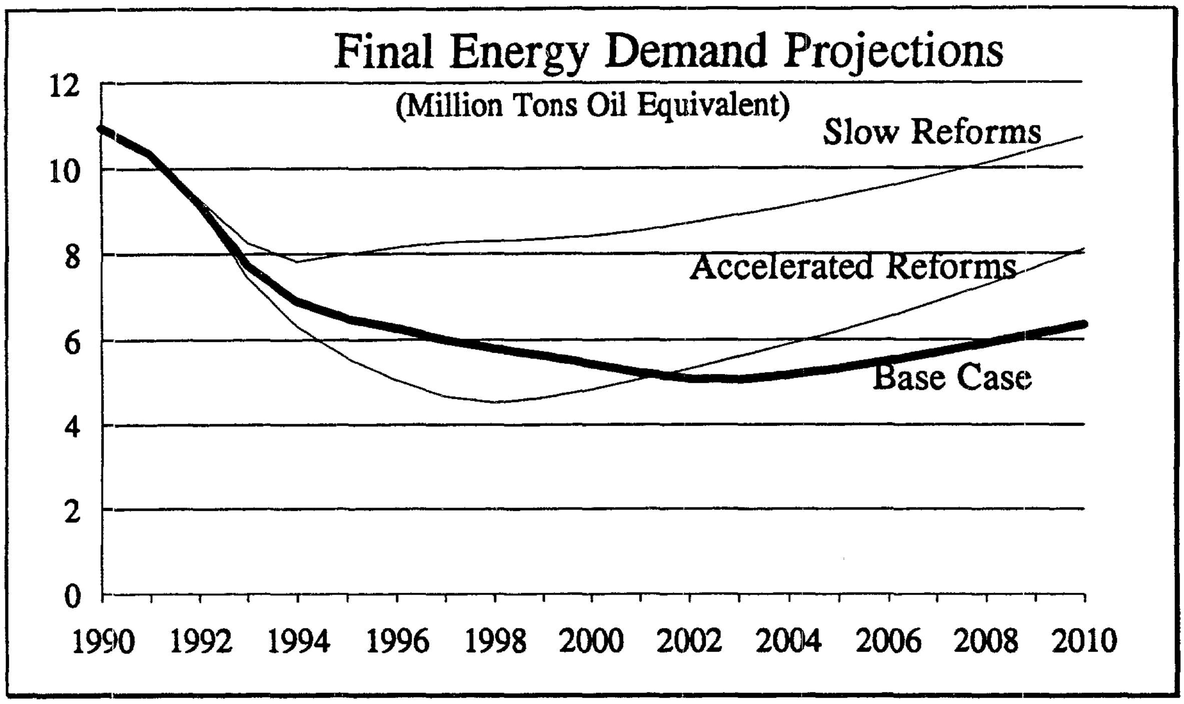

Figure 3.7

Table 3.2: Share of Consumption by Sector in Base Case Demand Scenario
(as percent of total consumption of each fuel type)

Sector	Gas			Oil			Power		
	1990	2000	2010	1990	2000	2010	1990	2000	2010
Industry	49	59	56	46	40	42	39	40	32
Agriculture	4	2	2	12	8	6	10	6	4
Transport	6	5	6	20	24	26	11	13	14
Distribution	1	1	1	1	1	1	5	5	6
Other Services	11	8	10	6	6	8	17	16	24
Households	29	25	26	16	20	18	18	20	19

3.35 Projected indices of GDP, final energy requirements, and energy intensity are shown in Figure 3.8 for the base scenario. The energy intensity, which is a ratio of energy demand over GDP, is projected to decline dramatically as energy efficiency improves because of restructuring and modifying incentives. The short-term negative development of this index (i.e., GDP falling faster than energy demand) is caused by the assumption (mentioned above) that a proportion of the energy use is fixed consumption and can only be reduced gradually.

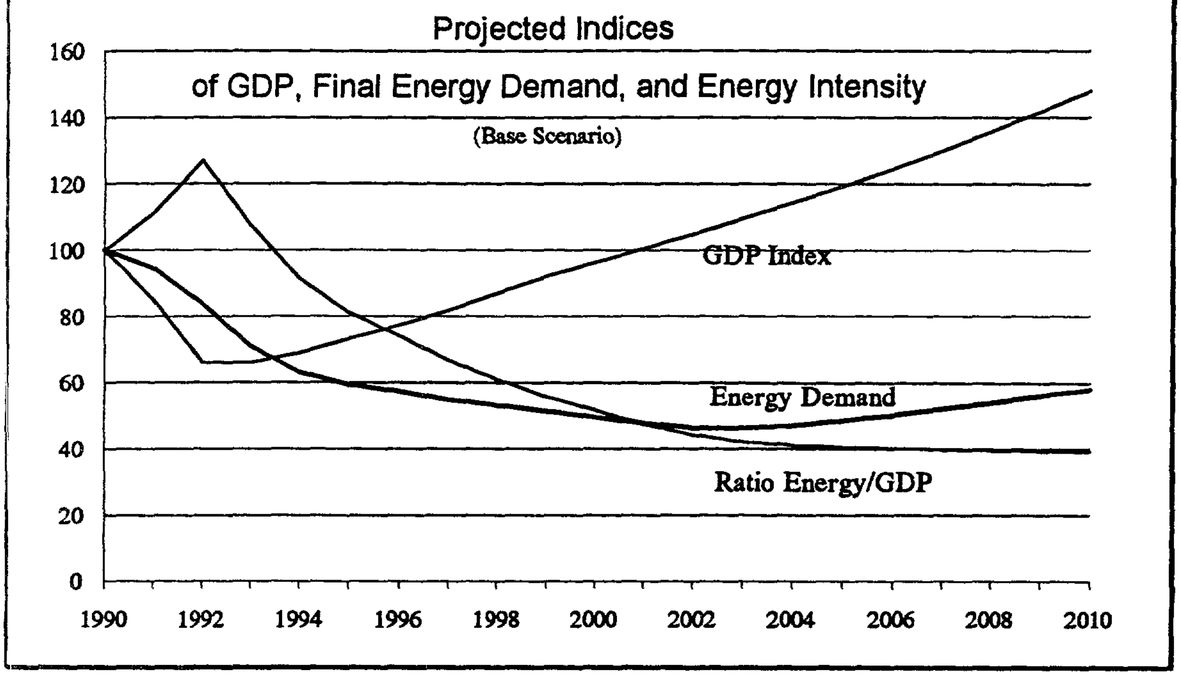

Figure 3.8

3.36 In Figure 3.9 developments in energy requirements are split into the various fuel categories. In absolute terms, the most spectacular development is the contraction in the use of oil products. However, it should be noted that in the short term, use of high-sulfur fuel oil in the power sector has actually been increasing relative to other fuels, reflecting cheap prices due to a glut on the market. Since neither the present industrial capital stock nor the modern technology to be introduced are based on significant coal use, coal is expected to constitute a relatively small part of the energy supply to Lithuania, at least until the Ignalina nuclear plant is retired. Based on current technology, gas-fired power plants are expected to be the most cost-efficient alternatives.

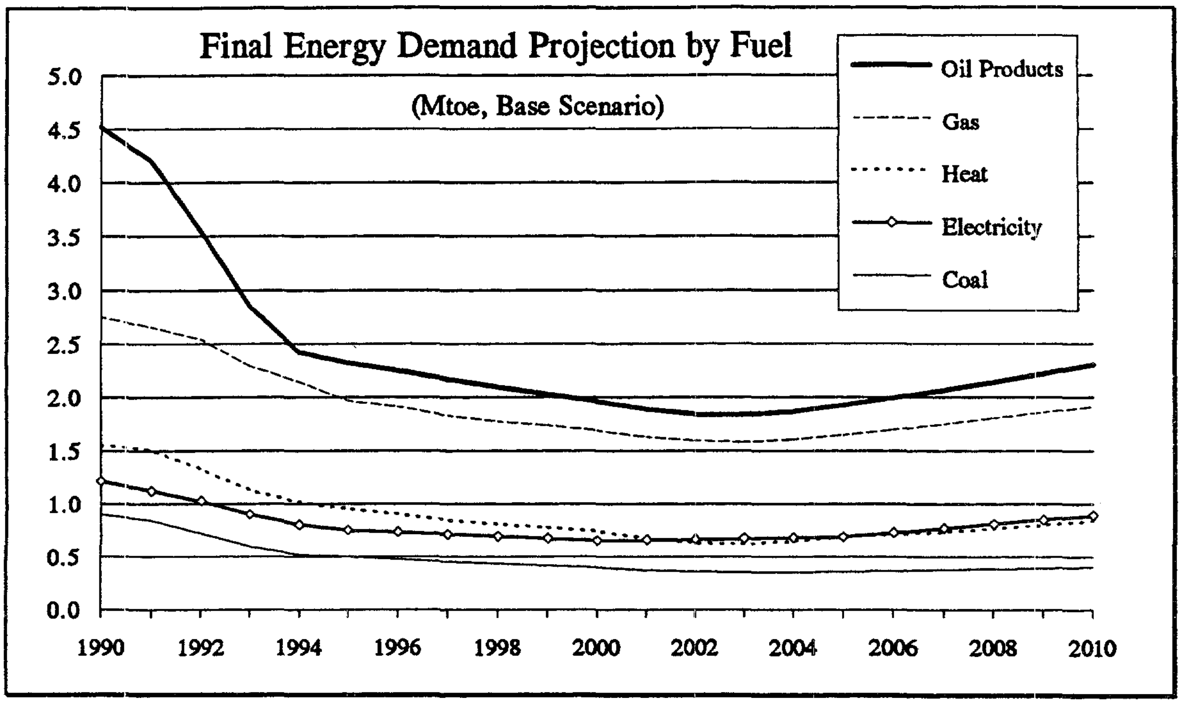

Figure 3.9

3.37 Figure 3.10 shows three projections for final electricity demand, in TWh/year. The starting point of 15 TWh for 1990 is a value calculated by the Bank for domestic demand based on net figures for domestic and export consumption (which were roughly equal). This figure is derived by attributing 50% of system own-use and 80% of losses to domestic consumption; only 20% of losses are attributed to exports because losses are lower on the high-voltage transmission system. It should be noted that the Lithuanian energy authorities calculate domestic consumption differently, such that 15 TWh in 1990 is not repeated in their own literature. The scenarios for accelerated reforms and for slow reforms in Figure 3.10 were chosen as the basis for the study requested from the Group of Seven (G-7) industrialized countries on the financial implications of retiring the Ignalina nuclear plant in 1995, 2000 or 2010. The findings of that study are summarized in Chapter VII.

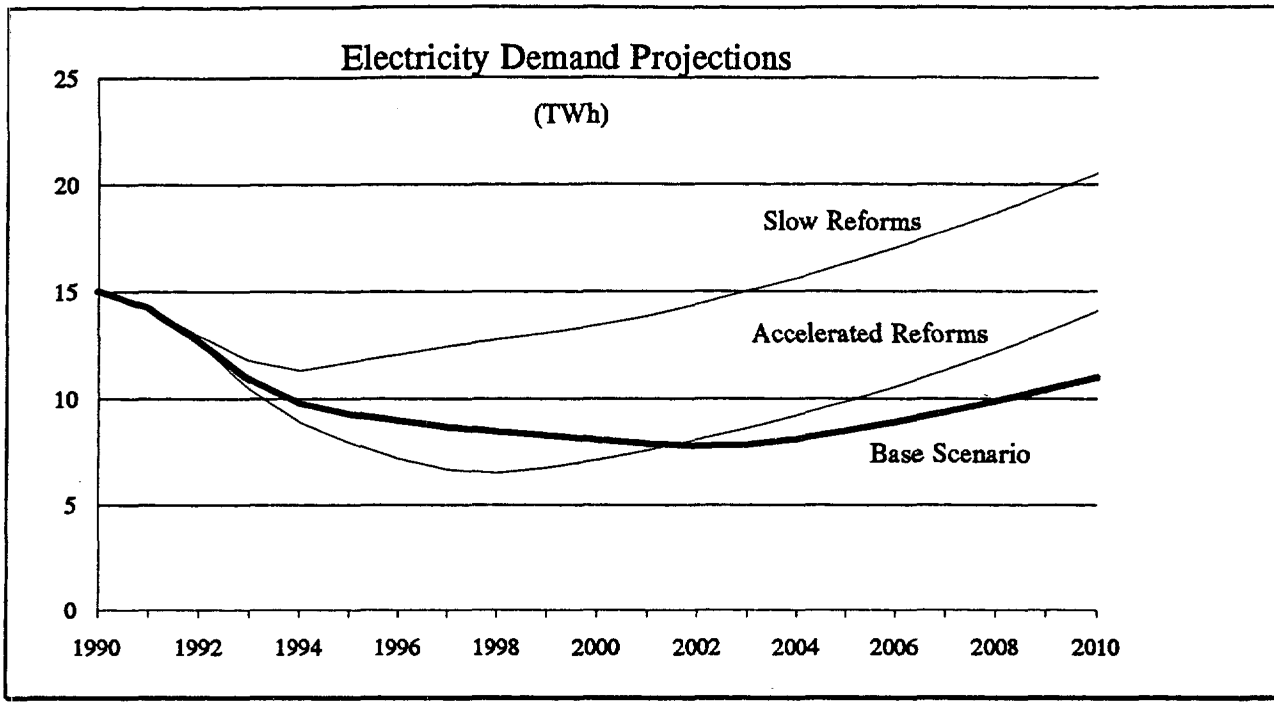

Figure 3.10

3.38 Clearly, these demand projections suggest that more rapid economic reforms are preferable to slow reforms because they ultimately facilitate faster economic growth but slower growth in energy demand. In reality, energy demand in Lithuania has already fallen faster than the rapid reforms scenario suggests. This is largely a reflection of the fact that the demand model tends to smooth the adjustment, whereas Lithuania has actually been convulsed by sudden and dramatic price increases, supply disruptions, and other factors which a long-term forecast cannot take into account. The most crucial step in reforming the energy sector is in immediately raising energy prices to levels that cover cash operating costs. This should eventually be followed by introducing marginal cost pricing or competitive markets. In reality, Lithuania has so few domestic energy resources that it would be fiscally difficult, if not impossible, to sustain a slow approach to reforms, at least in the energy sector. These issues are dealt with in more detail in Chapter IV.

IV. ENERGY PRICES, TAXATION, AND SUBSIDIES

A. The System of Energy Pricing and Subsidies

4.1 The energy sector in Lithuania is one of the few in which prices are still administratively set by the Government. Up until April 1994, the Ministry of Energy (MoE), in cooperation with the energy enterprises, evaluated the costs of production including fuel, transmission/distribution, limited provisions for depreciation and a 10% return on assets; these calculations then formed the basis for recommendations to the Cabinet of Ministers on end-user tariffs and subsidies. In April 1994, these functions were taken over by a semi-autonomous Energy Pricing Council (EPC) whose membership is made up of senior representatives of the Government, the energy enterprises, and some social organizations. The Cabinet is still the final arbiter of consumer tariffs, and often makes substantial revisions to pricing recommendations. Price controls for coal, LPG, gasoline and most other oil products were eliminated in early 1993 following a period in which a parallel state and private markets had existed.

Wholesale Pricing

4.2 The EPC also reviews transfer and wholesale prices between energy enterprises. The system of transfer pricing was developed to facilitate cross subsidization, and in practice there is rarely a fixed wholesale or transfer price which can be readily quoted. Instead, prices between transmission companies and distribution companies are adjusted on a quarterly or monthly basis for each enterprise in order to redistribute funds from more profitable distribution companies to less profitable ones. Differences in levels of profitability were supposed to be predictable, a product of the different share of industry (paying cross-subsidizing prices) in each region. The system also was intended to level distribution costs over the whole country. As a rule, the adjusted wholesale or transfer price actually bears little relationship to the effective unit price paid by the distribution company to its supplier. This is because the distribution companies collect revenues on behalf of both the transmission company and themselves. Thus, a distribution company's failure to collect from customers would likewise mean that the supplier would not be paid for its portion of energy delivered, and thus the actual price "paid" per unit of energy would be lower.

Direct Subsidies

4.3 In addition to cross subsidies between consumer groups, regions, and subsectors, the Government pays a number of subsidies directly from the budget to the energy enterprises. These subsidies were budgeted at roughly 5.1 billion talonas (51 million litai)[7] from both the central and municipal authorities in 1993 and rose to 150 million litai in 1994. The subsidies were broken down as follows:

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[7] The 174-billion-talonas combined municipal and central budget for 1993 does not make a distinction between expenditures from the budget on investment projects and subsidies to cover consumption. The 5.1 billion talonas figure presented in this report is an estimate of the funds used for subsidies only. In June, 1993 Lithuania introduced its new currency (litas) at 100 talonas = 1 litas. For consistency, most prices in this section are presented in talonas.

Subsidies (million litai equivalent)

Company	1993	1994[8]
Lithuanian Fuel	48.6	
Lithuanian Gas	2.0	53.9
Lithuanian State Power System	0.5	96.0

These subsidies in 1993 were applied mostly to cover the difference between average costs and prices paid by households, particularly for home heating oil (Lithuanian Fuel). Heating oil at subsidized prices was rationed at 3 tons per household for the heating season in 1993. Subsidies to Lithuanian Gas in 1993 were intended to cover the distribution costs for household cooking gas. However, since there are few households with meters, consumption of subsidized gas had to be estimated. Many consumers used their gas stoves to heat their homes during the first half of 1993, when the district heating systems worked only intermittently due to lack of money for fuel imports. As a result, this increased use of gas stoves rapidly depleted the 200 million talonas budgeted for subsidies and contributed to arrears of US$ 74 million to Russia, eventually causing disruptions to gas supply. Partly in response to these problems, subsidies in 1994 are earmarked almost exclusively for district heating consumption or for gas supplied to district heating enterprises.

Cross Subsidies

4.4 Both under Soviet rule and since independence, Lithuania has applied a number of cross subsidies, particularly the subsidization of household consumption with higher tariffs for industrial consumers. These subsidies are difficult to quantify precisely because they are based on estimates of industrial and residential consumption. Most intentional cross subsidization ended in 1992, leaving district heating as the only major area of cross subsidization. In March 1993, district heating prices were set at 8,800 talonas per Gcal for industry versus 300 talonas for residential customers. The implied cross subsidy was roughly 26 billion talonas for the LSPS district heating enterprises alone, or five times the level of total direct subsidies to the energy sector.

4.5 The system of wholesale pricing and cross subsidization began to break down after sharp rises in import prices in 1992 and general economic deterioration made it increasingly difficult to collect from consumers. The district heating system in particular suffered from these changes as industrial consumers in Lithuania began to disconnect from the heating networks due to the dramatic price increases. It is estimated that between 80-90% of industrial customers of district heat disconnected from the system during the first half of the heating season, causing a revenue gap that still has not been resolved. In addition, arrears from energy consumers began to rise dramatically, reaching about 16 billion talonas by March 1993 (about US$ 35 million, equivalent to 9% of the 1993 state budget). Although the system of wholesale pricing did not create the crisis, it seriously undermined attempts to quantify shortfalls in cross subsidization, arrears and the financial impact on energy enterprises. By the middle of 1993, the Government decided to abandon the industrial cross subsidy of district heating and replace it with an informal cross subsidy of heat from higher electricity

[8] These budget allocations are fungible between subsectors, so that the actual value paid to each of the companies may bear little relationship to that which is allocated.

tariffs. This new cross subsidy is discussed in conjunction with proposals for revamping the system of wholesale pricing and subsidies in Section G below.

B. Developments in Import Prices

4.6 As a country with few indigenous energy resources, Lithuania suffered a severe economic blow when Russia decided to raise energy export prices to "world-market" levels shortly after the dissolution of the Soviet Union. Despite Russia's intention, the prices which Lithuania actually paid for most of its energy imports stayed well below world-market levels until the end of 1992 or beginning of 1993. This is because the trade protocols negotiated between Lithuania and Russia for 1992 established all prices in US dollars but payments were actually made in rubles. The system of trade became entangled in disputes over the exchange rate to be applied, since the Lithuanian side claimed that 35 rubles per one US dollar was agreed at the time of signing (which was effectively a subsidized rate after January 1992), whereas the actual trade protocols established no rules for exchange rates. In many cases, payment still has not been made pending resolution of these disputes, so it is impossible to quote an accurate price for the import of most energy products in 1992. During the second half of 1992, Russian energy exporters increasingly demanded payment at the prevailing exchange rate -- which under hyperinflationary conditions became a considerable burden administratively as well as financially for Lithuania since the country did not have access to such a large volume of rubles. By the beginning of 1993, hard currency was demanded for all payments for energy imports, although in practice many transactions occur on a barter basis (priced in dollars).

4.7 Trade protocols are negotiated between governments of the former Soviet Union with the main aim of balancing trade. Major issues, such as price and volume, are settled in the protocols, whereas detailed issues are left for agreement between the exporting and importing companies. However, the volume of goods specified in the protocols seem to function as quotas to be made available for exports, but often are not binding on the importer. There is no system of enforcement or compensation to the exporter for goods made available but not taken, nor for goods contracted but not delivered. As a result, even prices agreed upon in the protocols are not always binding, particularly when negotiated in soft currencies. It is therefore difficult to quote exact prices that Lithuania pays for energy imports, particularly since transmission costs are often paid in rubles whereas the actual energy is paid for in dollars. An indicative list of import prices without transmission for 1993 is contained in Table 4.1.

Table 4.1: Estimates of Import Prices for 1993

Energy Import	Price US $
Crude Oil (ton)	125
Natural Gas (1000 cu m)	80-85
Nuclear Fuel	
per assembly	73,000
estimate per year	120 million

4.8 These prices are at or near world market levels. The price for crude oil is for supplies obtained directly through the protocols, but in practice crude oil is often not available for export to Lithuania. Some crude oil is obtained outside the trade protocols, but its prices are difficult to track, particularly as the privately owned distributors sometimes avoid Lithuanian taxes. In light of the non-binding nature of the trade protocols, any significant upward movement in the spot-market price for oil would almost certainly bring a revision to the indicative price of US$ 125 per ton for Lithuania. Natural gas prices (between US$ 80 and $ 85) do not include transit fees, which are negotiated in rubles. The price roughly equals charges to other countries outside the former Soviet Union (for instance, Hungary pays $ 90 including transit). The price of US$ 120 million to fuel the Ignalina nuclear power plant for a year is slightly lower than the estimated world-market prices to fuel a similar sized plant in the west. Although Lithuania in theory could purchase nuclear fuel from other suppliers, in practice only Russia produces the type of fuel required for RBMK reactors. Because Russia produces fuel for a number of plants, it almost certainly could undercut potential Western competitors; nonetheless, it would be in Lithuania's best interest to keep looking for alternative competitive sources of supply.

4.9 Lithuania's dependence on Russia for fuel imports gives the country little negotiating leverage with its more powerful neighbor. As a result, there is a pervasive impression in Lithuania that the Russians are 'punishing' Lithuania with unfair prices. Although there is certainly some room for downward revision of prices -- Latvia, for instance, paid only US$ 79 per 1,000 cubic meters of gas in 1993 -- most evidence suggests that Russia sets prices for Lithuania on a commercial rather than a political basis. It is certainly true that Russia effectively subsidized CIS energy imports in 1992, but the more favorable treatment of these countries is likely to end[9]. Lithuania is commercially disadvantaged in that its supplies of natural gas and substitutable goods (diesel and heavy fuel oil) are both supplied by Russia. Without expanded oil unloading facilities (which are likely to prove prohibitively expensive, see Chapter VIII), Lithuania will have to negotiate long-term contracts with Russia. As a rule, Russia cannot charge Lithuania more for energy than it does neighboring countries precisely because this would encourage those countries to export to Lithuania, undercutting Russia with its own energy resources. Lithuania's means to purchase gas through third parties thus remains limited, but Russia in the medium term also has limited ability to negotiate new long-term contracts with Western Europe, thus making it important to hold on to its former Soviet markets[10].

C. Costs of Production, Distribution, Sales, and Taxes

4.10 Calculating the cost of production, distribution and sales of energy products is a critical first step in setting energy prices in Lithuania. As a rule, fuel represents 90% of the costs (as the Lithuanians calculate them) for district heating, electricity generation from thermal plants, gas supply, and petroleum products. In Western Europe, there is a wide range in the proportion of fuel in final energy prices (before tax), but the percentage usually falls well short of the 90% average in Lithuania (e.g., fuel costs account for roughly 70-80% of gas prices to West European industry, 25-50% of residential gas prices, and 65-80% of heavy fuel oil prices). The difference is largely a result of lower wages and artificially low depreciation and maintenance costs in Lithuania. Assets in the energy sector are grossly undervalued because the central planning system valued new energy facilities at levels unrelated to market prices and because high inflation has eroded much of the value of assets

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9 For example, Ukraine paid approximately 2,050 rubles per 1,000 cubic meters of gas in the fourth quarter of 1992 versus 8,300 rubles paid by Lithuania. Ukraine and Lithuania now pay in hard currency.

10 Western Europe has been unwilling to be excessively dependent on Russian gas whereas Russia's potential for export far exceeds potential demand in Western Europe.

despite periodic indexations. For example, on the books of Lithuanian energy enterprises the average value of assets per kW of installed capacity in the electricity subsector was about 2,000 talonas in March 1993, or roughly US$ 4 per kW. This compares to about US$ 600 per kW to install new combined cycle gas turbines (not including interest during construction). The total asset value of the Ignalina nuclear power plant was less than US$ 20 million.

Pricing Strategies

4.11 In the near term, Lithuania should aim to cover at least the cash operating expenses of the energy enterprises (see Section G below and Chapter V) with the eventual aim of introducing economic efficiency pricing including possibly long-run marginal cost pricing or market driven prices where appropriate. Most energy prices currently are set at levels that cover fuel costs and most operating expenses -- the notable exceptions being prices for district heating and residential gas -- but it is clear that there are often inadequate funds allocated for maintenance. During the transition period, the depreciation component of current costs should be replaced with a more realistic calculation of required maintenance costs to ensure that the existing capacity and transmission and distribution networks are adequately maintained. Such a strategy would be viable in the short term since energy demand is falling rapidly, leaving the country with significant over capacity in most of the subsectors and therefore limited investment requirements. The single largest component of energy costs for the foreseeable future will remain fuel, particularly since wages will remain low relative to Western European wages and fuel import costs will be roughly equivalent. In the near term, the biggest variation in cost will be a product of the exchange rate, since the Lithuanian talonas (and litas) moved erratically against the dollar during 1993 (fuel imports are paid for in dollars, while consumers pay for energy in local currency). However, the exchange rate stabilized in late 1993 and was pegged to the dollar at 4 litai = US$ 1 in March 1994. It is expected that the Lithuanian litas will eventually appreciate somewhat in real terms (perhaps 10-30%) against the dollar, such that this appreciation will gradually make energy costs for consumers more affordable.

4.12 District heating and the Ignalina nuclear power plant are two special cases in Lithuania's drive to cover all cash operating expenses. The district heating systems are very inefficient (see Chapter VI, Section D) and therefore prices to cover cash operating expenses would represent an unrealistically high burden on consumers, particularly considering the low income levels (the real costs of district heating would represent between 40% and 75% of an average two-person income in Lithuania). By contrast, the costs of operating Ignalina are very low if the capital costs are treated as sunk (which effectively they are, at current depreciation rates)[11], and the cost of needed safety upgrades is excluded. Fuel costs for the Ignalina power plant remain roughly 0.8 US cents per kWh (at world market prices), while estimates of total fixed and variable costs over the next two years suggest that operating costs can be held to about 1.4 US cents per kWh. Since Ignalina currently supplies about 90% of Lithuania's power, this is effectively the short-run marginal cost of wholesale electricity, but it is only a fraction of West European electricity costs (electricity prices range from 5 to 12 US cents per kWh). However, the possibility that Ignalina will be retired for safety reasons (see Chapter VII) means that low-cost power production cannot be relied on for the long term. Options for pricing district heating and electricity are elaborated in Section G below.

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[11] If a decision is made to continue to operate Ignalina, significant internal revenues would need to be generated to pay for safety upgrades (of between US$ 60-100 million per unit) and, eventually, decommissioning costs. Investments in spent fuel storage of US$ 20 million is necessary immediately.

Taxes

4.13 A value added tax of 18% is levied on all goods produced in Lithuania including most energy products. However, residential consumption of some energy products will not have VAT levied on it until January 1995. In addition to VAT, excise taxes are levied on petroleum products and electricity. A flat ad valorem excise tax of 10% is charged on electricity, while excise rates on petroleum products vary with each product (from 2% to 15% of the total price). On top of the excise tax, a 10% road tax is also levied on diesel and gasoline. Energy enterprises also pay 7% interest on state capital (of which two-thirds is retained by the enterprise for investment) and land leases equal to 6% of the land value. There are also a number of modest environmental and resource taxes paid on the use of energy products. In addition to the direct taxes, the price of energy reflects standard taxes paid by the energy enterprises in Lithuania (and all other enterprises). These include a 30% tax on wages and a 29% profit tax.

4.14 Taxes on energy products in Lithuania are not excessive compared with West European taxes (which vary greatly, but often represent well over half the end-user price for energy). However, it is important to administer the tax system in a consistent manner among all enterprises so that it is perceived to be fair. The Mazeikiai refinery has complained that it pays 30% more tax than private importers/distributors pay on the sale of oil products, effectively making it uncompetitive. It is still unclear why the refinery pays more tax than private companies, but initial inquiries suggest that although the same tax rates apply to all companies, private companies are sometimes able to evade taxes. The Government should strive more rigorously to enforce the tax laws evenly, but if the tax on oil products is uncollectible, it should abandon the tax entirely, since the Mazeikiai refinery will be providing little or no tax revenue as long as it is uncompetitive. The Government should not bar private companies from the oil products market, since private companies have provided the country with important supplies at a time when supplies of crude to the refinery have been erratic.

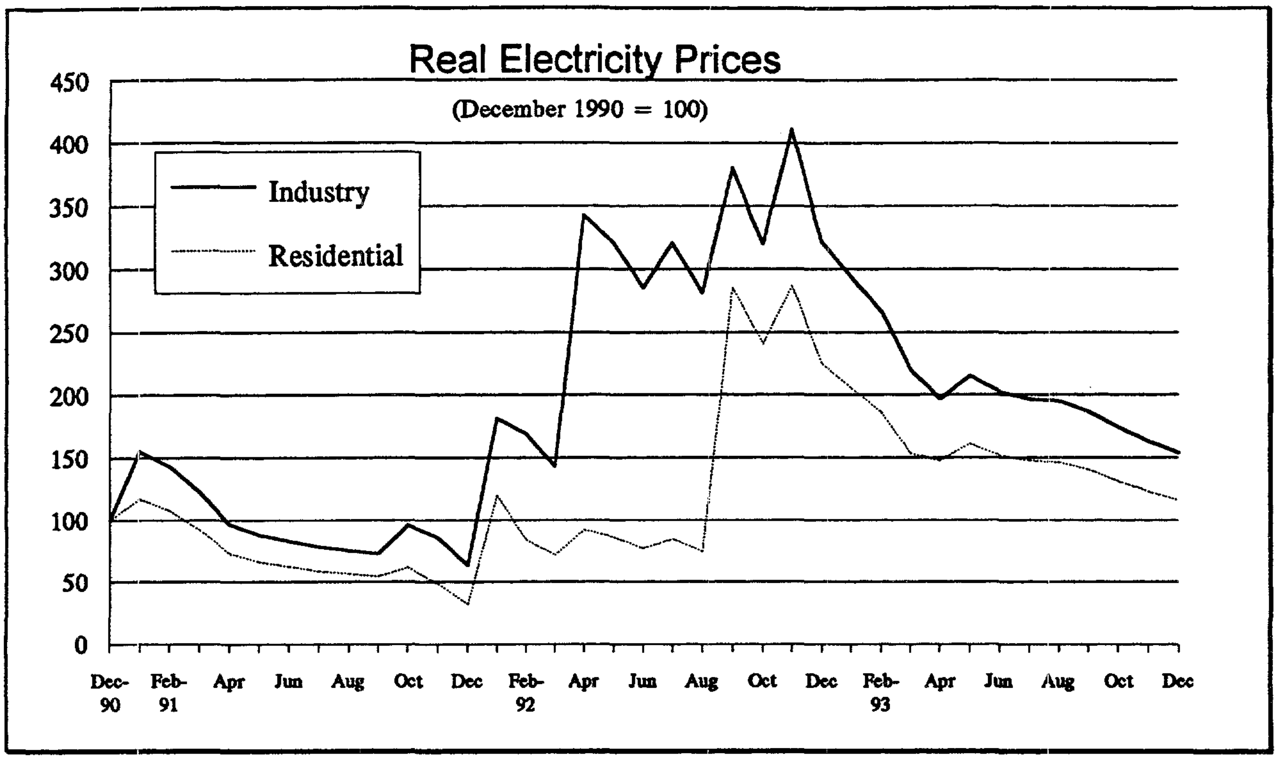

Figure 4.1

D. Developments in Consumer Prices

4.15 Following the dramatic rise in import prices during 1992, Lithuanian authorities raised prices for industrial customers to at least cover the fuel costs. Later in 1992, electricity and most gas prices for residential customers reached the same level; only residential district heating and heating oil prices remained heavily subsidized. During the first quarter of 1993, domestic energy prices were frozen and thus fell in real terms to approximately half the level of November 1992. In theory, all energy prices, except for residential district heating and heating oil, are to be maintained at cost recovery levels. In practice, price adjustments have often been too infrequent to compensate for movements in the exchange and inflation rates. The development in real energy prices is shown graphically in Figures 4.1 to 4.4, with further details in Annex 4.1. With the exception of industrial district heat prices, downward movements in real energy prices, as shown in the graphs, are caused solely by inflation and exchange rate movements; industrial heat was lowered in nominal terms when the cross subsidy of residential heat was abandoned.

4.16 As can be seen in Table 4.2, with the exception of electricity, industrial prices for energy have increased to at least half of West European prices. By contrast, household prices have lagged behind industrial prices and are well below both West European prices and economic costs. Although electricity, gas, and heat meters and control equipment have been installed for most large industrial consumers, residential customers rarely have gas and heat meters, nor is it usually possible to disconnect an individual customer from the distribution system. In the short and medium term, metering and control equipment will be too expensive and impractical to introduce for heat, although the Government is trying to accelerate introduction of gas meters. Long term, metering and control equipment to make MoE responsive to price changes, will be crucial for Lithuania to improve energy conservation. In the meantime, Lithuania has little choice but to constrain supply of household heat and gas in order to keep subsidization within budgetary limits (see Section G below).

Table 4.2: Consumer Energy Prices in Lithuania Compared to West European Prices[a]
(US$, March 1993)

Product	Lithuanian Prices		West European Prices		Lithuania as % of West	
	Industry	Household	Industry	Household	Industry	Household
Crude Oil (ton)	82		135		60	
Natural Gas ('000)	86	50	114	236	76	21
Gasoline 76 (liter)	0.13	0.13	0.25	0.25	52	52
Diesel Fuel (liter)	0.15	0.15	0.24	0.24	64	64
Heavy Fuel Oil (ton)	73		111		66	
Heating Oil (ton)	116	13	197	203	59	6
Electricity (MWh)	13	12	78	106	16	11

a/ Based on an unweighted basket of West European countries before tax.

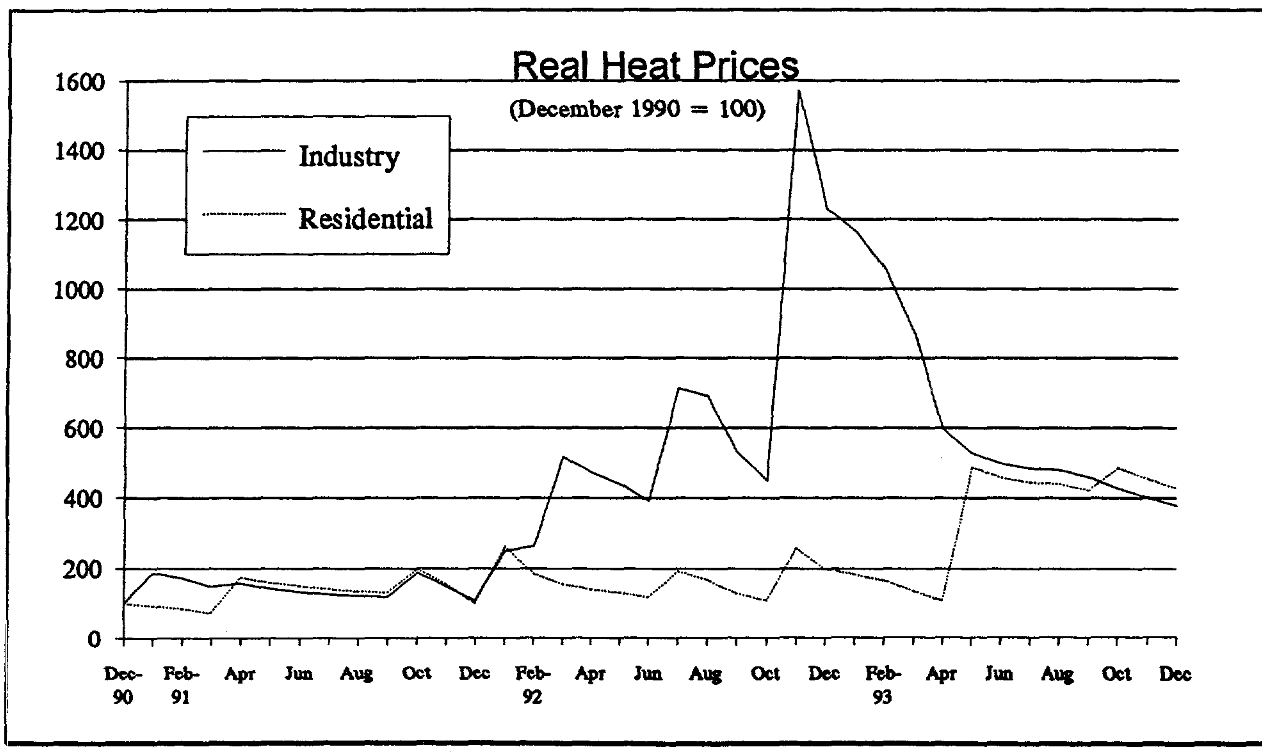

Figure 4.2

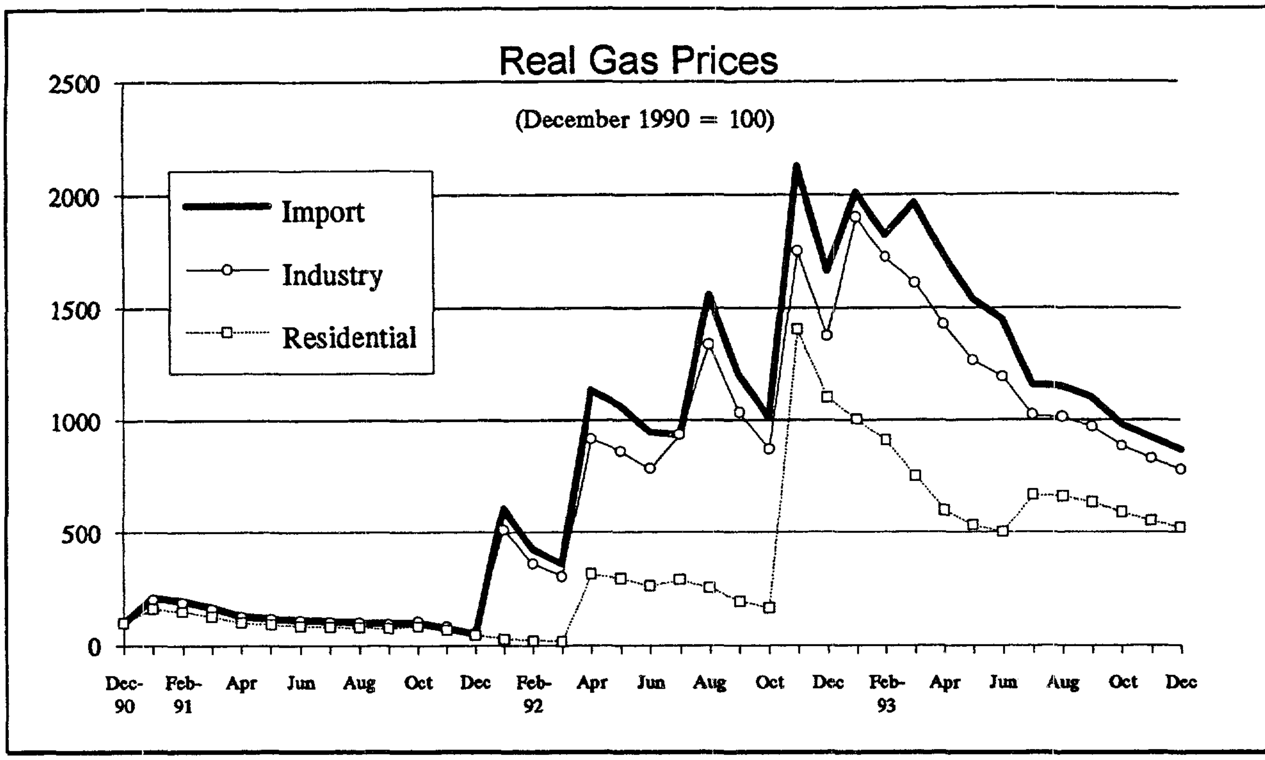

Figure 4.3

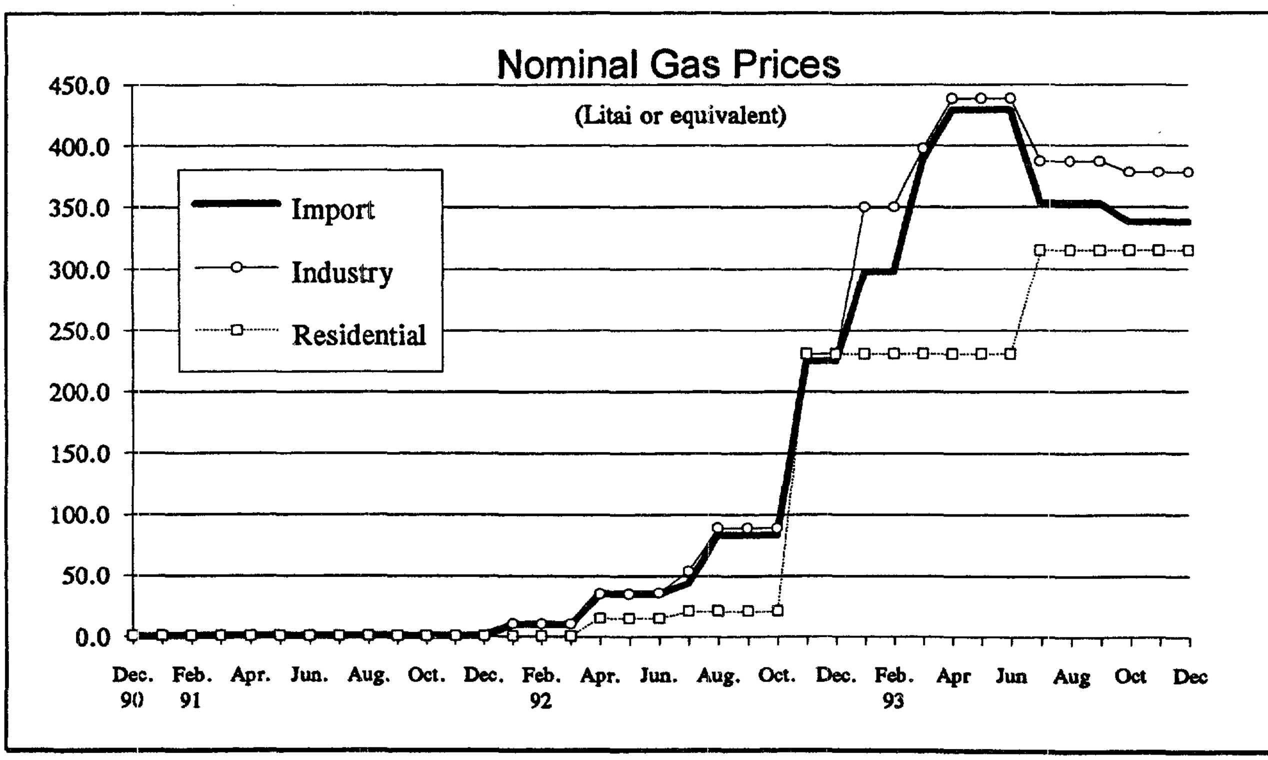

Figure 4.3A

NB: The nominal fall in gas import prices reflected a strengthening of the Lithuanian currency against the dollar.

4.17 Most Lithuanian electricity customers have meters, and time-of-day meters are increasingly common. Lithuania employs a differentiated tariff structure for electricity use; this has been used as a basic tool to help the country shave its peak domestic demand to levels that the Ignalina nuclear power plant can satisfy. Differentiated tariffs vary by consumer group with the night rate at about 40% of the peak rate. Electric power is the most advanced of the energy subsectors both in its use of tariffs and meters, and in its collection record. The system's main inadequacy is charging industrial customers the same average tariff as residential customers, which does not accurately reflect the distribution of costs between these two consumer groups.

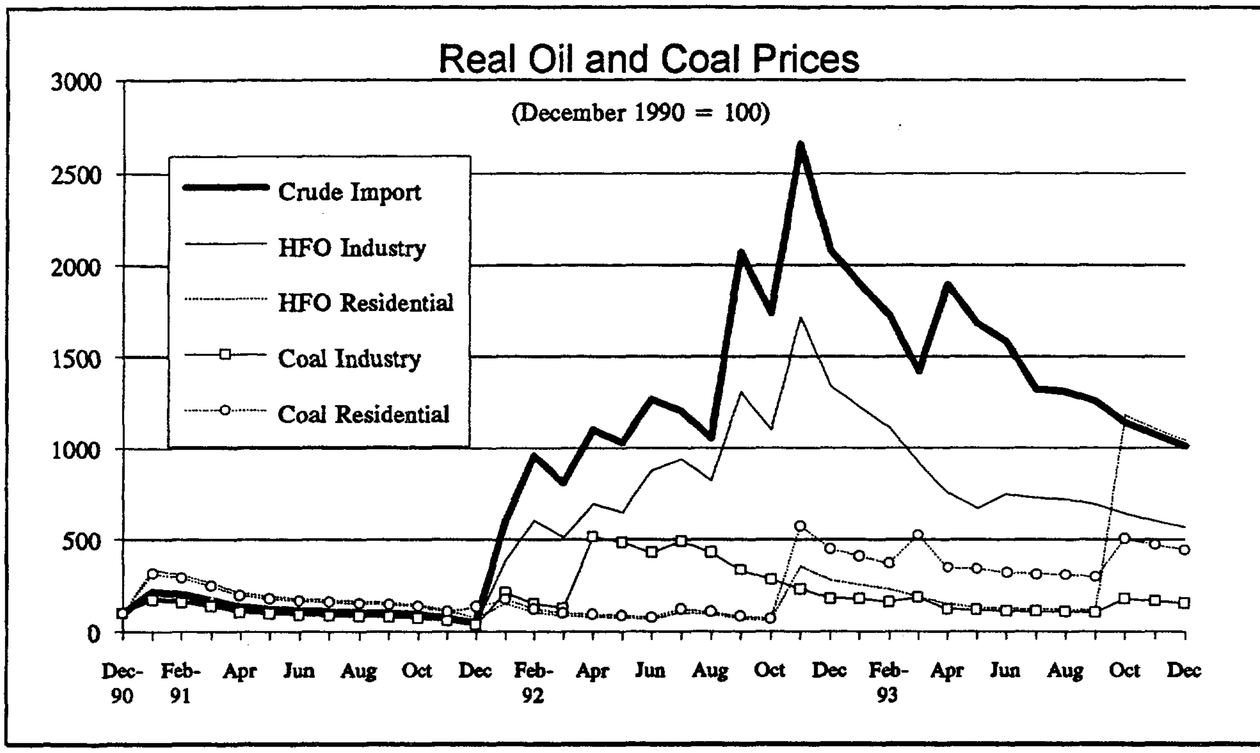

Figure 4.4

Recent Developments

4.18 During the second half of 1993, the Government adjusted prices every month to avoid the lags associated with inflation rate and exchange-rate movements. However, toward the end of 1993 and the beginning of 1994, those prices which were still administratively set were held constant in nominal terms. While the stable exchange rate prevented sharp increases in fuel import costs, other costs continued to climb. Therefore prices in the first quarter of 1994 were below levels sufficient to cover all cash operating expenses. The World Bank Power Rehabilitation Project partially addresses these problems by requiring that average electricity tariffs before tax be raised to at least 11.5 Lithuanian cents (a 58% increase) and residential heat tariffs be raised to at least 30 litai per Gcal.

Price Setting

4.19 In the medium term, the Cabinet will continue setting energy prices, although this the autonomy of the Energy Pricing Council should be increasingly strengthened to improve the objectivity of pricing recommendations (see Chapter V). A more comprehensive short-term strategy is discussed in Section G below. In the interim period, prices should cover cash operating costs and adhere to a few basic principles:

- Price adjustments should be made regularly and be synchronized to avoid price differentials that induce source switching that is unjustified on economic grounds;
- Price calculations should include provisions for bad debts[12];
- Residential tariffs not immediately raised to cost-recovery levels (district heating) should be adjusted regularly in real terms to attain levels eventually which at least cover cash operating expenses;
- Differentiated tariffs should be introduced where feasible to flatten otherwise costly peak demand.

E. Issues of Export Pricing

4.20 Lithuania has been a net exporter of petroleum products and electricity. Recent difficulties in obtaining crude oil supplies have limited petroleum product exports to a small amount under tolling contracts. However, electricity continues to be exported to Latvia, Belarus and the Kaliningrad region of Russia. Electricity exports are priced according to the overall costs of production and not on a marginal-cost basis. Since the Ignalina nuclear power station in 1992 was assumed to provide 80% of the electricity, its comparatively low unit cost of production was given corresponding weight in the calculation of the export price. A 25% export fee was added. The average cost of electricity production is not a proper basis for establishing an export price. Exports must be priced in relation to the most expensive generating unit in operation. The loss per kWh in 1992 from thermal power plants was substantial. Beginning in 1993, Lithuania began to cut back electricity exports to the point where Ignalina could cover demand, since Lithuania's neighbors are unwilling to pay the actual (marginal) cost of electricity produced by thermal plants. Electricity exports are now priced in hard currency, although payment is often made through a complicated barter system. In mid-1993, Latvia was paying 2.2 German pfennigs (about 1.3 US cents) per kWh, while Belarus paid the equivalent of about 1.3 US cents per kWh in a mixture of currencies. Lithuania has been pursuing the possibility of receiving gas imports in exchange for electricity supply to Kaliningrad.

4.21 Lithuania does not currently provide differentiated tariffs for exports of electricity. In practice, this does not cause any economic loss to Lithuania so long as Ignalina continues to be operated and domestic and export demand in peak periods can be supplied by Ignalina alone. However, in the medium term, Lithuania should introduce differentiated tariffs in order to send the right signals to its export customers and further shave its peak demand. At current export prices, Lithuania should not export electricity unless it can supply domestic and export demand from Ignalina.

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[12] These provisions should be calculated for a 'normal' level of bad debt, not to cover previously accumulated arrears. The arrears problem could be cleared through rescheduling late payments (see the World Bank Technical Note, "Redesigning Energy Subsidies and Support Programs").

Moreover, the medium term potential for electricity exports is somewhat in doubt following the completion of a 750-kV transmission line from Russia (Smolensk) to Belarus. Russia has moved aggressively to undercut Lithuanian prices both for electricity exports and petroleum products, and it is unlikely that Lithuania can or should compete if its competitor sets prices below economic costs.

F. Effects of Prices and Subsidies

4.22 At 5.1 billion talonas, energy subsidies and support programs represent close to 10% of the Government's budgeted expenditure for 1993 (of which nearly a third are subsidies paid directly to energy industries and the remaining are support payments to the population). This figure does not include cross subsidies, which are difficult to quantify because they are contingent on demand and do not come from the state budget. There are several critical shortcomings of Lithuania's system of pricing and subsidies, including:

- The mixture of cross subsidies, direct subsidies to enterprises, and direct compensation to low-income families makes it very difficult to quantify the levels of subsidies required, or to adjust quickly to changing needs.

- Price changes have tended to be reactive and unpredictable. Lags in prices have created financial difficulties for energy enterprises which have often not been apparent until many months later.

- Subsidies in their current form are cumbersome and difficult to administer.

- The open-ended nature of subsidies has made it difficult to enforce a hard-budget constraint on energy enterprises, particularly on the distribution companies. This is exacerbated by the lack of fixed wholesale prices. Subsidies therefore represent a source of continuous fiscal pressure and financial uncertainty for energy enterprises.

- Low, subsidized prices do not send the right signals to consumers to conserve energy. Because subsidies are tied to a certain maximum quantity of energy consumed, most consumers will opt to take the maximum.

4.23 The financial implications on energy enterprises of unclear prices and subsidies are substantial. The added financial uncertainty of open-ended subsidies and wholesale prices has forced many energy enterprises to postpone maintenance work -- a policy that will cost more in the long term. The fact that subsidy programs have not worked has also built up considerable arrears, which will eventually have to be taken out of the budget or from consumers through higher tariffs. In short, the Government has applied a series of stop-gap measures which have only postponed, and in many cases, exacerbated the problems. Proposals to rework the system of pricing and subsidies are discussed in Section G below.

G. Reforms to the System of Pricing and Subsidies

4.24 The GoL recognizes the need to phase out subsidies in the energy sector, but also the need to support low-income households in Lithuania. Increasing the problem is the fact that the district heating system is inefficient. If district heating tariffs in January 1992 had been at cost recovery levels, the average household in a 60 square-meter apartment would have paid 7,000 to 13,000 talonas per month -- much more than West Europeans pay for equivalent heat and equal to 40 to 75 percent of a two-person average income. Such extreme distortions force Lithuania to subsidize heat consumption, particularly since most district heating users are captive consumers.

4.25 Under its most recent program, the Government 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 the price rises (of about 10 fold) for that part of their heat bill which exceeds 25% of the household's income. This direct subsidy 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 Government announced in early Autumn 1993 that it would enforce payment of the subsidized heating tariffs by linking electricity supply to the payment of heating bills. While this novel method of enforcing heating payments is a positive development, the system of subsidizing district heating suffers from many of the problems of the old one: 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. Moreover, there are effectively three different subsidies being applied to district heating (electricity cross subsidy, direct operating subsidies and consumption specific social support payments). The system is administratively complex and sends the wrong signals to consumers: the full tariff before compensation is already at a subsidized price.

4.26 There are more efficient ways to protect low-income groups without the distortionary effects of energy price subsidies, particularly through targeted social programs to low income groups. Over the longer term, Lithuania should consider introducing more appropriate pricing systems including competitive markets where this is feasible and long-run marginal cost pricing where natural monopolies exist. The British Know-How Fund financed a study on pricing issues in Lithuania, and a consortium led by Kennedy and Donkin issued their final report in July 1993. The study is comprehensive in its scope and should provide a much more complete basis for developing the pricing system than could be presented in this report alone. These long-term changes to the pricing and subsidy system would also involve substantial institutional restructuring which is discussed in Chapter V. Pending these changes, the Government will have to implement a more realistic, interim program for the energy sector which can provide a minimum level of heat to all household consumers while still ensuring that low-income groups are protected. A proposed two-phase program for the interim pricing system would take the following steps:

PHASE I

- Immediately raise all energy tariffs except district heating tariffs to levels which cover cash operating expenses. A formal system of monthly price adjustments would then be implemented to take into account inflation (local costs) and the exchange rate (import costs). The pricing formula should be transparent and predictable for all consumers.

- Deregulate industrial district heating tariffs, allowing local district heating companies to encourage industrial consumers to reattach to the system where this is economic.

- Eliminate the fluid system of 'wholesale' and transfer pricing and replace it with contracted wholesale prices. A hard-budget constraint should be placed on all energy enterprises, including the distribution companies.

- Abolish the current system of cross subsidies in which the energy enterprises themselves redistribute the funds. Replace cross subsidies with an electricity tax of approximately 0.35-0.5 US cents per kWh. Electricity revenue from this tax should be administered by the government and distributed through the budget to the district heating supply companies.

- Provide direct income support payments to the 15-20% of the population whose income fell below the 1,800 talonas per month minimum living standard (in January 1993). Remove any tie between social support payments and energy consumption.

- Where rationing of district heating is necessary, design the rationing in a way that is transparent and fair.

- Raise district heating tariffs for residential consumers to sustainable levels (e.g., 50% of production costs). A small monthly real increase (say 2.5%) should also be included during the heating season.

- Liberalize prices on tradables (oil products, LPG, coal, etc.).

- Accelerate introduction of the planned new accounting system, including provisions to allow the revaluation of assets.

PHASE II

- Rehabilitate the district heating system, introducing local fuels (wood-chip boilers) where it is feasible.

- Introduce metering and control equipment on the building level for district heating on systems where variable flow can be established. Introduce gas meters for all household consumers.

- Raise district heating prices for all consumers to allow recovery of all cash operating costs.

4.27 At minimum (rationed) levels, households in Lithuania consume about 6.8 million Gcal of heat per year. At approximately US$ 12 to produce one Gcal, the cost of supplying heat to Lithuanian households would be US$ 82 million. Current Government projections expect households to pay US$ 44 million of this cost. A 0.35 US cent tax per kWh on electricity -- equivalent to the surplus implied in the latest price increase -- could raise about US$ 49 million a year, which more than covers the difference between revenues from households and costs. Households paying more than 25% of their income for heat even at the subsidized price would be compensated by direct welfare payments. The advantage of an electricity tax over simply raising prices (as proposed by the Government) is that a tax will ensure that the subsidy has a hard budget constraint and is not taken from the working capital of LSPS. The electricity price then can be set independently of the tax based on the operating costs of the utility. Such a tax would make the subsidy easily quantifiable and administratively simple. It will also send a clear signal to consumers that electricity prices are artificially low; much higher tariffs will be required in the medium term if Ignalina is retired early.

4.28 The subsidies for district heating should be set for a finite period (e.g., to 1995), and should be linked to the upgrading of the district heating system. Several factors will help eliminate the subsidy: (a) the exchange rate is expected to appreciate in real terms (10-30%), making imported fuel cheaper relative to tariffs; (b) household incomes will gradually rise in real terms; and (c) the district heating system will be upgraded to reduce losses and make use of local fuels. In the interim, the Government should abandon its compensation program in favor of direct budgetary transfers to the lowest income groups. Cross subsidies from industry -- which are unreliable -- should be abandoned in the gas subsector and should not be reintroduced in the other subsectors. Over the longer term, having meters at the building level for heat and at the individual residence level for gas will allow consumers to become responsive to price signals and encourage conservation of energy.

V. ORGANIZATION OF THE ENERGY SECTOR

A. Current Institutional Structure

5.1 The Lithuanian energy sector remains largely state-owned with control exercised principally by the Ministry of Energy. Although individual enterprises in the energy sector are relatively autonomous in their day-to-day operations, the MoE appoints the general directors and is active in establishing policy, administering subsidies, and negotiating prices with the Government. The Government has relaxed fuel distribution and import controls to nurture a parallel market in petroleum products, but private activity is as yet limited. In practice, the Government still negotiates most energy imports and exports.

5.2 The main operating organizations are the Lithuanian State Power System, Ignalina nuclear power station, Siluma (regional district heating), Lithuanian Gas, Lithuanian Fuel, Mazeikiai Oil Refinery, Klaipeda Oil Export company, the regional gas and electricity distribution companies as well as a number of research and construction companies (see Figure 5.1). Except for a few recently privatized construction companies and retail gasoline stations, all enterprises are state-owned; they are called 'special' state-owned enterprises, which gives the Government greater power to intervene than is normal for state-owned enterprises (SOE). They in turn control their own affiliates (the electricity generating companies and the fuel distribution companies). Affiliated companies function as fully owned and consolidated subsidiaries, except that they do not pay tax separately or submit financial statements. Since the financial and institutional organization of the subsectors is not consistent between subsectors, here is a quick synopsis.

Electricity and District Heating

5.3 The Lithuanian State Power System (LSPS) is the cornerstone of the electricity subsector, controlling the transmission grid, inter-company trade and external contracts, and all non-nuclear generation. Although Ignalina (nuclear power station) is independent of LSPS, it supplies all its electricity to LSPS and cooperates closely with the company. Affiliates of LSPS include four thermal generating companies, a hydroelectric station, the Kruonis pumped storage facility, the Vilnius dispatch center, and a maintenance company. The seven electricity distribution companies were made nominally independent of LSPS following the break-up of the FSU, but they were reconsolidated under the company in August 1993. In addition, all of Lithuania's district heating companies are now under LSPS control, although the Siluma and Alytus district heating companies were only consolidated under LSPS in August 1993.

5.4 LSPS sets the amount of electricity to be produced by its generating companies, contracts for fuel allocations, and pays its generators for electricity based on production costs. The only flexibility generating, distribution and district heating companies have in managing their own costs is in the payment of wages. LSPS makes a lump payment for wages to each affiliate, giving the local director some scope for raising wages or making minor investments.

5.5 LSPS has a large number of heat-only boilers providing heat under its district heating affiliates. CHP stations also provide heat to the district heating networks, although the recent drop in electricity demand has made this source of heat less economic than running heat-only boilers and supplying electricity from Ignalina. Siluma provides a central organization for 33 regional district heating units to help the individual companies buy equipment, analyze fuel efficiency, and manage the accounting.

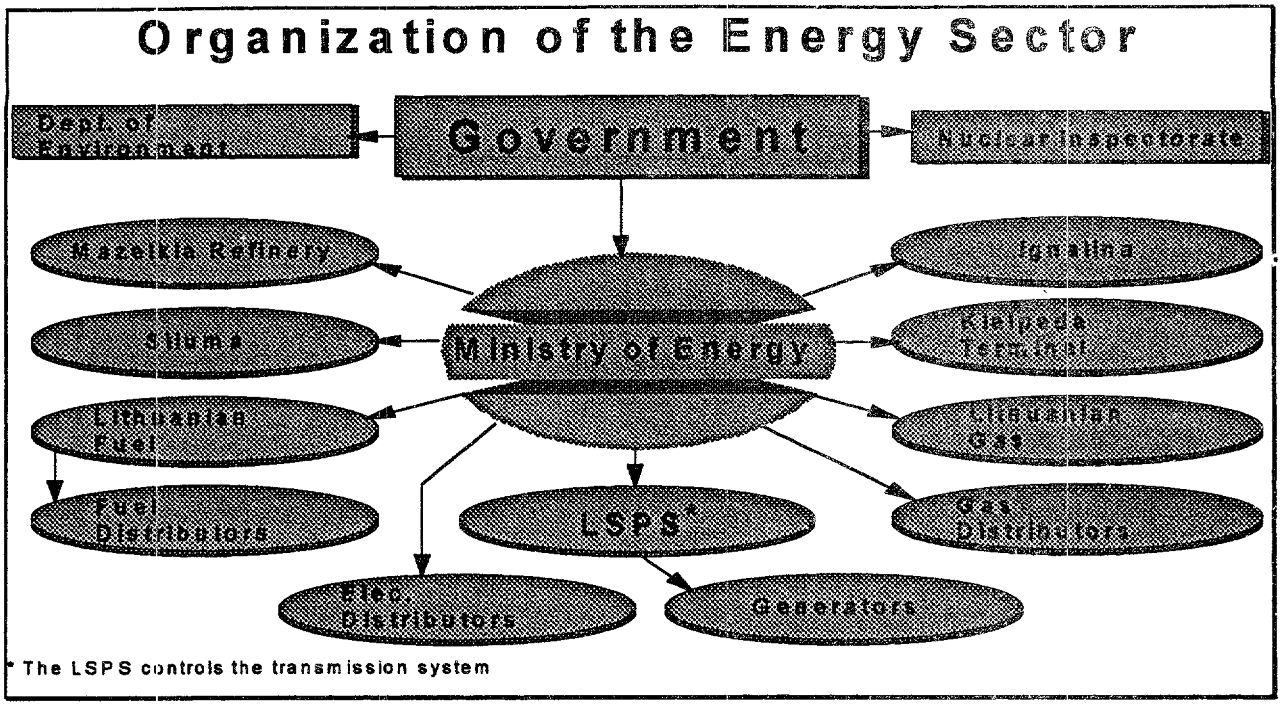

Figure 5.1

Petroleum (Fuels)

5.6 The petroleum subsector consists mainly of the following state-owned companies: Mazeikiai refinery, Klaipeda Oil Export Company, and Lithuanian Fuel. All three companies have the same legal status as, for instance, LSPS. Lithuanian Fuel has 13 distribution and one construction affiliates. The distributors are effectively still regional monopolies and are not specialized by product. More than half are technically bankrupt, with Lithuanian Fuel redistributing the profits between the distributors. Each distributor can buy directly from Mazeikiai, while Lithuanian Fuel itself contracts with power plants to supply fuel oil.

5.7 Although the internal pipeline system in Lithuania is owned by the state, a Belarus-based company controls the transit system for crude-oil imports and includes transit fees in the crude oil price. Mazeikiai negotiates contracts directly with Transneft, a Russian petroleum supply company.

5.8 The severity of the energy crisis has forced the Government to allow commercial pricing in non-monopoly areas of fuel distribution. Most oil products no longer have price controls. The same policy applies to coal, LPG, and other fuels, which can be sold without a transmission network.

Gas

5.9 The gas subsector consists principally of Lithuanian Gas, 10 regional distribution companies, a liquid natural gas distributor, and two support companies. As with the electricity subsector, the distributors are legally independent of Lithuanian Gas. However, they also receive effective subsidization through differences in the wholesale prices which are set for Lithuanian Gas. These subsidies come from the state budget through payments directly to Lithuanian Gas.

5.10 The distribution companies were separated from Lithuanian Gas shortly after independence. Theoretically, the distributors may buy gas from other suppliers. However, as there are no other suppliers as yet, Lithuanian Gas remains the sole supplier.

5.11 Lithuanian Gas imports supplies directly from LenTransGaz or other CIS suppliers and supplies gas to the distributors through its network. Distributors which import with other partners pay transit fees to Lithuanian Gas.

Other Institutions

5.12 A number of institutions outside the Ministry of Energy's control contribute to the sector as a whole. The Lithuanian Energy Agency was founded in November 1993 in Vilnius and is essentially an offshoot of the Ministry of Energy. The Energy Agency performs many of the functions previously under the MoE, but it is not financed from the state budget and is not subject to civil service salary limitations. The Lithuanian Energy Institute in Kaunas has emerged as an important research and planning organization. It has many analytical tools and resources to provide policy advice and supply and demand scenarios for the energy sector, but the institute has no formal policy role, and its advice is not binding on the MoE. Also in Kaunas is the Power Network Design Institute, which analyzes and designs high voltage transmission systems and interconnections.

5.13 The Baltic Cooperation Council has an energy committee to promote cooperation between the energy ministries of the three Baltic countries through regular meetings. In addition, the Ministers of Energy of Estonia, Latvia and Lithuania meet periodically to discuss regional energy issues..

5.14 The Dispatch Center (DC), in Riga, matches electricity demand with available supply for the whole Baltic region. It does so by telephone, since voltage and frequency control is performed through a hydro cascade on the river Volga.

5.15 Two regulatory bodies have been established -- the Department of the Environment and the Nuclear Inspectorate. Both are independent of the MoE, reporting directly to Parliament. In addition, an Energy Pricing Council was set up in March 1994 to advise the Cabinet on energy pricing. The roles of these departments will be discussed separately under the section on regulatory bodies.

B. Shortcomings of the Current Institutional Structures

5.16 The lack of a legal framework for the energy sector remains one of Lithuania's most pressing institutional problems; this is expected to be addressed once the draft energy law is adopted (see Section C below). The Government is also beginning preparation of the specific subsector laws and regulations which will follow the energy law. In the absence of a clearly defined energy policy, there is also significant confusion as to which institutions (apart from the Ministry of Energy) should play a role in energy issues. Communication is poor between the Ministries of Housing, Energy, Economics and Industry on matters of mutual interest such as conservation, industrial strategy and energy demand projections.

5.17 Although there have been some changes to the organizational structure of the Lithuanian energy sector since independence was declared in March 1990, the sector has not completely shed its central planning habits. Indeed, the steps taken thus far are largely cosmetic, and mostly the subsectors continue to operate as vertically integrated monopolies. The benefits of separating the distribution companies have not materialized largely because they have not really functioned as independent companies:

- Cross subsidies between distribution companies are still administered by the transmission companies through differentiated wholesale prices (see Chapter IV). These cross subsidies allow the distribution companies to operate without a hard-budget constraint, i.e., any operating loss incurred (regardless of reason) would be covered by funds from a more profitable distribution company.

- In the absence of firm wholesale prices, the transmission companies have had little control over their own finances. The distribution companies do not pay for the energy delivered to them, but rather pass on a percentage of their collections from consumers. A poor collection rate by the distribution company thus will lower revenues of the transmission company, even though the latter has no control over the collection.

- The 'independence' of the distribution companies adds bureaucratic complexity to the decision-making process in areas such as load management without improving efficiency or financial management.

5.18 As a result of these deficiencies, the Lithuanian authorities have reintegrated the electricity distribution companies into the transmission and generation company (LSPS). Although this reintegration may improve the current system, the country appears to be abandoning a structure never fully implemented. Moreover, bringing the distribution companies back into vertically integrated monopolies will not solve all the problems listed above, particularly the problem of cross subsidies. Proposals for addressing these issues are discussed in more detail in Section D.

5.19 The Government has no pricing formula and makes no guarantee that prices will be adjusted in line with changes in the costs of providing energy. Even in a system of administered prices, the enterprises should know how these adjustments are to be made so they can plan appropriate investments and maintenance with a reasonable idea of what their revenues will be. A number of energy enterprises have found themselves in serious financial difficulty as a result of prices lagging behind costs. Regardless of the system chosen for setting or regulating prices, there must be a simple and transparent pricing mechanism. The foundation of the Energy Pricing Council may be an important step toward improving the country's pricing mechanism, but it is still to early to assess the effectiveness of this body. These issues are dealt with in more detail in Section E below and in Chapter IV.

5.20 The current institutional structure also suffers from a lack of commercial and competitive incentives. Unfortunately, the Lithuanian authorities do not appear to make a clear distinction between commercializing the energy sector and privatizing it. Commercialization occurs when an enterprise ceases to operate like a government department and adopts commercial management and operation practices. The commercialized enterprise is explicitly compensated from the state budget for the provision of any non-commercial services which are state-mandated. These services should be gradually phased out. Whereas the Lithuanian energy sector companies theoretically operate on commercial principles (i.e., they collect their own revenue, cover their own costs and are usually subject to hard budget constraints), the state is still instrumental in controlling inter-company 'commercial relations'. Such top-down management discourages initiative from the staff of energy enterprises to improve operational and technical efficiency. A number of minor state companies or affiliates of state companies have been privatized (e.g. construction companies, gasoline stations), and these companies do operate as fully commercial, private companies.

C. Current Restructuring

5.21 Lithuania is just beginning to draw up plans to restructure the energy sector and create a legal framework for energy trade. The Lithuanian authorities are preparing an energy law, with assistance from the Danish Energy Agency (DEA), and the World Bank. The aim is a broad legal framework for the energy sector followed by laws dealing with specific issues for each of the subsectors as well as detailed regulations. A number of suggestions to the original draft of the energy law have been made, including to:

- Clarify and strengthen the Law's regulatory scheme -- both as to pricing/tariffs and technical standards -- and define the competencies of the various proposed independent regulatory commissions;
- Add provisions to cover licensing, distribution and trade of energy;
- Incorporate an effort to integrate energy resource strategies;
- Reduce the degree of State control and, instead, encourage foreign and domestic private investment in the sector;
- Introduce transitory provisions to deal with the relationship of the Energy Law to other laws;
- Allow competition in the sector to encourage free market benefits; and
- Distinguish and separate more clearly the Government's role as owner, operator and regulator of the energy agencies.

5.22 The Energy Law has been presented to the Lithuanian parliament, but had not yet been passed by April 1993. Following the expected adoption of the energy law, the Bank is prepared to assist in the preparation of specific legal and regulatory instruments under the Energy Law to govern each energy subsector.

5.23 A number of other steps have been taken by the Lithuanian authorities which provide an important foundation for future restructuring:

- The Government has pursued privatization of small energy affiliates which are not involved in the core operations of the energy enterprises.
- The Lithuanian Energy Institute in Kaunas has drawn up skeletal restructuring proposals for the energy subsectors. The MoE is not bound to implement or even to consider these proposals from the Institute, but they have stimulated discussion.

- An extensive program to introduce gas metering has begun with the Government offering to cover up to 80% of costs.

5.24 The law on privatization establishes a legal framework for foreign currency auctions of Lithuanian companies, but a subsequent resolution forbids any foreign ownership in monopoly sectors and restricts foreign ownership to 49% of oil and gas pipelines, electric power transmission lines, and heating systems. Although the Government maintains the right to override these restrictions, the provisions on foreign ownership are currently too restrictive to encourage much foreign participation in the development of the Lithuanian energy sector.

D. Prospects for Commercialization, Demonopolization, and Privatization

5.25 In an ideal world, Lithuania would be able to allow perfectly competitive energy markets to govern the efficient allocation of resources, prices, and expansion of services. In reality, there will be serious limits on the extent to which Lithuania can introduce competition into the energy sector. Competition will be limited not only by the existence of monopolies (such as transmission and distribution of gas, heat and electricity), but also by the energy infrastructure that Lithuania has inherited. For instance, it will not be feasible for Lithuania to introduce a competitive electricity generation market until such time as at least one unit of Ignalina is retired (since Ignalina currently provides about 90% of the country's power needs, and no other generators could compete with its low production costs). In advising the Government on the energy law and restructuring proposals, the Bank has recommended that the introduction of competition remain as an ultimate goal for certain areas (e.g. electricity generation), but it has suggested that the timing of these changes be dictated by the specific circumstances as they develop in the country.

5.26 Although the prospects for competition <u>within</u> each subsector is limited, competition is already a major factor <u>between</u> subsectors and in international trade of energy products. For instance, the abundance of heavy fuel oil from different refineries throughout the FSU not only provides competition between suppliers but also competition against gas for which there is only one supplier (Russia). Competition for electricity exports is fierce, with cheap supplies available from Estonia, Lithuania, and Russia.

5.27 The Government has already taken important steps to liberalize trade in the petroleum products subsector to foster the growing competition. Competition currently comes mainly through imports from neighboring countries and Russia as well as from the Mazeikiai refinery. Private gasoline stations are now increasingly common in Lithuania. The elimination of price controls was an important first step in the liberalization of the oil products market; however, the Government may need to modify the tax system to ensure that all companies pay the same total rate of tax on oil products and therefore have an equal chance to compete. Taxes on private companies distributing petroleum products have been lower than those for the Mazeikiai refinery (see <u>Chapter IV</u>).

5.28 The introduction of competition in energy supply and distribution would most benefit the consumer. Under the current system, risks associated with investments and operation are passed on to the consumers. In other words, if a utility makes a poor investment or runs its equipment inefficiently by not making appropriate investments, the consumer pays the cost for this either in higher energy prices or through higher overall consumer prices sparked by inflationary government spending on subsidies. Under a competitive system, the risk (and rewards) associated with running the utilities would remain with the utilities themselves, giving them added incentive to provide the cheapest and most efficient service possible.

5.29 In the longer term, the prospects for competition will be defined by the following factors:

- As a small country, the main source of competition in the energy sector will come from imports, and Lithuania should strive to establish a common market in energy trade with its neighbors and eliminate any barriers to energy trade;

- Lithuania has good prospects for developing its own oil and gas reserves, which, although insufficient to provide all of Lithuania's needs, will nonetheless make a significant contribution to the country's demand. The energy law has been drafted to allow competition in the supply of oil and gas in order to attract foreign capital and hasten the development of these reserves;

- An early retirement of Ignalina would also open up the possibility for competition in electricity generation, particularly in competitive procurement of new generation, as has been the model in the United States since the mid-1980s.

5.30 Even in the subsectors where there is limited scope for competition, the Government should still strive to restructure these enterprises in order to inject commercial principles into their operations. The advantages of commercialization would be to:

- Allow individual production units to take the initiative in order to improve efficiency and invest in new equipment;

- Subject enterprises to hard-budget constraints, thus encouraging efficient use of energy and allowing companies to gauge their profitability;

- To encourage new investment in the sector.

5.31 The Government allows energy companies to incorporate (establish themselves as joint stock companies with up to 49% non-state ownership), but this legal distinction does not appear to give the company sufficient freedom from the state in its commercial operations. For instance, the right to hire and fire labor could still be annulled. The Bank has been helping the Government define its goals in the energy sector and establish the legal framework for the autonomous operation of energy enterprises including those which remain state-owned. A principal tool for this will be the establishment of an Independent Regulatory Agency, which is discussed in more detail in Section E below.

5.32 A plan of action for restructuring the electricity subsector is being prepared by the MoE and LSPS with some Bank assistance. The plan calls for a four-phase approach to restructuring which begins with the incorporation of LSPS (forming the National Electric Company), a separation of the sector service industries and distributors, the establishment of an independent regulatory agency and the eventual introduction of open access transmission and competition. A draft of this plan is presented in Annex 5.1. In addition to this plan, there are a number of recommendations for restructuring the energy sector which could be adopted immediately, including:

- Separate the heat, electricity and gas distribution companies from the transmission companies, allowing these companies to recover their local distribution costs. Separating the heat and electricity distribution companies will allow LSPS to operate on a commercial basis. Cross subsidies of heat with electricity could be replaced with a tax on electricity on consumption which would be phased out by about 1998 (see Chapter IV);

- Introduce a hard-budget constraint on gas, fuel, heat, and electricity distribution companies; incorporate these companies as entities legitimately independent from the distribution companies. This would end regional cross subsidies and establish fixed wholesale prices set, in the short-term, by the Government, and eventually by the independent regulatory agency;

- Transfer any regulatory, supervisory, and policy-making functions still under the energy enterprises to the Government or regulatory agency (e.g., technical inspection);

- Privatize services which do not fall under the core activities of the energy enterprises (e.g., construction, manufacturing, research);

- Complete the privatization of retail fuel stations.

5.33 Restructuring is a difficult and disruptive process, and it should not be implemented simply to attain a model structure which may not be appropriate for Lithuania. The preliminary steps outlined above are critical for the efficient operation of the sector and will also help the Government to quantify subsidies and arrears. Although the Lithuanian authorities have opted to reincorporate the distribution companies into vertically integrated monopolies for the time being, it should still impose hard budget constraints on the distribution affiliates. By the same token, a transparent pricing mechanism should be established even if it is not immediately administered by an independent regulatory body.

5.34 In the long term, there are other possibilities for attracting private capital and competition into the energy sector. For instance, the distribution companies could be franchised on fixed contracts using a competitive bidding process. However, such changes are well beyond the current institutional capacity of the Lithuanian energy sector and should only be considered after more critical restructuring is complete and the new institutions well established.

E. Regulatory Bodies

5.35 Introducing regulatory bodies concurrently with commercialization of the energy sector will help to separate clearly the role of the Government as regulator from that of owner. The goal of regulation is to promote the highest quality service and safety at the lowest possible price. However, financially weak utilities will not be able to provide high quality service to the consumer in the long term. While regulation must aim to protect the consumer, it must also allow a fair return on investment for public and private utilities, to ensure continuity in service delivery. Tariffs for each consumer classification must be reasonable given the costs of the services provided.

5.36 The regulatory bodies must also gain public trust by being autonomous, objective and apolitical. Under a system where the government still owns the public utilities, the regulatory bodies should ideally be autonomous from government control as well as free of undue influence from the utilities themselves. The regulatory bodies should operate in a transparent fashion, following open procedures for consulting all relevant parties in accordance with the specific regulations of the country. A simple process should be instituted to help consumers register complaints with the regulatory bodies and obtain published information on all of the bodies' major decisions.

5.37 Lithuania is setting up a regulatory framework, and its draft Energy Law calls for a clear separation of roles between the MoE in drafting an energy strategy and regulations and an Independent Regulatory Agency (IRA), in implementing the strategy and overseeing the regulations. As an interim step, the Government has established an Energy Pricing Council which submits pricing proposals to the Cabinet. This body may eventually be strengthened to take on the functions intended for the IRA. Under the Energy Law, the IRA commissioners would be nominated by the Government for six-year terms subject to approval by the Sejmas (parliament). The draft Energy Law separates the regulatory responsibilities still further, creating an Energy Superintendency to supervise compliance with regulations. In essence, the Superintendency would act as regulatory police, investigating customer complaints which could then be referred to the IRA, if appropriate. The responsibilities of the IRA would include:

- Regulating pricing and rate-setting for natural monopolies;
- Regulating the quality of services provided, relating prices to quality;
- Overseeing technical standards for the energy industries;
- Promoting competition in areas where this is feasible through proposals to the Government;
- Ordering anti-trust action;
- Ordering private divestiture if needed in areas where a private company attains monopoly status;
- Bringing legal action against violators of regulations or of prices established by the agency.

5.38 The specific regulations for the IRA will be determined once the body is legally established, i.e., the regulatory approach has not yet been agreed upon and, indeed, could be modified as the country's needs develop. It is recommended that the responsible agencies:

- Establish a simple and transparent pricing formula. Price capping may be the most appropriate system of price regulation for Lithuania for non-tradables since it does not require a costly review of asset values, it can be quickly and periodically adjusted, and it provides incentives for the utilities to improve efficiency and plan for long-term investments;
- Ensure that the IRA not only protects the consumer but also determines a fair price at which utilities can maintain their plant and equipment, raise capital in the capital markets and provide part of their own financing for appropriate expansion. Regulatory mechanisms should be designed which offer incentives to utilities to promote energy-saving measures among customers;
- Implement a transitional system of price regulation for district heating and electricity until all heating subsidies are eliminated;

- Reinforce regulation with anti-trust legislation to prevent collusion and other forms of anti-competitive behavior in areas where competitive markets can be fostered (e.g., the petroleum products market);

- Stagger the terms of office for IRA commissioners to ensure continuity.

5.39 The Government has also established nuclear and environmental regulatory bodies. Establishing these bodies is an important step in separating the regulatory system from the Government and the energy enterprises, but they are somewhat deficient in their present form:

- It seems imprudent to locate the Nuclear Safety Inspectorate (VATESI) in the Ministry of Energy building. This does not enhance public confidence that the Inspectorate is indeed an independent department of the Government. It is recommended that separate premises should be found for the Inspectorate independent of the MoE. Furthermore, it is widely recognized that the Inspectorate does not yet have adequate resources and enforcement authority to perform its mandate adequately. The Government would be well advised to mount an effort to strengthen the status of the Inspectorate with the provision of the necessary resources.

- The environmental department is thus far mostly a monitoring organization. It is recommended that the Environmental Protection Department be strengthened by giving it a clear role at the planning stage of new power stations and other industrial facilities.

- Since the MoE manages and, in effect, owns the Ignalina nuclear power facility, it exposes itself to charges of conflict of interest by being the main drafter of the law on nuclear safety regulations. Establishing a committee independent of the Ministry would help to avoid such a conflict. It is recommended that technical assistance be secured to help draft the nuclear safety regulations and to institute a Nuclear Law in Lithuania.

VI. ELECTRICITY AND DISTRICT HEATING

A. Electricity Generation and Storage

Overview

6.1 Total installed generating capacity of the Lithuanian State Power System (LSPS) is about 5,600 MW, a substantial investment for a country with a population of only 3.7 million people. The Ignalina Nuclear Power Plant (installed capacity 3,000 MW, derated to 2,500 MW for safer operation), together with the Elektrenai Thermal Power Station (1,800 MW capacity - oil or gas-fired generation) are the main power plants in the country. Traditionally, Lithuania has exported electricity to Kaliningrad (Russia) and Belarus, but recent increases in the import price of fossil fuels have caused the Lithuanians to reduce exports to a level that can be provided by Ignalina without the need to use expensive thermal plants. Moreover, the unfavorable economic climate in the FSU has rapidly reduced domestic electricity consumption (from a system peak of 3,158 MW in 1989, to 2,837 MW in 1991, to less than 2,100 MW in 1992 and 1993). Such developments leave Lithuania with more than sufficient system capacity to meet domestic requirements for the foreseeable future. Figure 6.1 shows consumption by individual sector for the period 1985-1992.

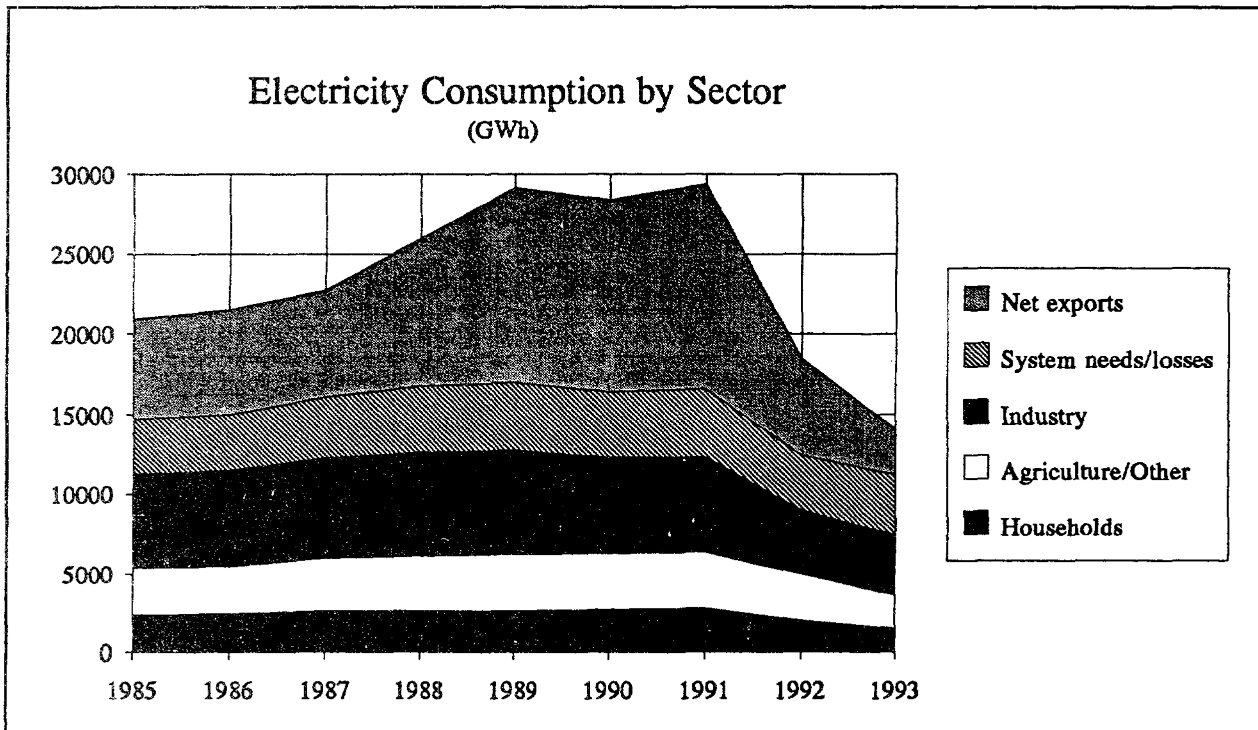

Figure 6.1

6.2 Lithuania depends on Russia for all of its oil and gas supplies for electricity generation. Since Russia now demands payment for these commodities in hard currency at world prices, Lithuania experiences difficulty in paying for the quantities of fuel it requires. The estimated requirement for 1993 was 1.5 million tons of oil at $120 per ton and 4.0 bcm of gas at $80 per thousand cubic meters. In late 1992, the Russian authorities informed that up to 1.5 million tons of oil and 4.5 bcm of gas would be available for sale to Lithuania in 1993. However, it was evident in the last quarter of 1992 that, even if Lithuania could pay the bill, this volume of imports would leave the country severely short of fuels. Output of the Elektrenai thermal units, therefore, was reduced sharply, and reliance shifted mainly to Ignalina. Figure 6.2 shows the current mix of installed capacity in Lithuania. Figure 6.3 illustrates the recent decline in system demand and energy production while showing the increase in available capacity which is due to the completion of two hydro pumped storage units at Kruonis.

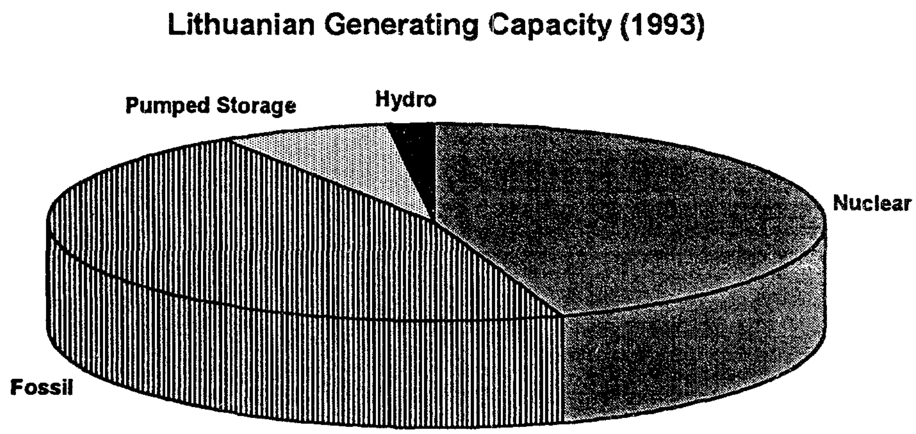

Figure 6.2

6.3 According to the Bank's demand forecasts presented in Chapter III, Section E, Lithuanian electricity demand is expected to fall dramatically over the remainder of this decade. If accelerated reforms are pursued, the forecasts show demand falling to 43% of 1990 levels by 1998, recovering to roughly 94% by the year 2010. Under a slow reform program, GDP will recover less rapidly, even as demand pursues a higher course (reaching a low of 76% of 1990 levels in 1994, and climbing to 137% by the year 2010). Even under high-demand assumptions, and in case Ignalina is shut down, there would be no need for new capacity until 2002; beyond that year, however, a maximum of 1350 MW of new capacity would be required by 2010. However, the incremental costs of producing electricity with fossil fuels would be substantial. These issues are elaborated in Chapter VII, while details of the capacity and supply of currently operating power facilities are presented in Table 6.1.

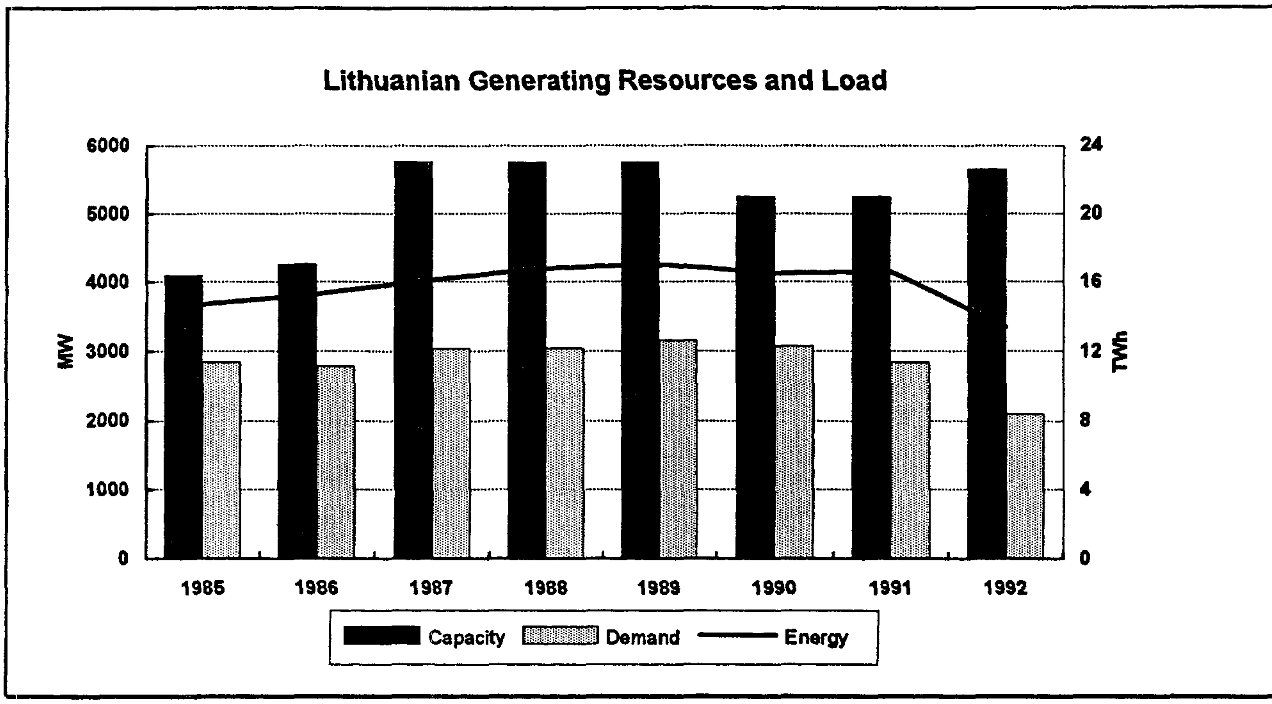

Figure 6.3

Table 6.1: Electricity Supply in Lithuania (1991)

Power Station	Capacity[a] MW	Operation h/y	Production (GWh) gross	net	Fuel Use Mtce
Elektrenai TPP	1,800	4,861	8,748.6	8,379.3	2.883
Vilnius CHP	384	4,524	1,737.0	523.8	0.817
Kaunas CHP	183	4,228	773.7	630.8	0.716
Mazeikiai CHP	194	3,121	605.4	532.6	0.384
Klaipeda	11	4,153	44.8	25.50	0.118
Kaunas Hydro	106	3,234	326.0	324.6	—
Ignalina	2,500	6,800	16,999.6	15,613.8	—
Total	**5,178**		**29,235.1**	**26,030.4**	

a/ Total capacity is exclusive of the Kruonis hydroelectric pumped storage facility which comprises 2 x 200 MW units and an additional 2 x 200 MW units under construction and due to be completed in 1994 or 1995.

6.4 Domestic electricity consumption after losses fell to 73% of 1990 levels in 1992. The decline accelerated throughout the year an into the next, such that demand in 1993 was only 60% of that in 1990. These developments in consumption patterns suggest that Lithuanian electricity demand is tending toward the low demand forecast. These forecasts are discussed in greater detail in Chapter III.

Thermal Power Generation

6.5 Lithuania's total thermal power generating capacity is 2,572 MW. About 1,800 MW of this capacity is generated by eight units (4 X 150 MW and 4 x 300 MW) at the Elektrenai Thermal Power Station (TPS). The remaining 772 MW is generated by the Vilnius, Kaunas, Mazeikiai, and Klaipeda combined-heat-and-power (CHP) Stations. The four Elektrenai 150-MW units (1 - 4) also provide district heating capacity (700 GJ/hr), which is almost as much as the Vilnius CHP Station (780 GJ/hr). The 300-MW units (5-8) do not provide district heat. During the current severe oil and gas shortages, energy production has been drastically curtailed from all thermal power stations. This reduction in output is dramatically evident in Table 6.2 and in Figure 6.4.

Table 6.2: Electricity Output in Lithuania (GWh)

Production Source	1990	1991	1992	1993
Ignalina Nuclear Power Station	17,033	17,000	14,638	12,260
Elektrenai TPP	7,812	8,749	1,821	579
CHP Plants	2,997	3,161	1,706	664
Hydro Plants	414	338	311	392
Kruonis Pumped Storage			237	187
Total Production	**28,256**	**29,248**	**18,476**	**13,895**

6.6 The Elektrenai Power Station is a unit-type power station. Each unit operates as an independent boiler and turbogenerator set with a condensate and boiler feedwater system, a unit control system and a main power transformer set that feeds into the 330-kV transmission grid. Cooling water is recirculated and stored in artificial reservoirs formed by dams on the Streva River. The warm cooling water is channeled to prevent it from mixing with the cooler intake water before entering the cooling lake. The first Elektrenai unit was commissioned in 1962 and is now 30 years old. The first two units have reached -- probably exceeded -- the limit on creep-rupture design operating hours for high-temperature and high-pressure steam system components. Some of these components, including boiler superheater tubes and headers, main steam piping, and possibly some components of the high-pressure turbine, must be replaced. Over the next decade, the remaining six units also will reach design operating-hour limits for high-temperature, high-pressure steam system components. Replacement of the most critical of this safety-related equipment will then be needed.

6.7 CHP stations with a total capacity of 772 MW are located at Vilnius, Kaunas, Mazeikiai, and Klaipeda. In Klaipeda, all units have dual-fuel designs, utilizing heavy fuel oil or natural gas. The CHP stations also have heat-only boilers (HOB) to supplement the heat output of the CHP plants when demand is high. For an optimum fuel efficiency and minimum cost of thermal energy supplied, the heat-only boilers should be used only for peak heat demand. In Lithuania, however, the ratio of heat-only boilers to total heat requirements appears to be high. When electricity demand justifies the expenditure, it is recommended that LSPS consider adding as much as 660 MW of additional generating capacity in five new CHP stations for the Kedainiai, Alytus, Panevezys, Marijampole and Siauliai district heating systems to better achieve the optimum mix of thermal and electrical energy for these systems. LSPS' future plans already include the addition of a third 180-MW CHP unit to the Vilnius CHP Station Number 3 by about the year 2000. However, before any further thermal generation projects are undertaken, developments in gas-turbine and gas-supply technology, including coal gasification, probably will make the gas turbine option even more attractive on economic, environmental, and diversity of fuel supply grounds.

6.8 Based only on visits to Vilnius CHP Stations 2 and 3 in October 1992, Vilnius CHP Stations have been maintained as well as resources have permitted. Vilnius CHP Number 3 Station appears to have problems similar to those of Elektrenai, which stem from faulty equipment design and poor-quality materials. No instances of poor-quality construction were noted. The Vilnius CHP Number 2 Station, is very old (1955), and in poor condition. Its steam boilers, which supply the CHP turbogenerators, and the turbogenerators themselves are badly deteriorated from lack of resources for adequate maintenance and mostly inoperable.

Plant Rehabilitation and Life Extension

6.9 "Rehabilitation" and "life extension" refer to efforts to make an existing plant operate more reliably and last longer than originally designed for. Replacing worn parts with newer technology allows the plant to approach its initial efficiency rating for an additional 10 to 20 years, and may significantly reduce environmentally damaging emissions. "Repowering" refers to additional modifications and improvements to achieve a useful life extension. For example, where natural gas is available, gas turbines may be added as a topping cycle either to the existing boiler or to a new heat-recovery steam generator. The heat-recovery steam generators capture energy residues from the high-temperature gas-turbine exhaust emissions for use in steam turbine-generators. Besides achieving higher thermal efficiency, this process adds extra capacity at very minimal cost and negligible environmental impact.

6.10 Rehabilitation and repowering are concepts developed since the late 1980s especially by the US electric utilities when the siting, licensing, and commissioning of new plants became increasingly difficult. Present rehabilitation techniques extend power station lifetimes by 20 years or more. As the industry gains experience and refines the technologies, the extended life-span will lengthen too. Rehabilitation and repowering are key elements in electric-utility industry planning.

6.11 The extent of the thermal unit rehabilitation program will be depend largely on plans for the Ignalina Nuclear Power Plant[13]. If Ignalina is to meet most of the country's electricity needs (it supplied over 90% in 1993) through 2008, the Elektrenai units require only a modest rehabilitation over the next ten to fifteen years (apart from replacement of equipment or parts that fail prematurely). On the other hand, if one Ignalina unit is to be retired early, say about the year 1998, an alternative power supply option would be to accelerate rehabilitation of the Elektrenai units (see para. 6.35).

6.12 Regardless of the timing of the retirement of the Ignalina units, a substantial upgrading of the iv safety-related features would be needed for the plant to continue operating beyond 1995, and this

[13] See also the companion report "Lithuania: Power Demand and Supply Options" (G-7 Study), World Bank, May 4, 1993.

means an outage of a year or more for each of the Ignalina units. For system planning purposes, this should be scheduled consecutively, i.e., upgrading of Ignalina Unit 2 only after Unit 1 has been restored to service. If projected electricity demand is strong during the 1994-96 period, when the Ignalina units would be down for safety-system upgrading, thermal power-unit rehabilitation will have to be planned carefully; only safety-related and essential maintenance work must be performed, including replacement of high-temperature, high-pressure steam system components which have reached or exceeded their design creep-rupture life. Performance-related work would cover major maintenance or replacement of components to improve thermal efficiency, availability, and reliability. Also envisioned is work to improve the station's environmental performance. Issues related to emission control are discussed further in Section E, Environmental Impacts.

6.13 The US Trade and Development Agency (USTDA) has funded a feasibility study (about US$ 400,000) by the Stone and Webster Engineering Company to examine the potential of rehabilitating and possibly repowering the Elektrenai power station as well as the CHP units providing electricity and heat to major cities. The study, which was completed in the summer of 1993, is based on a number of scenarios being considered for the retirement of Ignalina.

6.14 LSPS has already completed a substantive restoration on Unit 1 of the Elektrenai Thermal Power Station. This work did not significantly alter the initial design of the unit, but merely replaced the boiler tubing, main steam piping, high-pressure turbine casing and rotor, the generator stator, the main cooling water circulating pump motors, the boiler feed pump, and other components. The unit returned to services in June 1993 producing power to supplement the output of Ignalina. Rehabilitation work of a similar nature at Unit 2 began in June 1993 and was scheduled for completion in the first part of 1994.

Combined Heat and Power (CHP) Thermal Units

6.15 The individual CHP units resemble the Elektrenai Power Station, but range in capacity from a few MW to 180 MW. Their ages range from 57 years for the oldest turbogenerator set (a 3.5 MW set at the Klaipeda CHP Station) to 7 years for the newest boiler (560 tons/hr) at the Mazeikiai CHP Station. The Vilnius CHP Station Number 3 units (2 x 180 MW) were installed in 1983 and 1986. Thus the oldest of the CHP stations are ready for retirement and replacement or life extension. Since they are small, the units are likely to be retired and the retired capacity incorporated into the next new larger unit constructed. Although the larger CHP units should not require safety-related rehabilitation for several years, the stations now report a need for work in such areas as combustion control (for excess air control), modification of the burner system for reducing NO_x formation and installation of control technology for reducing emissions of SO_2 and Vanadium compounds. The Stone and Webster study mentioned above has also examined the rehabilitation needs and related cost of these CHP units (Vilnius, Kaunas, Mazeikiai, and Klaipeda).

6.16 Based on observations during October 1992 and information from the rehabilitation study, it is concluded that LSPS staff have maintained the thermal power stations reasonably well, given the available resources and the design and construction features of the plants. However, serious problems remain owing to the poor-quality materials used in equipment fabrication and some elements of the construction work. Moreover, most of the thermal units are approaching the end of their usable lives and will require substantial refurbishing, particularly of their high-temperature components.

6.17 Since low demand and cheaper power from Ignalina currently limit the need for the thermal units, the rehabilitation schedule of existing thermal capacity will be keyed to the retirement schedule of the Ignalina nuclear power plant. Based on the Consultant's preliminary results, an initial investment schedule was devised for four retirement scenarios, corresponding to those considered in the G-7 Study on Alternatives to Nuclear Power which are summarized in Chapter VII. Estimates of rehabilitation investment requirements appear in Table 6.3. Finally, under present demand and supply conditions, it seems that only a small number of units at Elektrenai (2 x 150 MW whose reconstruction was completed at the end of 1993 and one additional 300-MW unit) should be rehabilitated. Attention should be given also to the CHP units which will have to be operated in the winter to supply the needed heat load. Based on the above observations, the power Rehabilitation Project of the World Bank included a thermal unit rehabilitation component consisting of one 300-MW unit at Elektrenai and two 80 MW units at the Mazeikiai CHP plant.

Table 6.3: Thermal Rehabilitation Costs by Nuclear Scenario
(1993 US$ million)

Nuclear Retirement Scenario	1993-1995	1996-2000	2001-2005	2006-2010	Total
Early Retirement (1995)	100	240	110	110	560
Mid-Term Retirement (2000)	60	200	110	110	480
Staged (one unit in 1995)	40	200	110	110	460
End of Economic Life (2010)	25	50	240	120	435

The Gas Turbine Option

6.18 Historically, simple-cycle gas-turbine generator sets and gas-turbine steam combined-cycle power units have been characterized by low investment costs and short construction time. However, their low thermal efficiencies and high fuel costs, particularly for distillate fuel, generally make them unattractive to electric utilities for other than peaking service.

6.19 However, important developments in gas-turbine technology and increased availability of natural gas are revolutionizing the use of gas turbines for power generation. The most important technical developments are: (a) increases in gas-turbine/generator set capacities (up to 200 MW or even greater for simple cycle machines); (b) thermal efficiency gains to more than 40% for a simple cycle machine and a little more than 50% for combined-cycle units, now commercially available; and (c) improved reliability. Another factor in the current enthusiasm for gas turbines is increasing worldwide awareness of the very substantial but low-cost environmental benefits resulting from use of natural gas in gas turbines, including a significant reduction of carbon dioxide emission per unit energy produced (about 50% reduction compared to coal-produced power).

6.20 If an adequate and assured source of natural gas is available at reasonable cost over the anticipated life of the plant, these impressive developments in gas-turbine technology also set a ceiling on how much a utility can afford to spend on rehabilitating or repowering an existing conventional power station, compared with construction of a new gas turbine or gas turbine steam combined-cycle facility at either an existing or a greenfield site. Because of the attractive investment costs, high thermal efficiencies, short construction time and substantial environmental benefits, gas turbines deserve careful consideration for any proposed repowering of power generating or CHP plants.

The Kruonis Hydro Pumped Storage Facility

6.21 The Kruonis[14] Hydroelectric Pumped Storage Plant located on the Nemunas River, near the city of Kaunas, was designed by Hydroproject in Moscow. It was originally intended to be one of six identical plants in the USSR. Only two plants were ever built; the other is in Zagorsk, Russia, about 100 km from Moscow. The Kruonis plant was planned as part of the Northwest Interconnected Power System (IPS) of the USSR, anticipating the availability of cheap off-peak nuclear energy for night-time pumping. However, with a current round-trip energy efficiency of 73%, 1.37 kWh of pumping energy must be provided for every kWh generated. The initial design called for 8 x 200 MW units. Two 200-MW units were operating in 1993. The third unit is in an advanced state of construction and is scheduled for completion in 1994. The turbine and generator for the fourth unit have been completed, and the Lithuanian authorities plan to have it operating by the end of 1994 or 1995.

6.22 The upper reservoir consists of a concrete dam surrounding an almost circular area of approximately 6 square km. At the current stage of development, the change in elevation of the upper reservoir from full charge to full discharge is 6 m. The reservoir is lined with clay mined from the site and an earthen backfill. The size of the reservoir can be doubled by extending the walls of the dam an additional 6 m, if needed to operate units 5-8. Since the plans for these units are not active, enlarging the reservoir is unnecessary.

6.23 The environmental impact of the facility appears relatively benign. The most serious impact on human life was the relocation of families to allow for site construction. People living along the Kaunas lake expressed minor annoyance at the change in water elevation. Some problems were experienced initially with fish kills, but that is no longer a concern. No other biological impacts have been noted.

6.24 The plant was designed for completion in two phases. The first provides for a reservoir of 6 hours daily capacity for 4 units of 200 MW each, or 4800 MWh per day. Operated 5 days per week for 50 weeks, this provides 1.2 TWh of electrical energy on peak. The second phase, suspended indefinitely, calls for adding 4 more units and doubling the size of the reservoir, to double the annual production to 2.4 TWh. The off-peak energy required will be approximately 1.4 times greater, or 3.4 TWh. To accomplish this two-fold increase in stored energy, the storage capacity must be doubled at a cost representing only 10-20% of the initial investment in the upper reservoir and dam. This could be an important consideration when looking at Kruonis on a regional planning perspective.

6.25 The Kruonis plant will most benefit Lithuania in the long term if a cheap source of off-peak energy (such as Ignalina) exists. On the other hand, even if Ignalina is shut down, the net cost of charging Kruonis for peak use will usually be less than the cost of installing and operating new capacity -- particularly since some thermal units have problems operating at partial load in off-peak periods, and CHP facilities must satisfy district heating requirements regardless of electricity demand. Considered in a regional context, the plant may be a significant component of a longer-term regional energy strategy, involving other members of the Northwest IPS, Poland, UCPTE,[15] and (if the

[14] In the Soviet era, the Kruonis plant was referred to as Kaisiadorys after the district in which it is located. It has since been renamed to reflect the name of the nearby village of Kruonis, although it is still referenced both ways.

[15] Union of Companies for the Production and Transmission of Electricity, a West European organization of interconnected electricity systems.

appropriate connections are made) NORDEL. Kruonis offers other regional benefits in addition to displacing fossil fuel energy. In the generating mode, the plant has a fast response capability (100 MW in 15-20 seconds for each unit) and can be used as spinning reserve and system regulating capacity. This capability becomes increasingly important if a long-term strategy to interconnect with Poland and UCPTE is adopted.

6.26 As part of a comprehensive long-term regional energy planning study including the Baltics and neighboring countries, the optimum reservoir size and number of units at Kruonis should be investigated. The operating flexibility provided by the plant can be seen in the daily operating curves presented in Annex 6.1. While both operating units pump at full power to fill the reservoir in seven hours, instead of generating at full power for 6 hours during the day, one unit tends to run with some load variation over a 14-hour period. Depending upon the availability of off-peak energy, the plant could also run on a weekly cycle, especially with the expanded reservoir and 4 units, or the current reservoir and 2 units. This would allow an additional six hours of operation at full power (or 12 hours of operation at half power). Annex 6.2 shows the monthly peak load and monthly consumption as a percentage of the annual consumption for 1991, providing some additional insight into the distribution of monthly load factors.

6.27 While the load shape is changing owing to the restructuring of the economy, the weekday and weekend daily load curves for the four seasons of 1991 (see Annex 6.3) show that there is significant off-peak energy available on a daily and weekly basis. An hourly analysis of off-peak energy availability, and on-peak energy demand on an annual basis, for both the country and the region, needs to be conducted as part of the comprehensive planning study to better determine the optimum energy and capacity rating of the plant, the sources and costs of charging energy and its value to the system. This information then can be used to determine whether the expansion of the upper reservoir and addition of more units is justified.

6.28 Because of the strategic importance of the Kruonis plant to the future energy plans of Lithuania and the Baltic region, the need for completion of unit 4 should be studied carefully with current data of supply and demand, including best estimates of export possibilities, and realistic economic assumptions and forecasts. Long-term considerations should be taken into account, but investments could be postponed to an optimal timing to accommodate the present shortage of investible funds and reflect investment priorities. Phase-one (i.e. units 1-4) completion should include capability to operate the plant remotely and automatically from the Vilnius and Riga dispatch centers, provide a second variable frequency converter to provide redundancy in starting the pumps, and add additional 330-kV breakers to the existing minimal substation design for increased bulk system reliability.

Renewables

6.29 Renewable energy can play a meaningful role in the future energy supply of Lithuania. The possible hydropower resource is estimated at 400 MW in the Danish Riso Report M-2943, with only 100 MW currently utilized. A wind resource assessment is required to determine the economic viability of Lithuania's wind generation potential. Wood-chip plants attached to pulp and paper production plants, peat-fueled plants, small straw-fired boilers, geothermal potential and solar power all deserve further consideration. Conversion of small/medium heat and/or stream boilers to wood chips is the object of a feasibility study financed by the EC-PHARE program. The conversion could have significant economic benefits and is being actively considered for financing by the World Bank.

6.30 Geothermal resources have been identified in an extensive study performed for Latvia and Lithuania by the Geological Survey of Denmark and other consultants (initiated in March 1992) with funding from the Danish Ministry of the Environment (US$ 250,000). The investigation was focused on western Lithuania and Latvia, covering about 41,000 sq km in and near urban areas with an annual heat production of 100 terajoule (TJ) or higher. Geothermal aquifer zones, located at depths of between 1,200 and 2,200 meters, have been identified that could provide heat of 5 petajoule (PJ) per year. This would correspond to about 5% of the heat demand within the project area. The total energy content of the geothermal reserves was estimated at about 200 exajoule (EJ), compared to a total annual heat demand in Lithuania and Latvia of 270 PJ. The study will continue until 1998, followed by an implementation of geothermal projects (Phase 3) in the period 1998-2008. In the meantime, plans are being developed to establish a demonstration plant in Klaipeda and Vidamantai.

6.31 While renewable energy will not solve Lithuania's overall energy problem, a reasonable goal would be to increase its share from 4% to 10% of the primary energy consumption over the next 10 years.

B. Ignalina Nuclear Power Plant

6.32 The Ignalina Nuclear Power Plant (INPP) belongs to the RBMK family of graphite-moderated nuclear reactors and is the latest model of this type. The station consists of two 1500 MW units. Two more units were planned on the same site; some foundation work was done and equipment for unit 3 is already on site. Unit 1 entered service in 1984 and unit 2 in 1986. In 1990, both units were derated to 1250 MW each to increase safety margins. In November 1993, the Government, acting on the recommendation of a Special Ignalina Committee, decided to permanently cancel plans for the two additional RBMK units, dismantle unit 3 and sell the equipment purchased for this unit.

6.33 Ignalina is a base-load plant that has operated an average of 6800 hours annually over the period 1988-1991. Unit 1 was down from February through November 1992. During the fourth quarter of 1992, Unit 2 was down for repairs. A World Bank/IEA mission was there, in October 1992, when the shutdown of the second unit occurred, owing to a radioactive leak at the top of the steam drum, necessitating repairs. This event brought into sharp focus the heavy dependence of the electricity supply system on Ignalina and its susceptibility to unscheduled outages of one unit that might occur simultaneously with a scheduled refueling or maintenance outage of the other. This would disrupt not only exports but also the domestic supply, which would have to depend solely on the other thermal power units, especially the aging Lithuania Thermal Power Plant at Elektrenai.

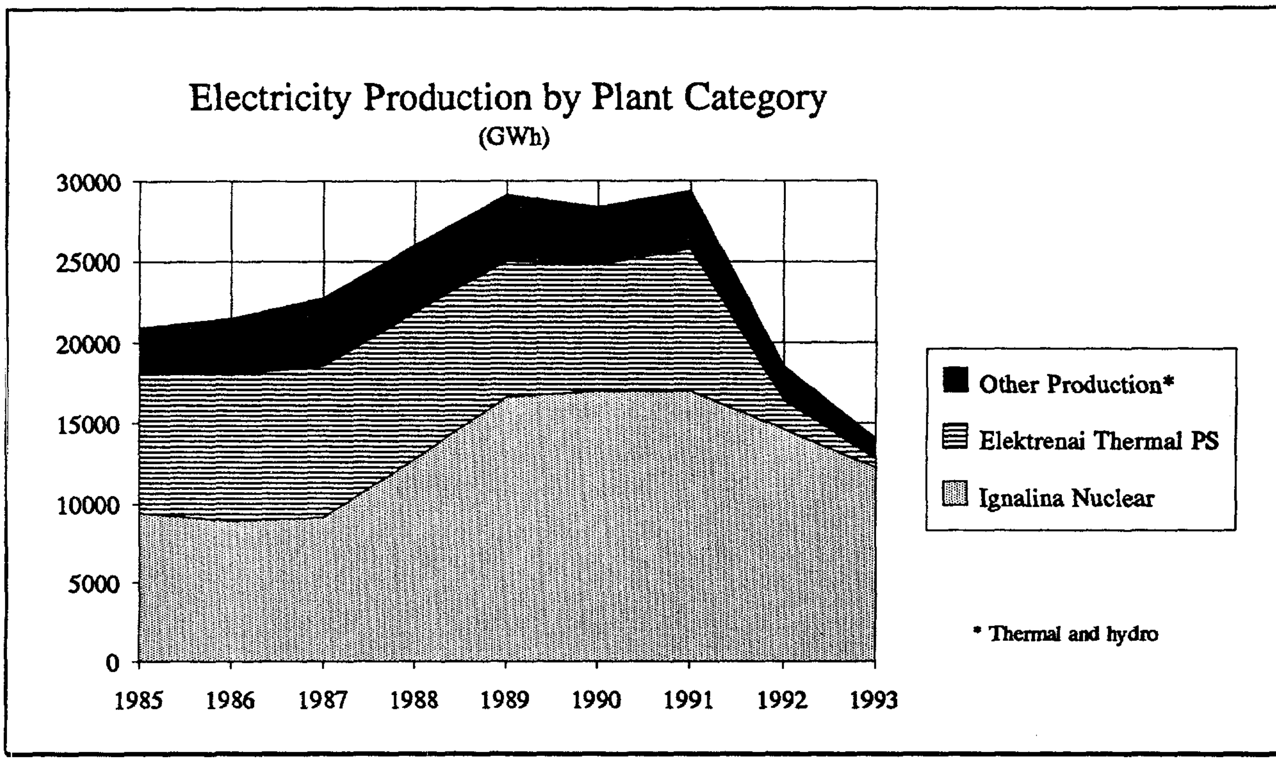

Figure 6.4

6.34 Nuclear fuel for the two reactors is purchased from Russia. The two-unit station requires 1,630 fuel assemblies to operate each year. The fuel price in 1991 was Rb 138,000 per assembly, for a total fuel cost of Rb 225 million. The import price for nuclear fuel subsequently increased to US$ 60,000 per assembly in 1993 and the new trade protocol sets a price of US$ 73,000 per assembly (about $120 million per year). This roughly equals the World Bank's estimate of US$ 125 million to fuel an equivalent western-type power station and is, therefore, the fuel price used in the analysis. Lithuania shows interest in purchasing fuel from western nuclear fuel suppliers to diversify its sources; however, it is doubtful that a western manufacturer would supply this unique kind of fuel at a price competitive with Russia's.

6.35 The accident at Chernobyl has heightened worldwide apprehension about the safety of Soviet-designed reactors and the method of their operation. Since it is the same RBMK type as Chernobyl, Ignalina has become the object of international pressure for early closure[16]. The GoL maintains that it cannot afford to retire Ignalina and will instead upgrade safety with the assistance of bilateral and multilateral donors. The Swedish Government has earmarked about US$ 10 million to provide the most needed upgrades, including an improved fire detection and protection system. In addition, the

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[16] The July 1993 Group of Seven Communique stated that "Urgent safety measures, coordinated through the G24, need to be implemented rapidly to secure real improvements at the plants still causing great concern. The states concerned bear the primary responsibility for respecting the fundamental principles of nuclear safety. Independent regulatory authorities should be strengthened and nuclear safety must be given higher priority in all the countries concerned, including the early closure of high risk reactors such as Chernobyl."

US and Canadian Governments and the EC-PHARE program have offered assistance to help improve operational safety, operating procedures, operator training and management of the utility. These measures would enable the units to operate only through the medium term. In February 1994, the Government of Lithuania and the management of Ignalina signed an agreement with the Nuclear Safety Accountant (NSA), managed by the European Bank (EBRD), for a grant of ECU 33 million for further safety upgrades of the two units. The agreement also provides for a number of possible scenarios as to the operating regimes and the eventual retirement of the two units. A final decision on the future operation and retirement of the two units will be made after the completion of an in-depth Nuclear Safety Assessment to be performed by the INPP under the supervision of VATESI (the Lithuanian Nuclear Safety Inspectorate) under terms of reference agreed with a panel of international nuclear safety experts selected in agreement with EBRD. Provided that external assistance is made available, the results of the Assessment will be produced by December 31, 1995. More details on the status and activities relating to the Ignalina nuclear power plant appear in Annex 6.9.

C. Electricity Transmission and Distribution

Transmission

6.36 Lithuania's 330-kV transmission system consists of 1520 km of overhead lines and includes interconnections with Latvia, Belarus, and the Kaliningrad area of Russia. A new line between Klaipeda and Siauliai with a T-connection point to the north of Siauliai will enter service in 1993. A diagram of the present network appears in Map IBRD 24405. Conventional steel towers, mostly of Russian origin, carry duplex ACSR aluminum-steel-reinforced conductors. The conductor sizes, line lengths and capacities appear in Annex 6.4.

6.37 The subtransmission system consists of a 110-kV network with a total length of 4,900 km. About 88% of the power, including the transfer of export and import energy, moves through the 330-kV system. Some 24 smaller generating plants with a combined capacity of 935 MW connect directly to the 110-kV system, thus reducing the total load flow on the 330-kV system (see Annex 6.4).

6.38 Installed transformer capacity in the 330-kV/110-kV substations totals 3,765 MW, which compares with a peak load in Lithuania of 3065 MW in 1991. Owing to the expected decrease of future peak load, the transformer capacity will be sufficient at least for this decade. Substations and their capacities are listed in Annex 6.4.

6.39 Regarding voltage control on the 330-kV system, because only 2 x 50 MVAr capacitor banks, but no reactors are installed, voltage control for the full net must be performed with reactive power generation in the power stations. During summer (light load) conditions overvoltage occurs on the 330-kV network. This must be corrected, and shunt reactors installed. LSPS indicated that such reactors will be needed, but there are no detailed studies. Optimum size and location of the reactors must be determined. Installations for Klaipeda, Siauliai, and Jurbarkas are planned. Transformer load tap changers can help control voltage in the distribution system.

6.40 330-kV substation protection equipment is mainly of an electromechanical type manufactured in Russia with reasonably accurate fault-detection capability. However, the control wiring for the outdoor switchyard control circuits is often poor, and this can cause it to malfunction. Thus the systems for blocking incorrect local hand control of disconnect switches are often out of order, jeopardizing the safety of the operating personnel.

6.41 Transmission and distribution system losses run about 11%, of which 5% is incurred directly at the 330-kV and 110-kV voltage levels. Investments in extended line capacity for loss reduction cannot be justified only on the grounds of loss reduction. Calculations on system losses at 330-kV and 110-kV levels appear in Annex 6.4. The fault frequency for the 330-kV transmission system has been low with an average of only 2.6 (max 5) line disconnections per year during the period from 1973 to 1991. (Annex 6.4).

6.42 Equipment failures in the transmission system are frequent. Poor construction of the 330-kV transformers has resulted in very high transformer losses especially during warm periods when they are sometimes taken out of service. Several high-voltage three-winding transformers do not have voltage regulating ability. The tap-changing equipment on load tap-changing transformers is worn out and replacement parts are not available. Transformer insulation is aging and becoming brittle, raising concern that transformer failures will become more frequent. The insulating columns on the disconnect switches are losing both mechanical and electrical strength. Mechanical failures and flashovers are common; about 200 switches need to be replaced. Many of the high-voltage circuit breakers (CB) are air-blast breakers, and there is growing concern that many may not be able to interrupt the available fault current. This can create a risk for workers and cause serious operating problems. Special gaskets for the Soviet-made breakers are scarce and problems with the poorly designed Soviet air compressors are only compounded by the difficulty in obtaining spares parts and replacements from Armenia. Some 25 CB compressors need replacing. Much of the station equipment is near the end of its useful life. In 1987, about Rb 25 million worth of upgrades was considered necessary. This estimate needs to be updated using current prices. Maintenance problems abound also owing to the lack of heavy tools, vehicles, and fuel. Many spare parts are no longer available.

6.43 Static Stability of the present system is good but depends on lines through Belarus and Latvia. Soon, 880 MW of night-time pumping capacity will be required at the Kruonis pumped storage plant. These 880 MW, in combination with the now lower load forecast, especially in the area of Vilnius and Kaunas, will result in a load exceeding the economic but not the thermal limits of the three transmission lines (nos. 453, 456/454, and 450/452/333 in Annex 6.4). Construction of the planned US$ 48 million 330-kV Ignalina - Kruonis line to provide reserve capacity, reduce losses, and reduce dependence on the lines (no. 450, 452 and 333) through Belarus should, therefore, be deferred until it is justified on thermal grounds. The dynamic stability of the system depends on the systems of neighboring countries and will be studied further within the Master Plan for the Baltic States, in cooperation with the power companies of Estonia, Latvia and Lithuania, Vattenfall of Sweden and IVO of Finland. This report was completed at the end of 1993.

6.44 The current transmission system capacities are sufficient to handle replacement power from the Ignalina site or up to 1500 MW from a possible new coastal site without any significant extension of the transmission system. Map IBRD 24405 shows the following Lithuanian interconnection lines at the 330-kV level:

- 5 lines to Belarus
- 4 lines to Latvia
- 3 lines to Kaliningrad

Of the 18.7 TWh generated by Lithuania in 1992, 5.3 TWh were exported over these lines:

- to Belarus 3.9 TWh

- to Russia/Kaliningrad 1.3 TWh
- to Latvia 0.1 TWh

6.45 During 1992, the load demand fell considerably in Lithuania and in neighboring countries. Changes in pricing and trade patterns soon will create a completely new market for the exchange and export of energy. Poland, Hungary, Slovakia and the Czech Republic are expected to be connected to the West European UCPTE interconnected power system between 1995-1997.

6.46 The Baltic States have three main options for synchronous interconnections:

- Remain interconnected with the former Soviet IPS system with its extensive installed generating capacity of 33,000 MW in the Northwest Interconnected Power System (IPS).

- Connect to the UCPTE network via Poland.

- Connect to NORDEL (the Nordic countries) via Finland.

6.47 Since the present 330-kV Baltic transmission network has 14 interconnecting lines with Belarus and Russia, including 3 lines to Kaliningrad, a realistic option in the short term might be for the network to stay connected to the IPS and to install high-voltage direct current (HVDC) connections to the other adjacent power networks for energy trade and increased reserve capacity. The Polish connection to UCPTE in combination with HVDC links between Poland and Lithuania and between Estonia and Finland will complete the often discussed vision of a "Baltic Ring." The second HVDC cable to cross the Baltic Sea, from Sweden to Germany, will enter services by the end of 1994. Further cable crossings are under discussion between various power companies in the region.

6.48 Future system development should be based on expected trade agreements with countries in the area. The Polish Power Transmission Company is now extending its 400-kV transmission network from Warsaw to Bialystok near the Lithuanian border and has expressed interest in a link with Lithuania. Thus a link to Poland would appear prudent. Such an interconnection will provide trading opportunities with Poland and other European countries when connected to UCPTE and will reduce Lithuanian dependence on energy trade with the CIS. The approximate investments for the interconnection for 600 MW (cost of right-of-way excluded) are summarized in Table 6.4.

6.49 Before a decision on the Polish interconnecting line can be made, the choice of synchronous/asynchronous interconnection must be made. Trade agreements are also needed for the power exchange. Preliminary calculations indicate that a relatively high price for the transmitted energy and a low cost for the HVDC converter equipment would be required for a reasonable pay-back period. One possibility is to buy -- cheaply -- one of the existing HVDC converter stations now located at the borders of the former East Germany, the former Czechoslovakia or Hungary with the UCPTE countries, when it is no longer needed. This could make the interconnection and the associated HV transmission lines economically attractive.

Table 6.4: International Power Grid Connection Costs

	Length (km)	US$ million
Line Kruonis - Alytus	60	21
Line Alytus - border	60	21
Line border - Bialystok	120	42
Total		**84**
Extension station Kruonis		5
Extension station Alytus (AC/DC/AC)		65
Extension station Bialystok		65
Total		**135**
Grand Total		219

6.50 Without the Ignalina-Kruonis line, it is recommended that a high night-time pumping load (> 400 MW) not be combined with export to Poland. A 400-MW pumping load will be possible with some voltage support. During the day, an export of 500 MW to Poland and similar export to Belarus is possible during 600 or 800 MW production at Kruonis.

6.51 Rehabilitating the present transmission network is very important for the future reliability of the system. A 4- to 5-year rehabilitation program should be scheduled and implemented. The program should include inspections of lines and stations as well as procurement of equipment and spare parts. A budget of about US$ 5-10 million per year for 7-10 years is needed, with financing from the proposed World Bank loan, including US$ 5 million for equipment and spare parts in the first year. This will ensure the continued viability of the Lithuanian power network. A feasibility study financed by USAID was completed in December 1993. This study provides complete lists of needed equipment and work, as well as the corresponding cost and benefit data, both for the dispatch center and for the transmission system upgrades.

System Control

6.52 Lithuania was previously a part of the Northwest Interconnected Power System (IPS), one of 11 IPSs of the former USSR. Ten IPSs are interconnected, and each has a regional control center. They operate in a coordinated fashion with the central dispatch center in Moscow. Primary frequency control is exercised from Moscow via a 4,000 MW hydro cascade on the Volga River. Frequency control limits are much less stringent in the IPS than in the UCPTE. The frequency band within which a load fluctuation induces no change in power production must be as low as possible: < +/- .02 Hz for UCPTE versus < +/- 0.2 Hz for IPS. In order to operate as a permanent part of the UCPTE interconnection, it will be necessary for Lithuania to upgrade its frequency control capability significantly through some combination of the following measures:

- Replacing turbine governors;

- Adding controls at the power plant to receive the Automatic Generation Control (AGC) signals from the control center;
- Adding reliable communication links between the control center and the plants and substations;
- Installing an energy control system with automatic generation control capability;
- Adding sufficient regulating capacity;
- Adding adequate spinning reserve to meet UCPTE requirements;
- Strengthening UCPTE interconnections to meet the n-l security criterion and system reliability criteria; and
- Opening IPS interconnections or examining asynchronous operation with either UCPTE or IPS.

Dispatch Center

6.53 The current dispatching facilities consist of a four-level hierarchy with the dispatch center at Riga the highest coordinating level, followed by dispatch centers at Vilnius, the seven enterprise centers and about 50 district centers. These are supported by an extensive voice and data communication network which uses power-line carrier, cable and radio systems. The basic scheduling decisions are made at the Dispatch Center in Riga. Almost the entire system relies on hardware and software that needs to be upgraded. Substantial manual intervention is required to key in data received via fax and teletype. The dispatch center at Vilnius is not able to control net interchange or participate in frequency regulation. The communication system is operating at slow speed and is subject to error. More details on the dispatch system appear in Annex 6.5.

6.54 Internal LSPS efforts are under way to upgrade the system to a distributed PC-LAN-based architecture. However, this is unlikely to suffice. Therefore, it is recommended that: (a) the communication and computer systems be upgraded to state-of-the-art; (b) additional software for frequency and interchange regulation be considered (coordinated with other members of the Interconnected Power System (IPS) i.e., Latvia, Estonia, Kaliningrad, Belarus, and Russia; and (c) the existing remote terminal units (RTUs) be replaced by more modern microprocessor-based systems. This will make it possible for Lithuania to gradually conform to the standards required within the UCPTE system. Based on benefits realized due to improved security and economy, Lithuania can expect to achieve savings of about 3-4% in operating costs in the long term. For fuel consumption corresponding to 10 TWh, this translates to at least US$ 4 million a year. An upgrade of the dispatching and communications facilities should cost about US$ 10 million and can be justified easily by the savings. Upgrading the transmission system and dispatch center is a component of the proposed "Power Rehabilitation Project" to be financed by the Bank.

Distribution

6.55 Distribution is performed by seven distribution enterprises that are affiliates of LSPS. Each enterprise operates and maintains the entire transmission and distribution network within its service territory, using a centralized dispatch center for the control of its transmission network. Included in each enterprise, under the control of the centralized dispatch center, are several regional dispatch centers to monitor and control the operation of the 10-kV distribution system. The distribution system equipment is old, but it works. For example, the underground distribution network consists of oil/paper insulated lead sheath cable, some of it 50 years old. There is no modern cross-linked polyethylene insulated cable. The level of automation in the operation of the network is also very low. Customer record-keeping, meter reading, and billing is still manual. Further effort is required to identify the greatest needs in the distribution system and identify and set priorities for investment. Modernization should reduce losses, save money, and improve both productivity and reliability of service. Management training in distribution system organization and technical training in design, operation, and maintenance is recommended.

D. District Heating

6.56 Up to the summer of 1993, the district heating (DH) systems in Lithuania were organized under two entities -- the Lithuania State Power Systems (LSPS) and Siluma. In August 1993, Siluma was placed under LSPS. Both reported to the Ministry of Energy (MoE). LSPS is by far the larger organization and operates the thermal power plants in Lithuania that provide district heating. LSPS has organized the DH systems into six regions: Vilnius, Kaunas, Klaipeda, Siauliai, Panevezys and Alytus. LSPS represents 85% of the installed DH capacity in Lithuania, and Siluma represents smaller DH systems (Annex 6.6).

6.57 In Lithuania, the DH systems supply a major part of residential areas and industries with heat. Residential areas 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. According to LSPS data, 62 PJ are produced per year in the LSPS systems to supply 26 million m^2 of housing area. The unit consumption of 2.4 $GJ/m^2/year$ is more than double the known consumption of Western Europe. The high unit consumption results from poor building standards and the condition of the DH systems. This report only concerns the DH systems.

6.58 In the LSPS DH systems, 75% of annual heat production is hot water and 25% is steam. In the future, production and distribution capacity should focus on hot water systems with a maximum temperature of 130° C for space heating and hot water for domestic use. Future industrial use of steam can be more economically produced in each individual industry, rather than centrally. Waste heat from the industries might then be supplied to the DH networks.

6.59 In 1991, the LSPS systems consumed 2.1 bcm of natural gas and 2.3 million tons of heavy fuel oil (HFO). The quantity of other fuels consumed was negligible. Of this fuel consumption, the bulk, 1.8 bcm of natural gas and 2.0 million tons of fuel oil, was consumed in heat-only boilers. By 1993, the total fuel consumed for the district heating systems in Lithuania had fallen to 0.74 bcm of gas and 0.9 million tons of HFO representing drastically lower industrial consumption and constrained supply to residential consumers.

6.60 The DH systems indigenous in Lithuania have considerable potential for diversifying fuel use. When the necessary infrastructure and supply system is established, it will always be possible to convert some of the heat production units to local fuels (e.g., wood chips). This would require only small investments in the boiler houses, because the heat transportation system remains the same.

6.61 The main problems in the DH systems are as follows:

- Heat production plants use mainly Heat-Only Boilers (HOB). Only 30% of the annual heat production comes from low-grade sources such as Combined-Heat-and-Power (CHP) plants. CHP plants exist in the major cities of the country, i.e. Vilnius, Kaunas, Mazeikiai, and Klaipeda. The CHP plant in Mazeikiai supplies heat only to the refinery and not to the city. The rest of the annual heat production, about 70% of the total, is produced in HOBs fueled by natural gas or heavy fuel oil.

- The DH systems are run in the "constant-flow operation" mode, which is necessary for the proper operation of jet-pumps installed for each end-use consumer. The consequence of the constant flow operation is that:

  a. load dispatching is impossible;
  b. consumer heat regulation is impossible, and metering makes no sense; and
  c. power consumption of water pumps is excessively high.

- The pipe systems suffer from high water leakage and heat losses. The Lithuanian DH system must cope with a 200% loss of total network water volume a month, whereas a figure of 0.3% per month is the norm in modern, preinsulated pipe systems. The lack of metering makes it impossible to obtain information on the heat loss from the pipes, but energy savings of 20-30% of annual heat production seem likely.

6.62 Suggested corrective measures include:

- The increased utilization of waste heat from CHP plants, either through construction of new CHP plants to capitalize on existing networks, or through construction of additional transmission pipelines to take advantage of existing CHP-capacity. When converting from HOB to CHP units, the production efficiency will improve by more than a factor of three. As mentioned before, choice of fuel for the CHP units has no effect on the DH system. This depends entirely on logistics and accessibility of fuels. Construction of smaller boilers burning domestic fuels such as wood chips, straw, and agricultural waste products will save expensive imported high-grade fuels.

- Renovating household installations (substations) to enable them to operate with variable flow and pressure, replacing the main circulation pumps with pumps equipped with a variable speed drive, and installing System Control And Data Acquisition (SCADA) systems and meters, first at the large consumers, and later at the small consumers. Renovating household installations is necessary to obtain the possibility of load dispatching, consumer heat regulation and metering. However, the direct energy savings from this renovation is estimated at only 10-15%. Rehabilitating household installations is a necessary precondition to rehabilitate and improve the DH systems in order to obtain further energy savings by means of variable pump speed drive, load dispatching, etc.

- The gradual installation of preinsulated pipes in all transmission and distribution networks. All renovation works should use preinsulated pipes, assuming that, at the same time, measures will be taken to keep the operating temperature below 130° C and the water quality sufficiently high to prevent internal pipe corrosion.

Based on an estimated 200% water loss per month, the heat loss from a network can be estimated at 8 GJ/year/m^3 of network volume.

6.63 Based on total production and investment costs, the options for new DH capacity can be rank ordered -- from least to most expensive -- as follows:

- Waste incineration plants
- Industrial plants
- Combined Heat and Power plants
- Coal-fired Heat Only Boiler
- Oil-fired Heat Only Boiler
- Gas-fired Heat Only Boiler

6.64 The institutional aspects of the DH-systems are expected to change in the near future. In restructuring the subsector, the authorities should strive to move ownership of and responsibility for the DH companies as close as possible to the consumers, which means to municipalities or consumer cooperatives. This close relationship is likely to improve the operation of the DH systems and the quality of service.

6.65 When consumer regulation of heat consumption becomes possible, the tariff structure should gradually be changed from a fixed tariff to one related to heat consumption. When this happens, the consumers will be motivated to invest in energy saving equipment (e.g. insulation, heat control devices, etc.) and reduce their heat consumption, particularly if the changes are gradual and they have time to adjust to the new tariff structure.

6.66 Technical assistance to the District Heating Enterprises (DHE) is urgently needed to help prepare Master Plan studies for the analysis and improvement of the DH systems of the major cities, and to provide the basis for least-cost rehabilitation projects that could be considered for financing by the World Bank and other lending institutions. In addition, training of the local DHE personnel would be highly desirable and should be included in the technical assistance programs.

Table 6.5: District Heating Project Costs

Heating District	Project	Energy Investment (US$ million)
Vilnius and Alytus	Rehabilitation	22
Lithuania	Boiler Conversion	7
Mazeikiai	Hot Water Pipe	11

6.67 A number of projects that seem technically and economically viable have been tentatively identified in Annex 6.7 and are summarized in Table 6.5. Since the existing boilers are fueled with natural gas and heavy fuel oil, the viability of the projects should be compared to a world market fuel-oil price of US$ 3.6/GJ, which indicates an internal rate of return of 13% if the lifetime of the projects is estimated at 20 years. Calculations should be based on the following conditions:

Energy savings:

Newly installed CHP-units are expected to operate 4,500 hours a year at full capacity, at a heat production efficiency of 250% (i.e., a third as much fuel is consumed for one unit of heat production compared with heat-only-boiler systems).

Energy savings are estimated at 30% after substations are modernized, the network is renovated and control equipment is installed .

Investments:

Substations:	US$ 10,000/0.3 MW
Control system:	US$ 4,000/MW
CHP-units:	US$ 150,000/MW
Pipelines:	US$ 300,000/MW

6.68 The DHE investments in CHP units cover only 10% or so of the required investments. The figures previously mentioned are only rough estimates, and local differences are not considered. Detailed Master Plan Studies of DH systems in Poland, which is similar to Lithuania's system, show internal rates of return varying between 20% and 30%.

6.69 When operating a modern DH system, the environmental impact is smaller than if the same amount of heat was supplied in any other way. This is because:

- The utilization of waste heat from CHP plants requires no additional burning of fuels.
- Smoke purification equipment can be installed in central boilers, which is not practical for individual homes.

E. Environmental Impacts

Air Quality

6.70 The principal environmental impact from Lithuania's thermal power generating plants is on air quality. Most of the stations burn a high-sulfur vanadium-containing heavy fuel oil (HFO) in burners and burner systems that neither burn the fuel cleanly nor minimize nitrogen oxide (NO_x) formation and subsequent release to the atmosphere. As a result, the plant releases some soot from poor combustion (fine particulate containing vanadium, nitrogen oxides, sulfur oxides and carbon monoxide) into the atmosphere. Poor combustion control frequently results in use of excess air which adversely affects thermal efficiency.

6.71 With the prevailing winds from the east, both the Elektrenai Thermal Power Station and the Vilnius CHP No. 3 Station are upwind of densely populated areas. The maximum ground level (ambient) concentration of pollutants from both stations occurs about five kilometers east of the station, in densely populated areas.

6.72 In addition to the large power plant and CHP boilers, Lithuania has many smaller heavy-fuel-oil-fired HOBs. These smaller boilers are usually run by less well-trained operators and are not equipped with suitable instrumentation and control equipment for monitoring, controlling, and optimizing combustion conditions and efficiency. As a result, these smaller boilers emit more soot per unit of heat than the larger power and CHP boiler facilities. Because they are located in populated areas and their chimneys' heights are usually lower than those of larger plants, dispersion of combustion gases and their entrained particulates is less effective. Therefore, their environmental impact may be more pronounced than that of the larger power and CHP boilers.

Sulfur and Nitrogen Oxide Emissions

6.73 The only substantive sulfur-dioxide emissions from thermal power stations result from burning of high-sulfur heavy fuel oil either produced by the Mazeikiai refinery or imported from Belarus or Russia. Ambient concentrations of sulfur oxides near the largest power station at Elektrenai and the Vilnius CHP No. 3 Station are reported by LSPS to frequently exceed Lithuania's national ambient air-quality standards. Emissions of nitrogen oxides is also estimated to exceed western standards. Additional use of fossil fuels, which would be needed to replace electric generation from the nuclear plant at Ignalina, would exacerbate the air conditions, especially if less costly high-sulfur fuel continues to be used, since it would increase the total amount of air pollutants emitted into the air. Although discussions are being held in Lithuania for reduction of air emissions from power plants, the priorities, budget constraints and limited funds for investment make it unlikely that flue-gas desulfurization equipment will be installed in the foreseeable future. However, the planned rehabilitation of the thermal units at Elektrenai may offer considerable scope for low-cost emission reduction measures, particularly for the reduction of nitrogen oxides through the reconstruction of the burners. More details on strategies for the reduction of power plant emission appear in <u>Annex 6.8</u>.

VII. THE ALTERNATIVE POWER SUPPLY (G-7) STUDY

A. Introduction and Background

7.1 This Chapter presents a summary and the main conclusions of a separate G-7 report on alternative power supply. The G-7 Study is a more detailed analysis of the electricity subsector reviewed in Chapter VI, focusing on a special problem posed by the various options for the retirement of the nuclear power plant at Ignalina. The G-7 Study is, therefore, a companion, and hence a complementary study to the present report.

7.2 The Group of Seven (G-7) industrialized countries, which include the United States, Canada, Japan, Germany, France, the United Kingdom and Italy, included in their July 1992 communiqué proposals related to the safety of certain Soviet-designed nuclear reactors deemed "unsafe" by the international community and installed in a number of countries of the Former Soviet Union (FSU) and in Central and Eastern Europe (CEE).[17] The G-7 communiqué said "the scope for replacing less safe [nuclear] plants by the development of alternative energy sources and the more efficient use of energy" should be studied and, "together with the competent international organizations, in particular the IEA, the World Bank should prepare the required energy studies including replacement sources of energy and the cost implications." A study was undertaken in response to the request from the G-7.

7.3 The scope of the study included the electricity subsector in Lithuania and the energy sector, more generally, in the context of overall economic conditions in the country and the region. More specifically, the study constructed case studies, estimated the possible shortfalls in capacity and energy, proposed ways to match existing gaps, and estimated the financial requirements both for the needed capital expenditures and incremental operational (fuel) costs. The estimates for the necessary upgrading of nuclear units associated with each case study were provided, as requested in the G-7 communiqué, by the European Bank for Reconstruction and Development (EBRD). Shutdown and decommissioning as well as spent-fuel and waste management costs (both capital and recurrent) were calculated, when necessary, by the World Bank/IEA team using the latest available information in the technical literature. Furthermore, the study is not a full least-cost power system analysis, which would require more time and resources. Although such a study would be desirable and probably will be done in due course, the analysis presented in the report offers a good rough estimate of the needed investments in the changing energy environment.

Existing Generation System

7.4 As discussed in Chapter 6, Lithuania currently has one nuclear power station of the RBMK[18] type at Ignalina which consists of two units nominally rated at 1,500 MW each. Each of the two units has been derated to approximately 1,250 MW to enhance safety; thus the currently available combined gross capacity is 2,500 MW. Unit One entered commercial service in May 1985, and Unit Two in August 1987. Assuming a design lifetime of 25 years, the units would be retired about 2010. The units have operated an average of 5,500 full-load equivalent hours for the past five years. In addition,

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[17] These countries are Armenia, Bulgaria, Slovakia, Lithuania, Russia, and Ukraine.

[18] RBMK stands for "Reaktor Bolshoy Moshchnoshti, c Kanalami", i.e., reactor of large power with cooling channels.

Lithuania has 2,700 MW of thermal capacity and 400 MW of pumped storage capacity details of which appear in Chapter 6.

Present Supply and Demand of Electricity

7.5 Total electricity generated by Ignalina and the thermal power plants far exceeds domestic demand, enabling Lithuania to export significant power to Belarus, the Kaliningrad region of Russia, and Latvia. With capacity requirements for domestic electricity consumption in Lithuania rapidly declining owing to the changing economic climate (peak demand of 3,158 MW in 1989, 2,837 MW in 1991 and less than 2,500 MW in 1992), and with exports to Belarus also declining because of economic change in that country, there appears to be plenty capacity to meet regional requirements for the foreseeable future.

B. Analysis Methodology

7.6 The analytical approach used in the G-7 study was to:

- Examine the characteristics of the existing electricity demand and supply as well as transmission, interconnections and trade;

- Develop scenarios of demand, supply and fuel prices through the year 2010 and constructed the most probable cases; and

- Consider options to bridge any potential shortfalls in capacity and estimated the financial implications (both capital costs and additional fuel costs) of retiring one or more unit of Ignalina before the end of its economic life.

Nuclear Scenarios

7.7 For the purposes of the analysis, three optional dates for the permanent retirement of the Ignalina nuclear power plant were established in consultation with the Ministry of Energy and the Lithuanian Energy Institute (LEI). The "immediate retirement" date was considered, for practical purposes, to be the beginning of 1995; the "long-term retirement" was the year 2010, corresponding to the end of the plant's design economic life. A "mid-term retirement" date, the year 2000, was also considered. Finally, the analysis included a "staged retirement" in which one unit is retired in 1995, while the other is operated through 2010. Safety upgrades were assumed for all scenarios except for "retirement in 1995." Decommissioning costs are expected to be deferred for at least 10 years, estimates of which were made by the study team.

Demand Scenarios

7.8 Two demand scenarios, labeled "high" (slow reforms) and "low" (accelerated reforms) were developed by the study team using a structural model that takes into account forecasts of Gross Domestic Product (GDP), elasticities of demand with respect to GDP and energy prices, the restructuring of the economy, and the gradual substitution of capital stock with more energy-efficient equipment. A demand forecast developed by the Lithuanian State Power System (LSPS) was between the Bank's high and low forecasts, and was therefore dropped from the analysis at LSPS' request.

Electricity Exports

7.9 The regional aspects of electricity balance were considered, since both Kaliningrad and Belarus are presently dependent on Lithuania for a share of their power requirements. However, as demand in both countries is currently falling, a cap of 6 TWh for 'profitable' exports was imposed on the analysis -- roughly in line with 1992 exports, but down from about 14 TWh at the end of the 1980s. Exports to these countries were only included in cases where Ignalina had surplus electricity, since Lithuania currently cannot profitably export from its surplus thermal capacity. The link of electricity exports to the macroeconomic picture must be noted; loss of exports and of the corresponding revenues would be a serious blow to the country's balance of payments. Electricity exports represented about 15% of total exports in 1992.

Gas Price Scenarios

7.10 Two gas-price scenarios have been considered: one reflects zero real price increases through the study period from the current "world market" levels ("base gas case"), assumed to be US$ 3.5 per million Btu. The other price escalates by 3% per annum in real terms ("high gas case"). The different gas-price schedules are of interest to the extent that they produce different results with respect to operating costs for the system and possibly different conclusions regarding the choice of capacity additions (when such additions are required). Base case-price scenarios are also assumed for heavy fuel oil (HFO), also at US$ 3.5 per million Btu, which is of interest for fuel switching within existing power plants, and coal (US$ 2.0 per million Btu), which is of interest as a potential fuel for new generating facilities.

Thermal Plant Rehabilitation

7.11 Under all nuclear scenarios, the rehabilitation of the main thermal power stations was assumed to provide variable load and back-up power to Ignalina. The timing of the rehabilitation depends on the nuclear scenario and the expected shortfall. After discounting, differences in cost between thermal rehabilitation schedules are small. Since the analysis focused on incremental costs relative to the long-term retirement of Ignalina, the comparison ignored the rehabilitation costs (being about the same for all cases).

Case Studies

7.12 The possible combinations of scenarios for nuclear unit retirement, demand and fuel prices produced a total of 16 cases (4 x 2 x 2). Of these, 10 were selected for further analysis.[19] These study cases, identified in Table 7.1, are relevant to the analysis because they bracket the power requirements and associated costs by including the most likely scenarios as well as the most extreme (hence, interesting for contingency planning); the most onerous case would obviously be the combination of high demand with early (1995) Ignalina retirement and high gas prices. The cases not considered are either unrealistic

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[19] The original analysis included 48 possible combinations with 20 cases included in the study. Following discussions of the first draft with the Lithuanian authorities, the methodology for exports was changed and the official demand scenario was dropped. Therefore, only 10 cases were considered in the final version of this study.

(such as the case of high demand with high prices and 1995 retirement), or cases that fall between the upper and lower bounds of the cases considered.

Table 7.1: Description of Cases

	Scenario Combinations		
Case #	**Year of Ignalina Retirement**	**Demand Scenario**	**Gas Price Scenario**
1	1995	high	base
2	1995	low	base
3	1995	low	high
4	2000	high	base
5	2000	low	high
6	2000	low	base
7	2010	high	base
8	2010	low	high
9	"staged[a]"	high	base
10	"staged[a]"	low	high

[a/] The staged shut-down scenario includes the operation of only one Ignalina unit for the full analysis period and early retirement (1995) of the other.

7.13 The costs of operating the electricity system were derived for the study cases by assuming that power from Ignalina, when available, will supply as much of the base-load requirements of Lithuania as possible. Requirements which exceed Ignalina's capabilities will be met by the existing thermal and hydro peaking units in a least-cost rank order, followed by one or more options based on a list of candidate technologies. All cases in which Ignalina is retired before 2010 result in substantial additional costs for operating the present system (since more costly thermal generation must replace less expensive nuclear), and, for some cases, in additional capital and operating costs for either demand management or new capacity to meet the shortfall.

C. Potential Gaps in Supply and Demand

Demand/Supply Gaps

7.14 Owing to Lithuania's substantial surplus capacity, only three scenarios required additions to capacity during the study period. Under the assumption of a "low" demand scenario, no new capacity is required throughout the study period (2010) regardless of the timing of Ignalina retirement; in this case, the consequences of retiring Ignalina in 2000 instead of 1995 are limited to the incremental costs of providing electricity from the existing thermal stations. These results indicate that the best strategy to avert a supply crisis under any scenario for the retirement of Ignalina would be to pursue an economic restructuring policy and energy conservation measures that would allow the "low" energy demand scenario to materialize.

7.15 In circumstances where the process of reform is delayed or slow, the resulting high-demand scenario still does not create any capacity shortfalls until 2002. Only three cases experience any capacity shortfalls, with a maximum of 1350 MW required by the year 2010. Even in these cases, capacity additions are small enough and far enough out in the study period that, after discounting, they have only a small impact on the overall costs. There is therefore little difference in capital costs between the 10 scenarios, and the main criterion for deciding on the least-cost option for an early or mid-term retirement of Ignalina would be the incremental fuel costs.

7.16 It should be noted that capacity shortfalls may occur in Belarus or Kaliningrad as a result of an early retirement of Ignalina even in cases where Lithuania has enough capacity to supply domestic demand. However, demand in Lithuania's export markets is currently falling rapidly while Russia has an increasing amount of spare capacity. It is therefore highly unlikely that the early closure of Ignalina will cause any critical energy shortfalls in neighboring countries[20].

Table 7.2: Summary Of Early And Mid-Term Retirement Scenarios (Against the reference Cases 7 and 8)

Cases	Retirement Scenario[a]	Total Costs US$ billion[b]	Remarks
1, 2, 3	1995	1.0 - 1.6	High cost, feasible with low domestic and export demand
4, 5, 6	2000	0.7 - 1.0	Moderate to high costs, sensitive to gas import price
9, 10	Staged	0.3 - 0.6	Moderate cost, feasible under low demand conditions

a/ Cases 7 and 8 are excluded from this table since the retirement date of 2010 is the reference case used as a basis for comparison.

b/ Incremental cost expressed as Net Present Value (NPV) are given in 1993 US$ and include capital, fuel, safety upgrades, decommissioning and operating expenses in excess of what it would have cost to keep Ignalina running to 2010.

D. Cost Implications of Ignalina Retirement

7.17 The Overall Cost Implications of the cases analyzed are summarized in Table 7.2. Total costs of replacing nuclear with non-nuclear generation are far more substantial than capital costs alone, since fuel costs would be considerably higher than the corresponding costs for Ignalina. Indeed, capital costs are relatively modest in all the cases, representing less than 15% of total incremental costs of non-nuclear operation.

[20] In 1993, most of the electricity requirements of Belarus were met with imports from Russia (nuclear power from the another RBMK nuclear station at Smolensk), while Kaliningrad was supplied by "wheeling" power from Russia through Lithuania. Still net electricity exports from Lithuania amounted to about 3 TWh.

Most Feasible Options

7.18 From the financial implications derived in the study, it does not seem feasible to pursue a 1995 retirement of both units of Ignalina, unless the electricity demand follows a low course (as in Case 2 and 3). Even then, the incremental fuel cost would be quite substantial. Perhaps the most feasible option would be to retire one unit of Ignalina early according to the staged retirement program at minimum incremental cost, and put off the decision on the other unit until closer to the year 2000. This would mean that safety upgrades (at a cost of about US$ 67 million or, in this case, up to US$ 100 million) would still need to be performed on one unit, but these costs would be small compared to savings from dramatically reduced requirements for incremental fuel. On the other hand, Lithuania, on its own, will not be able to commit the minimum of US$ 300-600 million in present value terms to provide for all the costs of alternative generation if a shutdown of one or more units is envisaged before the end of their useful lives.

7.19 Regardless of which nuclear option is pursued, Lithuania will be faced with substantial short- and medium-term financing requirements to improve the safety of Ignalina or to facilitate its retirement. Many of these costs are common to all the cases analyzed, such that they tend to cancel one another out in the analysis of incremental costs. However, in order to ensure the safe operation or retirement of Ignalina, Lithuania will require assistance over the next decade in order to: (a) rehabilitate its thermal capacity to provide backup or replacement power for Ignalina; (b) build facilities for the safe, long-term storage of spent fuel; (c) upgrade the safety of any nuclear unit(s) which will continue to operate; and (d) guarantee that proper procedures are followed for closing down and decommissioning Ignalina once the units are retired.

7.20 In order to facilitate the estimation of cash flow requirements in the short-to-medium term, an additional table has been constructed. Table 7.3 presents, therefore, gross, undiscounted investment costs to the year 2000. 'Low nuclear' for Lithuania corresponds to the 1995 retirement of both units of Ignalina, 'medium nuclear' corresponds to the 2000 shutdown, while 'high nuclear' allows both units to operate to the end of their useful economic life (2010). It should be noted that these costs are expressed gross before discounting, whereas the detailed analysis only shows those costs which are net of the costs that otherwise would have been incurred if Ignalina were kept in operation to 2010 (after discounting of 10% per year). It must also be kept in mind that capital costs are a small fraction of overall economic costs of the options examined. Therefore, Table 7.3 gives a good indication of short-term capital

Table 7.3: Short and Medium-Term Investment Requirements (Undiscounted 1993 US$ million)

Years of Investment	High Nuclear		Medium Nuclear		Low Nuclear	
	1993-1995	1996-2000	1993-1995	1996-2000	1993-1995	1996-2000
New Capacity	0	0	0	0	0	0
Thermal Rehabilitation	51	25	130	188	81	240
Spent Fuel Storage	25	50	25	50	25	0
Nuclear Safety Upgrades	70	130	68	68	15	0
Closing Down & Decommissioning	0	0	0	20[a]	20[a]	0
Period Total	146	205	223	326	141	240
Total to year 2000	351		549		381	

a/ Decommissioning (including dismantling) costs, estimated to at least US$ 300 million per unit would be required ten to twenty years after closure. These are taken into account in the analysis, but fall outside the time period of this table.

VIII. PETROLEUM SUBSECTOR

A. Introduction

8.1 Lithuania depends on Russia for all its imports of crude oil, using the pipeline network from Western Siberia via Belarus. All of the crude oil is allocated to the Mazeikiai Refinery. The refinery is a toll processing type, such that the oil usually remained Russian property and was rarely purchased outright by Lithuania. Since the refinery's commissioning in 1980, Lithuania has sharply increased crude oil imports. In 1980, the state imported about 2.2 million tons (Mt); from 1986 to 1990, about 12 to 13 Mt; and in 1991, 11.8 Mt. Following the economic crisis and supply constraints, crude imports fell to 4.1 and 5.2 Mt in 1992 and 1993 respectively. Supply difficulties iwth Russia have led the Government of Lithuania to pursue crude oil supply diversification, exploration of indigenous oil reserves, and improvement in energy efficiency.

B. Crude Oil Supply and Transportation

Oil Supply

8.2 Crude oil supply constraints are expected to continue for several years due to insufficient crude oil receiving infrastructure other than the pipeline from Russia, a severe shortage of hard currency, and uncertain profitability of the Mazeikiai Refinery in the midst of the economic reform.

8.3 Lithuania has limited oil reserves, both onshore and offshore. At present, exploration activities are under way in the most probable onshore oil fields. The potential oil reserves in the country are expected to be no more than 150 Mt (50 Mt from onshore and 100 Mt from offshore fields) including proven, probable and possible reserves. These indigenous reserves will fall well short of supplying Lithuania's total crude oil needs, but could make a significant contribution of up to 25% of total needs. More detailed information appears in Annexes 8.1 and 8.2.

Oil Supply Infrastructure

8.4 The present crude oil supply is limited to the single supply source from Russia. West Siberian crude oil which reaches Polotsk, Belarus, by two pipeline routes is further transported to Birzai, Lithuania, where it meets two pipeline branches. One goes to Mazeikiai and the other to the Ventspils port, Latvia, both with a design capacity of 45,000 tons a day (t/d). At present, there is no alternative crude route for substantial imports of crude oil to the Mazeikiai refinery.

Oil Supply Diversification

8.5 Although Lithuania may seek steady and continuous crude oil supply from Russia, it is crucial for the state to develop an alternative crude-oil supply route. To this end, Lithuania has begun installing a new pumping station in Ventspils, Latvia, in cooperation with the Government of Latvia, and intends to convert the existing crude-oil export pipeline from Birzai, through Ventspils, to an emergency crude import line. If this system were used, Russian crude oil export via Ventspils would have to be discontinued. Using this system, crude oil would be transferred in a reverse direction for the approximately 300 km from Ventspils to Birzai with a reduced capacity of 25,000 tons a day. From

Birzai to Mazeikiai, the flow rate would correspondingly be reduced, securing about 70% of the design capacity of the Mazeikiai Refinery.

8.6 The Klaipeda State Oil Terminal Company (KSOT), an arm of the MoE for petroleum product export trading, has developed plans to expand its handling capability of petroleum cargo from the present 9 Mt/y of Russian fuel oils for export to a total of 11.7 Mt/y of petroleum product imports-exports. However, the GoL has begun preparation of a single-point mooring project at Butinge with a pipeline connecting the facility to the Mazeikiai refinery (see Annex 8.2 for details). Financing sources have yet to be identified, and the economic justification for the Butinge project depend critically on the ability to export additional Russian oil products. These levels of additional exports may not be realized if Russia pursues its current plans to increase its crude handling capacity on the Baltic Sea.

C. Supply/Consumption Balances for Refined Products

Consumption

8.7 Consumption of major energy petroleum products (gasoline, kerosene, diesel oil and fuel oil) increased from about 7.9 million tons per year (Mt/y) in 1985 to 8.7 Mt/y in 1987, and declined to 6.4 Mt/y in 1990, before recovering to a level of 7.0 Mt/y in 1991. The decline in 1990 and 1991, relative to the previous five years, reflected constraints in crude oil supplies from the former Soviet Union (FSU), but the general contraction of the economy and reduced dependence on thermal power production under conditions of falling electricity demand were factors too. Consumption of products in 1992 collapsed to about 3.3 Mt primarily owing to lack of foreign exchange to import crude oil for domestic refining of petroleum. In 1993, consumption fell slightly further to about 3.1 Mt. The share of heavy fuel oil in the share of petroleum product consumption decreased from 40% in 1991 to about 27% in 1993 (Annex 8.3). This occurred despite increasing use of heavy fuel oil over gas in heat and electricity generation.

8.8 The agriculture and general public [21] sectors account for the major part of gasoline consumption, followed by Industry and Transport sectors. Diesel oil is consumed predominantly by the agriculture, industry, and transport sectors, in that order; while electric power and industry sectors account for more than 80% of fuel oil consumption. In all, the electric power and district heating sector accounted for 36-45% of total petroleum energy products consumption, followed by industry (25-29%), agriculture (14-18%), transport (9-11%), and general public (3-9%).

8.9 Future demand for petroleum products will depend upon:

- The depth and rate of general economic contraction and the strength of the subsequent recovery;

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[21] Please note that the definition of sectors (and corresponding fuels consumption) differs from the normal international method of classification. For example, in the case of transport fuels -- gasoline and automotive diesel oil -- a large part of the consumption shown under industry and transport sectors reflects fuel consumption by vehicles owned and operated by industrial units and Government Ministries/city transport agencies. Sectoral consumption statistics would need to be recast under normal, internationally used nomenclature that can then be used as a basis for specific fuel demand projections taking into account the expected structural and growth changes in each user sector.

- Structural changes in energy transformation and end-use sectors during the transition to free-market economy;
- The rate of inter-fuel substitution, and end-use efficiency gains;
- Growth of personal income; and
- Availability of sufficient convertible currency to import crude oil petroleum products.

8.10 According to the Bank's demand model presented in Chapter III, demand for oil products could fall to less than half of 1990 consumption by 2002 and recover to roughly 53% of that level by 2010. This contrasts sharply with forecasts by the Lithuanian authorities. According to these estimates, gasoline and diesel oil consumption would decline from 1.0 - 1.1 Mt/y and 1.1 - 1.2 Mt/y, respectively, in response to contraction of their major user-sectors, and rebound to those levels by 1996-1997. Home heating oil and kerosene demand would fall from 0.4 Mt/y and 0.5 Mt/y, respectively, and regain these levels by 1995-1996. Industrial fuel oil demand will be strongly influenced by gas substitution in the power sector, the retiring date of the Ignalina nuclear power station, as well as structural changes and efficiency improvements in the industrial sector. Lithuanian estimates of fuel-oil demand range from 2.0 - 5.5 Mt/y though 1996. Clearly, there is a great disparity between Lithuanian and Bank forecasts on future oil products demand; getting agreement on these demand forecasts will be an important step toward developing a strategy for the subsectors.

Supply

8.11 Most refined products for the domestic market come from the Mazeikiai refinery. Its refining capacity of about 13 Mt/y is about twice the domestic product demand. Although there is a mismatch between production and domestic demand profiles, supply capacity for each major energy product is significantly more than domestic demand, the surpluses being exported mostly to the Baltic countries and Kaliningrad, as well as to other republics of the FSU. Crude supplies in 1990 fell to about 9.6 Mt/y (relative to about 13 Mt/y during the previous 3 years) due to political problems following the country's declaration of independence. Crude supplies rose to 11.8 Mt/y in 1991, but then fell sharply to about 4.1 Mt in 1992, due to lack of foreign exchange and price disputes. Supplies receoved slightly in 1993 to about 5.2 Mt. Production for the refinery prior to supply constraints is shown in Annex 8.4.

Consumption/Supply Balances

8.12 The country was a net exporter of refined products during 1985-91. Supply/consumption balances during the period 1985-91 are shown in Annex 8.5.

D. Physical Facilities and Operations

The Refinery

8.13 The country's only refinery is located at Mazeikiai, some 96 km inland from the Klaipeda port, and 110 km from Ventspils port in Latvia. Its initial hydroskimming capacity of 6 Mt/y, commissioned in 1980, subsequently grew to the current 13 Mt/y, including a fluid catalytic cracking (FCC) secondary conversion in 1985 and 1989. Its location and capacity, planned under the central planning system of FSU, equipped the unit to meet the refined products demand of the Baltic countries with exports to other contiguous republics. It was one of the FSU's most modern refineries and has a good processing configuration, good internal matching between primary and conversion capacities, and is well-maintained. Physical facilities at the refinery are summarized in Annex 8.6.

8.14 Crude oil feedstock is transported to the refinery by a 700-mm pipeline from Russia, passing through Polotsk in Belarus, running parallel to another 700-mm exports crude line between Ufa and Ventspils (See Map IBRD 24406). Although the pipeline within Lithuanian territory is owned by Lithuania, transport operations are managed by Transneft in Belarus, on the basis of crude supply contracts between GoL/Refinery and Government of Russia/Russian supplier. In 1992, crude supply volumes were governed by inter-republican trade protocols which specified the volumes and prices expressed in US dollars. However, trade disputes over the cross exchange rates led to inadequate supplies of crude being delivered to Lithuania. Refinery operations were suspended in July 1992 and were resumed only sporadically because of crude supply stoppage, except for small quantities of crude processed under tolling contracts. Refining increased somewhat in 1993, but the Mazeikiai refinery still only operated at 40% of its capacity.

8.15 The refinery's vulnerability to supply disruptions is a major issue for future operations. However, any effort to diversify supply sources would need to consider:

- Creating least-cost infrastructures for crude oil receipt, storage, and transport to the refinery;

- The competitiveness of the refining operations. Issues to weigh would include optimized crude slate, optimum capacity, investments for improved energy efficiency, yield patterns to maximize high value-added products, and export potential (taking into account regional cooperation with the other two Baltic countries in terms of markets and infrastructures for crude oil receipt; and

- Financial constraints that continue to limit the country's ability to attract investment and finance the import of crude for refinery operations. Participation of the other Baltic states and the private sector should actively be pursued.

Marketing and Distribution

8.16 Refined products are marketed domestically by Lithuanian Fuels (LF), which is also responsible for the import and export of petroleum products and coal. LF owns and operates 14 main storage terminals across the country. Some 95% of its products are transported by rail and the balance by truck. It has no long-distance pipelines. Storage capacities of many of the terminals are barely adequate and some are inappropriately located, causing pollution problems in nearby residential areas.

Moreover, the physical condition of the terminals is generally poor. Loading and unloading at the terminals is manual due to lack of the proper equipment. Quantity reconciliation is poor, masking the likely excessive extent of transfer and transport losses (by some estimates up to 10%). The existing storage capacities are shown in Annex 8.7.

Sector Organization

8.17 The Ministry of Energy exercises administrative control over the two main agencies -- Mazeikiai Refinery and Lithuanian Fuels. This control extends to refining, import/export trade, product storage, transport and distribution of refined products. It initiates and enforces sector policy, negotiates inter-Republican trade protocols, allocates foreign exchange for imports, and approves investment and operating budgets. The refinery is managed by a board of 17 directors (including a Director General, Technical Director, Commercial Director, Economics and Finance Director, and the 13 chiefs of the oil storage terminals), and enjoys a high degree of autonomy in day-to-day management of refinery operations. The management structure of Lithuanian Fuels is similar, but import/export trade and domestic distribution is controlled by the Ministry, with Lithuanian Fuels acting as a sales agent. Prices of refined products at the ex-refinery stage and at the retail stage are set by GoL on a cost-plus basis and do not necessarily reflect international fuel market prices.

Environmental Aspects

8.18 Lithuania at present has no national standards setting permissible levels of pollutant discharges into the air and water bodies, or for monitoring solid dumps created by refineries or storage/transport distribution activities; nor do air quality and water quality standards exist. Among environmental authorities and refinery/marketing agencies, there is consensus about the absolute, maximum permissible quantities of pollutants, by categories of pollutants, from point sources and area (bubble) sources; however, they do not appear to be measured relative to the content per unit of air or water. It is thus difficult to estimate the impact of such permitted emissions on the general environment. Under the penalty regime instituted from mid-1991, penalty levels for non-conformance increase with higher emissions over the agreed-upon emission quantities.

8.19 The refinery measures pollutants discharged into air from each major point source (e.g., process heaters and FCC regenerator effluents) every three to six months. Pollutants at ground level (GLC) are measured in the sanitary zone (area outlying the refinery about 1-km radius from its boundary), and at 1.5, 2.0, 3.0 and 3.5 km from the refinery boundary, using portable equipment at 9 pre-defined coordinates. Environmental authorities make their own measurements periodically to determine conformity and levy penalties. The refinery routinely pays fines for exceeding discharge limits.

8.20 The refinery processes liquid effluents (after required chemical pretreatment of effluents from individual plant sections) through two trains of treatment facilities, each consisting of mechanical removal of free hydrocarbons followed by chemical treatment, and by activated sludge biological treatment. These facilities have a total capacity of 36,200 m^3 per day and operate reasonably well. However, due to lack of on-line analyzers and automated controls, episodic surges in pollutant levels cause high levels of pollutant discharges in final effluents. Liquid effluents after treatment are discharged through a dedicated 106-km pipeline into the Baltic Sea.

8.21 Semi-solid sludges have been stored in five large lined ponds since 1980, and now contain about 120,000 tons. While there is no pollutant seepage into the 'sanitary' zone, seepage within refinery boundaries has been detected, but the impact on groundwater has not been measured. A large incineration facility, commissioned in 1986, is inoperable due to design and equipment problems. The refinery has no plan for liquidating the accumulated inventory.

8.22 The product storage terminal at Vilnius has no system to contain and treat liquid run-offs or to monitor aerial pollution. This is probably typical of all storage terminals owned and operated by Lithuanian Fuels.

8.23 Environmental pollution control has not received sufficient attention by the refinery management. However, steps have begun to procure on-line analyzers for pollutant monitoring and control from a US firm (Ametek). The World Bank recommends that the refinery initiate a program for pollution control to include development of appropriate standards for all types of emissions, an audit of the treatment and measurement facilities, recommendations on systems for improving pollution control, and training of operating and management personnel.

E. Investment Plans

8.24 The enterprises, country authorities and bilateral aid agencies have initiated studies to explore the investment outlook for the refinery, Klaipeda port, Butinge port, and transport infrastructure, and the bulk storage facilities associated with refining and product distribution.

8.25 One study by a UK firm on refinery modernization/rehabilitation, proposed a three-stage development program to improve the yields of higher value-added products and product quality by means of secondary processing of low-value fuel oil. The phased investment program would ultimately increase the yield of gasoline (of improved specifications approaching international standards in stages) from about 8% to 32%; and of middle distillates from 38.6% to 48%; and to reduce residual fuel oil make from 25% to practically nothing (with coking of remaining heavy fuel oils). Incremental investments required for staged development are estimated at US$ 106 million, US$ 318 million, and US$ 557 million, respectively, with payback periods of 2-3 years for each stage. However, the assumptions and methodologies used in the study for investment justification are flawed, and the study findings should not be used for investment decision-making. In particular, the study implicitly assumed that the refinery would operate at full capacity at all times, and under all modification scenarios, and further implies that the total production would be marketed. This assumption is questionable and, in addition, the netbacks from exports of surplus products in more distant markets would be smaller; these aspects have not been properly studied and quantified in the economic justification of proposed investments. The study, therefore, overstated the benefits of the proposed investment options. However, the following investments, oriented towards efficiency improvements, de-bottlenecking/modernization of process units, and environmental improvements are likely to be justifiable:

- Modernization of the existing catalytic reformer unit;
- Installation of an isomerization unit;
- Adding a fuel oil vacuum distillation unit, and selective de-asphalting of vacuum residuum; and
- Revamping/replacing process heaters and installing waste-heat recovery systems.

Decisions to make these investments would be subject to confirmation that they would enable the refinery to become fully competitive. Total investment would be in the range of $70-100 million. Other proposed capital-intensive investments such as a new FCC unit, residues hydroprocessing and delayed coking units should be investigated, fully taking into account the associated investments in ports and transport infrastructures, marketability of all surplus products and availability of optimized crude slates.

8.26 Studies on development of the Klaipeda port, carried out with bilateral assistance from Nordic countries, envision increasing the port capacity to allow import of crude oil (9-12 Mt/y), other refined products and also to export refined products (other than fuel oil for which facilities currently exist). The Klaipeda port development findings and recommendations are discussed in Annex 8.2. The studies, however, do not evaluate hydrological characteristics of the port area, nor do they optimize draft, vessel capacities and investments and operating costs in relation to their impact on total transport costs of crude delivered to the refinery. The possibility of pumping imported crude to Mazeikiai using the existing export crude oil pipeline from Russia to Ventspils in Latvia (by providing a spur line and reversing flow) has been investigated, and some investments in installing pumps at Ventspils have already taken place. On the other hand, the possibilities of expanding the Ventspils port as an alternative to Klaipeda has not been studied. Use of the existing export crude pipeline for pumping imported crude in the reverse direction would completely stop the 12-13 Mt/y of crude exports from Russia through Ventspils, and no agreement has been reached in this regard between Lithuania, Latvia and Russia. As a long-term solution, such an agreement is unlikely, thus reducing the initial investment choices to developing a new unloading port at or near Klaipeda or upgrading the facilities at Ventspils, coupled with a new crude pipeline from the selected port to the Mazeikiai refinery. During 1993, GoL initiated action to develop an unloading port at Butinge near the Latvian border. As this proposal triggered Latvian objections, in December 1993, Lithuania and Latvia began discussing a possible joint venture to develop the Liepaja port in Latvia as an alternative oil unloading port.

8.27 Evaluation of investment options and justification of the port(s), transport pipelines, and the refinery should be conducted in an integrated manner, rather than through a piecemeal process. All such investments will crucially depend upon the Mazeikiai refinery being able to supply refined products at prices competitive with the alternative import options of neighboring countries, assuming that its primary market will be in the Baltics. The economics and competitiveness of the refinery (with or without justified investments) will also depend on the costs of import and storage at the port and subsequent transport to the refinery. A proper evaluation of investment options that takes into account their mutual interdependence is essential.

8.28 In the summer of 1993, the European Bank for Reconstruction and Development (EBRD), with financing by the UK Know-How Fund, engaged consultants (Rothschild and Sons, and Trichem of the UK) to advise the GoL on available options and their implications, including options for retructuring of the refinery to allow private and foreign participation. It is recommended that investment plans being considered by GoL should be held in abeyance until the study and recommendations are completed. Investment decisions should be based on a Baltic regional approach to ensure a dependable market for products as well as alternative supplies at least cost.

8.29 Lithuanian Fuel's Investment plans for storage and distribution of refined products aim to: (a) rehabilitate and modernize its 14 main storage terminals; (b) expand and relocate some of the terminals to sites that would reduce pollution impacts in populated areas; (c) assure adequate operational storage (about 18 days on average) and strategic storage (about 60 days on average); and (d) rehabilitate or modernize about 57 retail pump stations. The estimated investment of about $21 million for storage rehabilitation and expansion and $3 million for service station rehabilitation seem too low (see Annex 8.8). It is recommended that a specific study be carried out by an international consultant to address the objectives of providing adequate operational and strategic storage capacities consistent with long-term regional domestic and export market demand, with modern systems for pollution abatement and control.

In the meantime, Lithuanian Fuels should initiate and implement divestiture of retail pump stations to domestic and foreign investors through outright sale, and use the asset sales proceedings for modernizing storage facilities.

F. Issues and Options

8.30 The Mazeikiai Refinery was originally established to process Russian crude oil and to supply the Baltic Republics' needs, and to export any surpluses to Russia, Belarus and other republics of the FSU. Political and economic changes in recent years have created uncertainties in crude oil availability, prices and markets, besides exposing distortions in policy, legal and institutional frameworks, management systems and deficiencies in pollution control.

8.31 The sector faces major challenges under free-market conditions, particularly during the transition period. The adjustment problems are exacerbated by financial (especially convertible currency) constraints, caused by the collapse of barter trade agreements among republics of the FSU and general economic contraction.

8.32 The key issue that needs to be addressed is the competitiveness of the refinery. It is difficult to assess at this time the relative economies of refining in comparison with the option of importing products to serve the domestic market. Data on costs of refining at the Mazeikiai refinery (Annex 8.7) are not complete, and not amenable to meaningful analysis for estimating the economic costs of refining. It is unlikely that the refinery will be competitive at full capacity. However, with proper improvements to energy efficiency and operational practices, as well as investments to improve the yields of higher-value products, the refinery could become competitive at partial capacity to supply Lithuania and the Baltic region.

8.33 The country does not have adequate infrastructure for importing crude oil, other than from Russia, and its transport to the refinery. The country's ability to pay much higher prices for crude oil, relative to the prices in previous years, and increasing quantitative restrictions on crude supply from Russia, have highlighted the need for crude oil supply diversification. However, Russian oil suppliers, enjoying considerable margins (of up to US$ 30 per ton) will most likely undersell any competition from alternative sources. Therefore, the alternative supply point makes sense only on security grounds. Since the additional unloading facility is likely to be underutilized (or not utilized at all) if Russian supplies can be procured at lower cost, the alternative unloading facility must be of the lowest cost possible. Perhaps a Single Point Mooring (SPM) could provide at least cost the necessary security against unforeseen supply disruptions. The results of the on-going studies should form the basis for an investment strategy in refinery and port/transport infrastructures.

8.34 As mentioned above, storage capacity for products at main bulk terminals is inadequate and poorly sited. The country also lacks adequate strategic storage to absorb discontinuities in crude/product supplies, as evidenced during the latter part of this year. It is recommended that a study be conducted on the need for, and justification of storage capacity rehabilitation or expansion. Accepted recommendations of the study should be implemented as a priority.

8.35 Although it is the intention of GoL to create a legal and policy framework conducive to private investment flows and free-market business operations with minimum government intervention, many of the policy reforms, particularly those relating to ownership, pricing and trade, have not yet been put in place. While the legal framework for environmental pollution control has been enacted, standards and rules, and enforcement agencies' capabilities have yet to be developed. Except for a few joint ventures with foreign firms in retail stations, privatization of the sector is minimal. In the context of the massive investment needs for sector rehabilitation, the issue of establishing an environment conducive to investment flows through changes in policy and institutional frameworks needs to be addressed urgently.

8.36 Owing to the severe crude oil supply constraints during the second half of 1992, the refinery has sought to use its capacity for toll processing and buying back some products from out of the processing fee margin to supplement product availability to the domestic market. The economics of such toll processing, with terms including 5.5 - 6.0% allowance for fuel and losses, and US$7-8 per ton of crude refining fee, are not clear. Nonetheless, in the situation of foreign currency availability constraints for import of products, a proactive approach to enter into contracts for toll processing should be pursued, however small the incremental product availability to the domestic market might be. In this context, the refinery should address operational and energy inefficiency aspects, and improve production flexibility (e.g., change of catalysts, revamp hydrogen production unit to liquid feed, etc.) to improve the economy of the refinery.

8.37 Institutional capabilities are deficient in: (a) sectoral data analysis, management, and demand projections; (b) accounting and financial management at the refinery and the marketing agency; (c) operations management and maintenance; (d) investment options analysis; and (e) foreign trade. These capabilities need to be developed as quickly as possible through a well-structured and targeted training program as a part of technical assistance.

IX. NATURAL GAS SUBSECTOR

A. Introduction and Overview of Institutional Arrangements

9.1 Natural gas plays a key role in the primary energy supply in Lithuania. In 1980, the share of natural gas consumption was 20.6% of total energy consumed. Since then, consumption has risen at an annual rate of about 1%, to 24.5% in 1985 and 30.5% in 1990. Despite this general trend, gas consumption fell to 17% of the primary energy demand in 1993, reflecting increased use of low-cost heavy fuel oil. However, this development is likely to be temporary, and the share of gas in primary energy demand is expected to increase again as more sophisticated refining techniques begin to reduce the current glut of heavy fuel oil on the FSU markets. Lithuanian authorities expect gas consumption to increase from 6 bcm in 1991 to 7.9 bcm in 2005, although the demand model presented in Chapter III shows gas consumption to recover to only 70% of 1990 levels by 2010. At present, all natural gas comes from Russia via Belarus through the transit pipeline network. In 1991, just under 6 bcm of natural gas were consumed in Lithuania, falling to 3.2 bcm and 1.7 bcm in 1992 and 1993 respectively. In addition, Lithuania transits about 2 bcm a year to Kaliningrad and Latvia, receiving some payment in kind in lieu of transit fees. Use of natural gas would substantially decrease air polluting emissions from thermal power plants, factories and households, which are currently using low-grade fuel oils with 2.5 - 4.0% sulphur content. Typically, fuel switch-over from the present dual-fuel (oil and gas) to all-natural-gas firing would bring about a decrease of almost 70% or of 100-140 thousand tons per year of the current pollutants emitted from the thermal power plants in Lithuania.

9.2 Until 1990, the natural gas subsector in Lithuania was controlled by the central agency of the former Soviet Union, Lentransgas. Under its jurisdiction, the gas distribution system gradually evolved during the 1960s through the 1980s. Today, the transmission gas pipeline in Lithuania spans approximately 1,400 km excluding extensive underground gas distribution networks in large cities.

9.3 Until 1990, Lithuania Gas (LG) was the sole gas subsector executing agency, directly under the Ministry of Energy (MoE). During that period, the entire management, including marketing and future investment programs, was directed by the former Soviet authorities. In 1991, in addition to LG, 10 gas distribution companies were formed, based on Lithuanian district divisions (Vilnius, Kaunas, Klaipeda, Siauliai, Panevezys, Alytus, Marijampoles, Ukmerges, Trakuduju, and Kedainiu). The distribution companies are responsible for expanding gas distribution networks to include all consumers in each district, while the responsibility of LG is to supply gas to the Jonava petrochemical complex and operate the national gas pipeline grid. LG also plays a pivotal role in import and export contracts under the MoE.

9.4 There should be clear responsibility in each enterprise in terms of management, finance and marketing. The present institutional arrangements need to be restructured to create more financially viable independent enterprises, utilizing gas price reforms, long-term gas retail contracts, an improved tariff collection system, a modern accounting system and investments from Western partners. The gas supply price to each gas distribution enterprise would need to be studied and adjusted to reflect the present and future gas distribution market in each district. Furthermore, it is essential to create a contested gas sector business environment, introducing privatization in areas not relevant to national security. More than one transmission company is not practical in Lithuania owing to the size of the Lithuanian market and the single source of supply (i.e., Russia); to counterbalance the lack of competition in gas supply, inter-fuel competition between gas, petroleum, electricity, LPG and coal should be fostered.

B. Gas Supply

9.5 The gas supply network in Lithuania has existed since the 1960s. Today, there are two main gas supply pipeline routes from Russia via Belarus. In addition, one bi-directional pipeline exists between Lithuania and Latvia. Overall, the total gas supply design capacity to Lithuania is about 14 bcm/y. Maximum operating pressure of the gas pipeline network is maintained at 50 bar(g). Inside Lithuania, there are three main gas supply lines; (a) Vilnius - Panevezys; (b) Panevezys - Siauliai - Klaipeda; and (c) Vilnius - Sakiai. One compressor station with a total compression horsepower of 6,260 kW is installed at Panevezys, about 170 km north of Vilnius, from which the compressed gas moves to Siauliai, Klaipeda, and consumers along the gas transmission pipeline. Russian gas exports through Lithuania exit at two locations: one at the border with Latvia, about 200 km north of Vilnius, using a bi-directional design capacity of 2 bcm per year, and the other at the border with Kaliningrad with a design capacity of 0.5 bcm per year. A more detailed description of the gas pipeline network and the pipeline design data is given in Annexes 9.1 and 9.2 respectively. A pipeline map is also provided in the attached map, IBRD 24406.

9.6 Lithuania is 100% dependent on Russia for gas. The current Russian gas supplier is Lentransgas, based in St. Petersburg. Since Lithuanian independence, gas has been supplied on short-term contracts (at present, on a quarterly basis). Until August 1992, the contract price was US$ 90 per 1000 m^3 of gas, with rubles accepted in payment, although the exchange rate was a source of continual dispute. Since then, Russia has demanded a gas price of about US$ 85 per 1000 m^3 (or US$ 2.7 per million Btu) with payment in hard currency. The present gas transit contract is based on an "unbundled", one-part rate (US$ 1.36 per 1000 m^3 per 100 km) payable in rubles at the prevailing exchange rate.

9.7 Lithuania is in a very weak bargaining position. The current price structure is a one-part, bundled rate and apparently there is no logical cost basis that reflects short-run marginal cost (SRMC) or long-run marginal cost (LRMC). Furthermore, the present gas supply and transit transactions occur without metering at the territorial borders, creating potential error and disagreement in terms of the gas supply volume and calorific value.

9.8 Given the limited energy resources and markets, Lithuania should pursue regional cooperation with other Baltic states, CIS republics and Eastern European countries in all possible gas trade areas, including gas supply and transit arrangements, unified regulatory frameworks, future investments and technical standardization. In particular, optimization of gas supply/distribution should be sought, maximizing efficiency of utilization of the existing gas pipeline network and storage in the region and through commercial cooperation. In parallel with the domestic gas price reform, MoE and LG should seek a longer-term contract with Russia, incorporating an indexation with competing fuels and periodic price reviews. The gas transit to Kaliningrad should be used effectively in negotiating gas supply with Russia.

C. Gas Consumption

9.9 Natural gas consumption in Lithuania had been steadily increasing since the 1960s. In 1980, less than 4 bcm was consumed, while in 1991 consumption reached nearly 6 bcm. Owing to the economic turmoil prevailing in Lithuania, total primary energy consumption is falling dramatically; gas consumption therefore fell to 3.2 bcm and 1.7 bcm in 1992 and 1993. Historical gas consumption by each gas distribution enterprise is given in Annex 9.3. In 1991, the largest share of gas (52%) was consumed by thermal power and district heating plants, followed by industry (37%), household and services (8%) and agriculture (3%). It is expected that this dominant share by thermal power, district heating, and industry will continue beyond 2000.

9.10 The recent fall in gas consumption is expected to last into the next decade and may partially offset the present gas supply constraint. MoE is encouraged to pursue extensive energy efficiency improvements, in part by establishing a demand-side management program in an effort to minimize the need for investment in future gas transmission systems. Energy efficiency improvements in such large gas consumers as thermal power, district heating, cement, and fertilizer plants needs to be achieved by modernization, process conversion and rehabilitation. Uneconomic plants may need to be shut down. Future gas marketing should target high value applications which can compete with other lower grade fuels even at relatively higher gas prices.

D. Domestic Gas Distribution

9.11 The Lithuanian gas supply system distributes natural gas to major cities, large industries, and power plants. From its inception in the 1960s, the gas distribution network has gradually expanded. In the Soviet era, gas distribution and allocation were planned by the then Leningrad State Engineering Institute, "Giprospecgaz" which gave priority to heavy industries. In particular, almost all the incremental gas supply in the 1970s was used as raw material in the production of mineral fertilizers. All major thermal power plants have gas supply connections and dual-fired (fuel oil and gas) boilers. Gas distribution contracts with power stations and industrial plants are made individually on a long-term basis using metered gas consumption.

9.12 In large cities, fairly extensive gas distribution service is provided. In Vilnius, about 530 km of underground gas distribution lines were installed for use by households. However, few households have gas meters. The present contract is based on an assumption that each family member consumes 8.5 m^3 per month.

9.13 At present, gas consumers in large cities account for almost 95% of the total gas consumption. Major gas users include thermal power plants, industries and district heating plants; these are listed in Annex 9.4. In the current gas supply situation, MoE plays a vital role in setting priorities for the distribution of a limited supply of gas to users. In general, consumers who own alternative-fuel firing facilities are the first to be excluded from the gas supply.

9.14 LG is already receiving substantial technical assistance from bilateral donors, particularly from the Danish Oil and Natural Gas (DONG) Co., to upgrade its planning capability for future gas subsector development, improvement of operations, optimization of gas supply and efficiency improvements. Following up on the present activities, a central information center should be established in LG to collect and analyze updated data on gas supply/demand, prices, contracts, etc. For future investments, a more analytical approach should be adopted, conducting master planning and feasibility studies.

E. Regulatory Framework

9.15 At present, there is no comprehensive gas regulation in Lithuania, although the former Soviet code, Gost, is used in practice. GoL established a committee to prepare national gas-related legislation and regulations. However, the current effort is limited to technical and contractual aspects including gas quality specification, gas supply regime, technical conditions of gas supply, gas metering, contracts with consumers and guidelines for consumers on energy efficiency improvement.

9.16 MoE and LG have initiated discussions with Danish consultants (DONG) for a study on the gas sector development under a government-to-government agreement (see Annex 9.5). However, the study does not seem to focus on establishment of a modern gas subsector regulatory framework. It is recommended that MoE and LG implement an additional study on this subject, utilizing technical assistance available from international grant aid agencies. In addition, modernization and standardization of accounting methods and technical practices should be expedited, using international codes and standards. This will bring cost savings in areas such as operations, maintenance, etc., increasing reliability of design and interchangeability of components.

F. Future Investment Plans

9.17 Originally, LG expected natural gas consumption for industry and district heating to continue increasing. As a result, LG planned and implemented a second 240-km gas pipeline project running from Panevezys to Klaipeda with a branch line to Mazeikiai, to provide additional gas supply of a maximum 5 bcm per year using the bidirectional gas pipeline to Latvia for imports. The major gas consumers for this gas supply project are: the cement plant in Naujoji Akmene with an additional 630 million m^3 per year by 1995; the Mazeikiai Refinery with new gas supply of 520 million m^3 per year by 1995; and Klaipeda city with an additional 205 million m^3 per year by 2000. As of now, about 30 km of pipeline materials with a diameter of 1000 mm have been purchased, weld-spliced, and are ready for laying near Panevezys. However, due to budget shortages, the remaining portion has been untouched. According to the original plan of Lithuanian Gas, about 40,000 tons of pipes need to be procured and installed in the following lines: (a) about 50 km of 1,000-mm diameter pipeline in the remaining section from Panevezys to Siauliai; (b) about 50 km of 700-mm diameter pipeline from Siauliai to Mazeikiai via Najoji Akmene; and (c) about 110 km of 500-mm diameter pipeline from Siauliai to Klaipeda. Lithuanian Gas estimates the cost of this project at about 800 million rubles in 1989. Today, the cost to procure the remaining portion of the pipeline materials would exceed US$ 40 million at international steel prices.

9.18 LG is also considering installing underground gas storage facilities near Sirvintos about 40 km north-west of Vilnius. This storage will be used for peak supply of gas consumption in winter time. The gas storage is essentially a dome of about 500 to 1,000 meters below ground level, filled with natural soil and rock covered by hard cap rock. The active gas storage capacity is expected to be about 0.5 bcm (maximum 1 bcm). According to the plan of Lithuanian Gas, a new compressor station with a total gas compression horsepower of 5,000 kW and a discharge pressure of 50 bar needs to be installed. The initial cost estimate in 1986 was in the range of 1.5 million rubles. The current cost at international prices may be more than US$ 50 million. It must be noted that there is a far larger underground gas storage facility at Incukalns in Latvia that could serve as a regional reservoir. It appears that using this

Latvian gas reservoir would be much more economic once Baltic regional cooperation is established and the parties learn to deal with each other on the basis of commercial and mutually beneficial contracts.

9.19 Lithuanian independence makes it urgent that metering stations be installed at the border with Belarus, Latvia, and Kaliningrad. LG identified a project to install metering stations at two border locations: one on the pipeline from Panevezys to Riga; and the other at the border of Lithuania to Kaliningrad, using EBRD's financing at an estimated cost of US$ 6 million. Information as of June 1993 indicates that LG is considering canceling the shared-cost Lithuania-Latvia metering station and making its own arrangements for the other station. This development highlights the difficulties still experienced in promoting effective regional cooperation and following internationally accepted commercial practices. In the near future, two additional metering stations are required on the main gas supply pipelines from Minsk and Ivaceviciai, both in Belarus. The additional cost is estimated at about US$ 5 million at the current international price.

9.20 The existing gas supply pipelines, in particular those constructed in the 1960s, need to replace a substantial portion of deteriorating equipment and/or materials. The gas supply pipeline from Ivaceviciai, Belarus, may be one such candidate. The scope of work and investment costs still needs to be identified.

9.21 Although Lithuania has extensive gas distribution networks in large cities, modernization is a matter of urgency. In particular, each household needs a gas metering device installed in the course of gas energy price reforms. More specific projects would be identified in the near future when the gas sector modernization study has been completed by the Danish consultants.

9.22 At present, there are no telemetering or control systems in Lithuania. As a result, LG has some difficulty in the operation and management of the gas pipeline network. In particular, LG lacks measures to respond quickly enough to a sharp variation of gas supply or in emergency cases, causing errors and omissions. LG is considering installing a low-cost system control and data acquisition (SCADA) system for the major existing gas transmission lines (especially from Panevezys to Klaipeda).

9.23 Based on discussions with local authorities, and making its own assessment, the World Bank made some preliminary, approximate estimates of the required investment costs for the above projects as follows:

Table 9.1: Gas Subsector Investment Estimates

Project	Investment (US$ million)		
	Local Currency	Foreign Currency	Total
A. Core Investment Projects			
i) Additional metering station	1	4	5
ii) Gas pipeline modernization	20	85	105
iii) Gas metering at households	5	25	30
B. Additional Investment Projects			
i) Gas pipeline ext. Panavezys-Klaipeda-Mazeikiai	15	50	65
ii) Low-cost SCADA	5	25	30

9.24 This list of projects does not include ambitious future projects such as the "Polepipe" (gas supply line from the North Sea through Denmark and Poland) and a pipeline transmitting gas from new field development in the Barents Sea. The scope, viability, ownership, scheduling and financing of these concepts, which are expected to require huge investments, have not yet been determined beyond the conceptual stage. These projects are, therefore, highly uncertain and, in any case, unlikely to be realized before the year 2000. In the near-to-medium term and in the realm of more realistic possibilities, substantial renewal and modernization are required to achieve a more reliable and efficient gas sector operation. Any commercial expansion projects would require thorough investigation, based on more accurate demand projections than currently used by LG, and should be based on full cost recovery. Modernization projects should include upgrading management and information systems (MIS), personnel training, and the replacement of existing hardware with modern equipment. After the modernization, a high load factor should be maintained to improve the performance of the sector.

X. INVESTMENT PLANS

10.1 In this chapter, the investments described in the preceding chapters will be assessed with regard to the level of investment required and the potential sources of financing. The investments are those proposed by the Government and its agencies, and by the Bank and its consultants.

A. Investment Costs

10.2 Soviet central planning has left Lithuania with an overdeveloped energy sector relative to the size of the country. This is in part due to the fact that Lithuania was developed as a regional supplier of electricity and oil products, but it also reflects the inefficiencies of investment decisions in an economic system which emphasized output over economic allocation of resources and cost-effective production. Since the energy intensity of the economy will decrease with conservation and efficiency improvements, there is little need for new capacity. Instead, all efforts should be concentrated on rehabilitating existing facilities and retiring, in a planned manner, those that are unneeded, inefficient, obsolete or unsafe.

Petroleum Sector

10.3 The estimated investment costs of a Core Investment Program (CIP) in the petroleum sector are shown in Table 10.1, together with those of the gas sector. This program takes into account proposals provided by the GoL and its consultants, but reflects also the World Bank's judgement as to the viability of the investments and the shortage of investible funds in Lithuania, particularly under the present economic conditions. The numbers are therefore highly uncertain. A number of studies, now under way, are expected to refine the level of investment that is economically justified. A larger investment program as proposed by the Government and/or reflected in consultants' studies is shown in Table 10.2. Most important is the reconstruction and modernization of the Mazeikiai refinery, a major asset in Lithuania's energy sector. Studies performed to date indicate investment costs of about US$ 100, 170, and 335 million in three partially overlapping phases, requiring three to four years each, and totaling more than US$ 600 million (Table 10.2). However, the feasibility of such high expenditures has not yet been demonstrated, especially as regards the marketability of the refinery's products. Taking into account the probable downscaling of output from the present capacity of 14 Mt of petroleum per year to an operating level of about 8-10 Mt/y, which is the present approximate aggregate demand of products in the three Baltics, a smaller core investment program is suggested of about US$ 40 and 60 million in the periods 1993-95 and 1996-2000, respectively. The detailed feasibility study, coupled with a market research study, in preparation with funding from the US Trade and Development Agency (USTDA), and the broader hyrocarbon sector studies by the UK consultants with funding from the Know-How Fund will provide the necessary information as to the appropriate physical facilities needed, amount of investment, and phasing of the rehabilitation program.

10.4 In order to increase the security of petroleum supply and in view of the severe disruptions experienced in 1992 and 1993, a new crude oil unloading facility is being planned with associated pipelines for transmission of crude to Mazeikiai and of products from Mazeikiai to the port for export. The GoL is committed to this investment and is seeking financing as a high priority. Although the need of an additional point of crude supply is understandable, the economic viability of such a project is not obvious, since crude oil from Russian suppliers transported by pipeline is more competitive (by about US$ 30 per metric ton) and the refined products are not expected to be competitive beyond the broader Baltic area. In addition, the environmental risks from the operation of the unloading port facilities and from potential spills are large in an area of potential tourist development. The cost of the port facilities and pipelines, estimated at US$ 300 million, could be justified on security rather than on economic grounds. The Bank suggests that other lower-cost means of providing additional security of supply should be explored; one low-cost option might be a single-point mooring (SPM) at an existing port in Lithuania or Latvia.

Table 10.1: Core Investment Program (CIP) in Petroleum and Gas, 1993-2005
(US$ million)

Facilities	1993-95	1996-2000	2001-05
1. Mazeikiai Refinery	40	60	60
2. Unloading Port & Pipelines	20	60	-
3. Products Distribution Network	20	50	-
4. Oil Field Development	25	100	150
5. Gas Subsector	35	55	50
TOTAL	140	325	260
Average per year	47	65	52

Table 10.2: Investment Program in Petroleum and Gas Proposed by GoL and Consultants, 1993-2005
(US$ million)

Facilities	1993-95	1996-2000	2001-05
1. Mazeikiai Refinery	100	170	335
2. Unloading Port & Pipelines	100	200	-
3. Products Distribution Network	50	50	-
4. Oil Field Development	100	150	150
5. Gas Subsector	95	205	90
TOTAL	445	775	575
Average per year	148	155	115

10.5 The distribution network for oil products is a potential investment priority where the economic viability and profitability can be established. On the basis of current losses (estimated to be as high as 10% of production using the current system of rail and road distribution), a distribution network, mainly from Mazeikiai to the Vilnius area, at an estimated investment of US$ 20 million in 1993-95 and US$ 50 million in 1996-2000 might be justified with attendant benefits in efficiency and quality of service.

The private sector would be the most appropriate investor in this area. If the economic climate of reform inspires a higher confidence in potential investors, the amount of investment in this subsector could increase, given its short payback period. The instrument of Contractual Performance Guarantee, recently introduced by the World Bank, could contribute significantly in this respect.

10.6 The development of local petroleum resources is already attracting interest from foreign investors. An investment of about US$ 50 million was announced in late 1992 by a Swedish company forming a joint venture with the Gargzdai state-owned oil prospecting enterprise. Local authorities said that about US$ 100 million would be invested in 1993-95 with an additional US$ 150 million in each of the subsequent two five-year periods, but the World Bank estimates that the investment rate will likely be slower. Most of the investment is expected to come from foreign investors if the necessary concession agreements can be concluded. It is suggested that a petroleum law providing the legal framework, clear and equitable tax regulations, rules for capital protection and repatriation, and adequate incentives be enacted as soon as possible to encourage vigorous entry of foreign capital in the sector and ensure rapid development of indigenous oil resources that could reduce the almost absolute dependence on imported crude.

Natural Gas Facilities

10.7 Investments in this sector have been identified in gas storage, metering, transmission and distribution networks opportunities (see Chapter IX). Given limited investment funds, the World Bank, in consultation with local authorities, split the investment program into two parts: (a) a Core Investment Program (CIP) consisting of the higher priority projects that fit within the overall energy strategy of energy conservation and efficiency, and (b) an additional investment program, consisting of desirable projects that could be financed if incremental financing was available. Table 10.1 shows that the CIP in the gas subsector requires about US$ 35 million in 1993-95, US$ 55 million in 1996-2000 and US$ 50 million in 2001-05. The additional investment program would require US$ 25 million in 1993-95, US$ 70 million in 1996-2000, and US$ 5 million in 2001-05. The investment program proposed by the GoL includes a gas storage facility at Sirvintos to provide security of gas supply and possibly improve cost effectiveness if the price differential between summer and winter is large. However, a large storage reservoir exists at Incukalns, Latvia, and it is likely to be more economical to enhance its capacity rather than build a new reservoir in Lithuania. It is therefore recommended that the planned investment in the Lithuanian gas reservoir await the proper evaluation of the capacity enhancement project at Incukalns in the framework of regional energy cooperation.

10.8 Total CIP requirements in the oil and gas sectors thus are estimated at US$ 140 million in the period 1993-95 or US$ 47 per year. In the 1996-2000 period, total CIP requirements are about US$ 325 million or about US$ 65 per year.

Electricity and District Heating

10.9 Estimated CIP requirements are shown in Table 10.3. The first two items concern the two units at the Ignalina nuclear plant which is a major energy asset of the country. If the plant is to continue operating for the medium or longer term, which is the stated policy of the GoL, certain investments would be necessary to upgrade safety and provide spent-fuel storage facilities. Safety upgrade costs were estimated by consultants to the European Bank for Reconstruction and Development (EBRD) at about US$ 68 million per unit. (If it is decided to continue operation of the units until 2010, the cost of safety upgrades would be higher, closer to US$ 100 million per unit.) The World Bank has estimated the requirement for investment in additional spent-fuel storage facilities, which would be needed as early as

1994, at about US$ 25 million in the short term (1993-95) and US$ 50 million in the medium-to-longer-term (1996-2000).

Table 10.3: **Estimated Core Investment Program (CIP) in the Power Subsector, 1993-2005 (US$ million)**

Facilities/Project	1993-95	1996-2000	2001-2005
1. Nuclear Plant Ignalina Upgrading[a]	68.0	68.0	-
2. Spent Nuclear Fuel Storage[a]	25.0	50.0	-
3. Thermal Plant Rehabilitation	50.0	70.0	130.0
4. New Generation[b]	-	-	550
5. Transmission and Distribution (T&D)			
Dispatch Centers & Communications	12.0	12.0	5.0
Transmission lines	10.0	158.0	25.0
Distribution	5.0	10.0	15.0
Subtotal T&D	27.0	180.0	45.0
6. District Heating	30.0	50.0	-
TOTAL	200.0	418.0	595.0
Average per year	67.0	84.0	119.0

a/ Assumes medium-term retirement of Ignalina, i.e., in the year 2000.
b/ Under a high-demand scenario, new capacity would be needed beyond the year 2000; about 750 MW in 2001-2005, and an additional 600 MW in 2000-2010.

10.10 Rehabilitation of thermal plant is being actively pursued by the Government, since it is needed as backup to the nuclear plant at Ignalina, to provide power for variable load and, in the case of combined-heat-and-power stations, to supply heat to the communities. Although the extent and phasing of the rehabilitation program is the subject of a feasibility study, an estimate of costs was made based on the old age of many units, and the rehabilitation work already performed at the Lithuania Thermal Power Plant: US$ 50 million in 1993-95 and US$ 70 million in 1996-2000. The rehabilitation program depends heavily on the retirement date of Ignalina. If it is to be earlier than the medium term (i.e., in about 1995 or '96, rather than in 2000), a more vigorous and expensive rehabilitation program would be needed to provide reliable thermal power to the system; in that case, safety upgrades would be unnecessary, and would save US$ 137 million and some additional investment for spent fuel; at least some expenditures for closing down and securing the plant would be unavoidable. In such a case, the thermal plant rehabilitation investment program would be about US$ 130 million in 1993-95 and US$ 200 million in 1996-2000, but the net incremental investment would be about US$ 22 million in each of the periods.

10.11 New generating plants would be needed in the case of early to mid-term retirement of Ignalina combined with a high demand scenario. Even then, new capacity would only be needed beyond the year 2002 (see Chapter VII and the G-7 study. Assuming a mid-term retirement of Ignalina, about 750 MW of additional capacity would be needed in 2001-05 and 600 MW more in 2006-2010. The estimated cost in the period 2001-2005 is US$ 550 million, assuming that the technology adopted would be gas turbine/combined cycle, the least capital intensive among the available power generating technologies.

10.12 In transmission and distribution, investment opportunities have been identified and are proposed as part of the power rehabilitation project to be financed by the Bank. Upgrading the communications and computer systems in the Vilnius dispatch center, providing advanced software for frequency and interchange regulation and replacing remote terminal units with modern equipment, would increase substantially the operational flexibility of the Baltic system, facilitate power and energy exchanges, and lead to a more economically operated system. Similarly, upgrading equipment in the H-V transmission system would require about US$ 10 million in the short term. In the medium term, extension of the H-V transmission system is envisaged, including an interconnection to Poland. The estimated investment of US$ 180 million in 1996-2000 includes US$ 68 million for a HVDC terminal at the border, to allow interconnection with Poland which is to be connected to the UCPTE European system by 1996. The estimated cost of US$ 68 million assumes that Lithuania can purchase a used HVDC station -- one now operating along the present border between the Central European countries and UCPTE -- rather than buying a factory-new system that would cost up to US$ 135 million and would, most likely, make the project uneconomic. Part of the total near-term requirements in this subsector are to be covered by the proposed World Bank loan.

District Heating

10.13 The cost of upgrading the DH systems of Lithuania could be great (see Chapter VI). A low estimate of the required investment, based on the World Bank's appraisal of the major DH system in Vilnius, is about US$ 30 million in 1993-95 and US$ 50 million in 1996-2000.

10.14 The total investment required in the electricity and DH sectors is therefore about US$ 200 million in the period 1993-95 with an average of US$ 67 million per year. In the next five-year period, 1996-2000, about US$ 418 million with an average of US$ 84 million per year is needed.

10.15 The total investment requirements for the energy sector -- about US$ 340 million in 1993-95 and US$ 743 million in 1996-2000 -- may still be too high for Lithuania to finance under present economic conditions. The CIP may have to be scaled down further, applying strict economic criteria. If the economy recovers as expected after 1995-96, the estimated energy investments may be more realistic. How the energy investments might be financed is discussed more fully in the next section.

B. Financing Possibilities

10.16 Although these rough estimates represent quite large investment costs for a country the size of Lithuania, a substantial portion is expected to be in local currency, depending on the type of project. On average, about 40% of total requirements could be in local currency. In principle, the sources of finance could be: (a) internally generated funds; (b) domestic borrowing; (c) foreign borrowing; (d) domestic equity investment; (e) foreign equity investment; (f) domestic grants from the Government budget; and (g) foreign grants.

10.17 If one assumes that the energy sector will be restructured and prices set at levels sufficient to cover costs and allow future investment and profit, most of the proposed expenditures could be financed without direct budgetary support. The Government would invest mainly in non-commercial projects to increase the security of petroleum and gas supplies and, possibly, to upgrade the safety of the nuclear plant.

10.18 In the petroleum subsector, the investments to modernize the refinery should be commercially viable. With liberalized domestic and foreign trade in crude oil and petroleum products and decontrolled prices, the refinery should attract the necessary commercial loans and equity investors to finance the modernization projects (see Chapter VIII). The Government's role should be restricted to establishing the legal and regulatory environment of petroleum and gas, arranging necessary feasibility studies and technical assistance and promoting joint ventures.

10.19 In the gas subsector, investments will depend on the Government's pricing policies; if prices to households remain subsidized, the Government must bear the investment costs. Since gas is a clean, efficient and versatile fuel, and continued demand for new connections can be expected, expansion of the gas network to new customers may be necessary. In this case, Lithuanian Gas may be able to charge these new customers directly for connections and meters to the extent that these costs are not reflected in the present tariffs. Investment in gas metering is highly recommended, since this would provide an incentive for consumers to conserve energy and provide a basis to charge the consumers accurately.

10.20 In the electricity subsector, availability of funding will depend largely on the development of electricity tariffs based on the true costs of generation, transmission and distribution. If electricity prices are not higher than costs, the electricity company will not be able to generate funds internally and, as a result, will also be unable to persuade either domestic banks or international lending institutions that it is credit-worthy. Equity investors will also be difficult if not impossible to attract. Foreign donors, which traditionally offer mostly technical assistance, will cover only a small fraction of the investment. In such a case, the investments would have to be provided by budget allocations while prices remain low, leading to increasing demand, and thus the need for more investment from the budget. Financing hard currency investments without access to foreign loans would lead to severe shortages in other sectors of the economy and jeopardize the success of the Government's stabilization program.

10.21 If an appropriate tariff program, allowing recovery of costs and a profitable operation of the electricity system, is agreed, the electricity company would be able to generate funds internally, and thus open access to both domestic and foreign lending institutions such as the World Bank. In addition, if an appropriate legal and regulatory framework is introduced and becomes effective, private investors could be attracted to commit funds to supplement the financing requirements by providing equity funds. Participation of the private sector should also bring about faster technology transfer, leading to a power sector of higher efficiency and improved service to customers.

10.22 Regarding safety upgrades, the agreement signed betwen EBRD, GoL and the Ignalina State Nuclear Power Plant provides a grant of ECU 33 million (about US$ 40 million) for urgently needed safety improvements (para. 6.35). I addition, the Swedish Government has provided a grant of some US$ 10 million to improve fire protection, make equipment and material tests, and bring about other operational improvements. Thus the line item in Table 10.3 for Ignalina upgrading has been partly secured as a grant. However, if GoL intends the units to operate beyond the medium term, more extensive upgrades would be needed, at a cost of about US$ 100 million per plant.

10.23 In the district heating subsector, where extremely low tariffs are levied on households, only two sources of financing are possible in the near term: local government budgets and direct support from the central government. In the longer term, when appropriate heat tariffs are established and flow control and metering systems are in place, user charges could become the principal source of financing system rehabilitation. Technical assistance has already begun with grant financing from the Danish Energy Agency to develop master plans in the country in general and in three major cities in particular. The results of these studies are expected to provide the basis for financing DH rehabilitation components or projects by the World Bank and/or other international financing institutions.

10.24 In addition to the World Bank, other lending institutions would be interested in investments in the sector if the conditions outlined above prevail. Such institutions include the EBRD and the European Investment Bank (EIB). The Swedish agency BITS has also expressed strong interest in providing loans in the energy sector. The World Bank is cooperating with these institutions and is planning joint missions in the future to ensure that its own financing means are leveraged to better meet the total investment requirements of Lithuania.

10.25 In order to expand financing options to include direct foreign investment, commercial credits and domestic equity participation, the energy sector in Lithuania will need to be restructured and commercialized. This is true even in areas in which national security considerations prevent privatization. These issues are dealt with in more detail in Chapter V.

ANNEXES

Lithuanian Energy Balance 1991, original units

	Coal	Crude Oil	Petroleum Products							Natural Gas	Nuclear Power	Hydro Power	Electric Power	Heat
			Subtotal	LPG	Gasoline	Diesel	LFO	HFO	Other					
	Mt	Mt	Mt	Mt	Mt	Mt	Mt	Mt	Mt	bcm	TWh	TWh	TWh	M Gcal
PRIMARY SUPPLY:														
Production											17.000	0.338		
Imports	1.000	11.757	0.220	0.080			0.040	0.100		6.000			3.720	
Exports			-3.649	-0.240	-0.957	-1.304	-0.031	-0.757	-0.360				-16.470	
Total Primary Supply	1.000	11.757	-3.429	-0.160	-0.957	-1.304	0.009	-0.657	-0.360	6.000	17.000	0.338	-12.750	0.000
TRANSFORMATION:														
Petroleum Refinery		-10.963	10.963	0.285	2.086	2.376	0.362	4.434	1.420					
Electr./Heat Generation			-2.258					-2.258		-3.300	-17.000	-0.338	29.350	19.492
Own Uses in Energy Ind.		-0.794											-2.574	
Distribution Losses													-1.689	-1.390
Secondary Supply	0.000	-11.757	8.705	0.285	2.086	2.376	0.362	2.176	1.420	-3.300	-17.000	-0.338	25.087	18.102
FINAL USE:														
Industry	0.100		1.775	0.010			0.042	1.187	0.536	2.000			5.692	7.166
Agriculture	0.300		0.388				0.056	0.332		0.200			2.600	
Residential/Commercial	0.500		0.251	0.080			0.171			0.300			3.795	10.937
Transportation			2.725		1.129	1.072			0.524				0.250	
Other	0.100		0.137	0.035			0.102			0.200				
Total Final Use	1.000	0.000	5.276	0.125	1.129	1.072	0.371	1.519	1.060	2.700	0.000	0.000	12.337	18.102

Lithuanian Energy Balance 1991, million tonnes of oil equivalent

	Coal	Crude Oil	Petroleum Products							Natural Gas	Nuclear Power	Hydro Power	Electric Power	Heat	Total
			Subtotal	LPG	Gasoline	Diesel	LFO	HFO	Other						
	Mt	Mt	Mt	Mt	Mt	Mt	Mt	Mt	Mt	bcm	TWh	TWh	TWh	M Gcal	Mtoe
PRIMARY SUPPLY:															
Production											4.430	0.088			4.518
Imports	0.700	11.757	0.220	0.080			0.040	0.100		4.800			0.320		17.797
Exports			-3.649	-0.240	-0.957	-1.304	-0.031	-0.757	-0.360				-1.416		-5.065
Total Primary Supply	0.700	11.757	-3.429	-0.160	-0.957	-1.304	0.009	-0.657	-0.360	4.800	4.430	0.088	-1.097	0.000	15.024 *)
TRANSFORMATION:															
Petroleum Refinery		-10.963	10.963	0.285	2.086	2.376	0.362	4.434	1.420						0.000
Electr./Heat Generation			-2.258					-2.258		-2.640	-4.430	-0.088	2.524	1.949	-4.943
Own Uses in Energy Ind.		-0.794											-0.221		-1.015
Distribution Losses													-0.145	-0.139	-0.284
Secondary Supply	0.000	-11.757	8.705	0.285	2.086	2.376	0.362	2.176	1.420	-2.640	-4.430	-0.088	2.157	1.810	-6.243
FINAL USE:															
Industry	0.070		1.775	0.010			0.042	1.187	0.536	1.600			0.490	0.717	4.651
Agriculture	0.210		0.388				0.056	0.332		0.160			0.224		0.982
Residential/Commercial	0.350		0.251	0.080			0.171			0.240			0.326	1.094	2.261
Transportation			2.725		1.129	1.072			0.524				0.022		2.747
Other	0.070		0.137	0.035			0.102			0.160					0.367
Total Final Use	0.700	0.000	5.276	0.125	1.129	1.072	0.371	1.519	1.060	2.160	0.000	0.000	1.061	1.810	11.007

*) In the conversion to mtoe, primary power production (nuclear and hydro) has been grossed up (*3) to arrive at the amount of fossil fuel necessary to produce the amount of electricity.
The Total Primary Supply sum number has been arrived at as if net electricity exports were treated similarly.

Lithuanian Energy Balance 1992, original units

	Coal	Crude Oil	Petroleum Products							Natural	Nuclear	Hydro	Electric	Heat
			Subtotal	LPG	Gasoline	Diesel	LFO	HFO	Other	Gas	Power	Power	Power	
	Mt	Mt	Mt	Mt	Mt	Mt	Mt	Mt	Mt	bcm	TWh	TWh	TWh	M Gcal
PRIMARY SUPPLY:														
Production											14.638	0.372		
Imports	0.904	3.538	0.500					0.500		3.506			5.338	
Exports			0.000										-10.641	
Total Primary Supply	0.904	3.538	0.500	0.000	0.000	0.000	0.000	0.500	0.000	3.506	14.638	0.372	-5.303	0.000
TRANSFORMATION:														
Petroleum Refinery		-3.207	3.207	0.095	0.608	0.690	0.203	1.275	0.336					
Electr./Heat Generation			-1.000					-1.000		-1.768	-14.638	-0.372	18.718	24.140
Own Uses in Energy Ind.		-0.331											-1.985	
Distribution Losses													-1.686	-2.287
Secondary Supply	0.000	-3.538	2.207	0.095	0.608	0.690	0.203	0.275	0.336	-1.768	-14.638	-0.372	15.047	21.853
FINAL USE:														
Industry	x		x	x			x	x	x	1.082			4.510	9.440
Agriculture	x		x				x	x		0.114			1.794	0.870
Residential/Commercial	x		x	x			x			0.360			3.240	5.750
Transportation			x		x	x			x				0.200	
Other	x		x	x			x			0.182				5.793
Total Final Use	0.904	0.000	2.707	0.095	0.608	0.690	0.203	0.775	0.336	1.738	0.000	0.000	9.744	21.853

Lithuanian Energy Balance 1992, million tonnes of oil equivalent

	Coal	Crude Oil	Petroleum Products							Natural	Nuclear	Hydro	Electric	Heat	Total
			Subtotal	LPG	Gasoline	Diesel	LFO	HFO	Other	Gas	Power	Power	Power		
	Mt	Mt	Mt	Mt	Mt	Mt	Mt	Mt	Mt	bcm	TWh	TWh	TWh	M Gcal	Mtoe
PRIMARY SUPPLY:															
Production											3.815	0.097			3.912
Imports	0.633	3.538	0.500					0.500		2.805			0.459		7.935
Exports			0.000										-0.915		-0.915
Total Primary Supply	0.633	3.538	0.500	0.000	0.000	0.000	0.000	0.500	0.000	2.805	3.815	0.097	-0.456	0.000	10.005 *)
TRANSFORMATION:															
Petroleum Refinery		-3.207	3.207	0.095	0.608	0.690	0.203	1.275	0.336						0.000
Electr./Heat Generation			-1.000					-1.000		-1.414	-3.815	-0.097	1.610	2.414	-2.302
Own Uses in Energy Ind.		-0.331											-0.171		-0.502
Distribution Losses													-0.145	-0.229	-0.374
Secondary Supply	0.000	-3.538	2.207	0.095	0.608	0.690	0.203	0.275	0.336	-1.414	-3.815	-0.097	1.294	2.185	-3.178
FINAL USE:															
Industry	x		0.000	x			x	x	x	0.866			0.388	0.944	2.197
Agriculture	x		0.000				x	x		0.091			0.154	0.087	0.332
Residential/Commercial	x		0.000	x			x			0.288			0.279	0.575	1.142
Transportation			0.000		x	x			x				0.017		0.017
Other	x		0.000	x			x			0.146				0.579	0.725
Total Final Use	0.633	0.000	2.707	0.095	0.608	0.690	0.203	0.775	0.336	1.390	0.000	0.000	0.838	2.185	7.753

*) In the conversion to mtoe, primary power production (nuclear and hydro) has been grossed up (*3) to arrive at the amount of fossil fuel necessary to produce the amount of electricity. The Total Primary Supply sum number has been arrived at as if net electricity exports were treated similarly.

Lithuanian Coal Imports
(thousand tons)

Year	Total Imports	Imported from				Average price rubles/ton
		Poland	Russia[a]	Ukraine	Kazakhstan	
1985	1119	826	68	225	-	30
1986	1313	1152	-	161	-	30
1987	1193	776	65	352	-	30
1988	1176	873	20	283	-	30
1989	1087	879	82	126	-	30
1990	1287	800	372	110	5	40-50
1991	1002	-	653	17	332	100
1992	904	-	646	51	207	4000-4500

a Heat content of Russian coal: 7500-7900 kcal/kg

Source: Lithuanian Fuel

Lithuanian Electricity Trade (GWh)

	1986 Net Exports/ Net Imports(-)	1987 Net Exports/ Net Imports(-)	1988 Net Exports/ Net Imports(-)	1989 Net Exports/ Net Imports(-)
Kaliningrad	2183	2395	2467	2522
Belarus	6213	7133	8088	10585
Latvia	-1293	-2881	-1335	-973
Total	7103	6647	9220	12134

	1990		
	Exports	Imports	Net Trade
Kaliningrad	3407	881	2526
Belarus	10395	533	9862
Latvia	2711	3124	-413
Total	16513	4538	11975

	1991		
	Exports	Imports	Net Trade
Kaliningrad	3653	1026	2627
Belarus	9698	338	9360
Latvia	3124	2361	763
Total	16475	3725	12750

	1992 Net Trade	1993 Net Trade
Kaliningrad	1277	387
Belarus	3901	1849
Latvia	109	653
Total	5287	2889

Development in Lithuanian Energy Prices 1990-93

	Consumer Price Index	Gas - Import Price Lt/1000m3		Gas - Residential Lt/1000m3		Gas - Industrial Lt/1000m3	
	Dec '92=100	Actual**)	Real*)	Actual**)	Real*)	Actual**)	Real*)
Dec-90	100	0.2	100	0.4	100	0.3	100
Jan-91	107	0.5	212	0.6	163	0.6	204
Feb-91	116	0.5	195	0.6	150	0.6	188
Mar	136	0.5	167	0.6	128	0.6	160
Apr	173	0.5	131	0.6	101	0.6	126
May	189	0.5	120	0.6	92	0.6	115
Jun	202	0.5	112	0.6	86	0.6	108
Jul	213	0.5	107	0.6	82	0.6	102
Aug	222	0.5	102	0.6	79	0.6	98
Sep	229	0.5	99	0.6	76	0.6	95
Oct	243	0.5	99	0.7	85	0.7	106
Nov	311	0.5	77	0.7	67	0.7	84
Dec	476	0.5	50	0.8	45	0.8	57
Jan-92	733	10.0	606	0.8	29	10.5	512
Feb-92	1044	10.0	426	0.8	21	10.5	360
Mar	1233	10.0	360	0.8	18	10.5	304
Apr	1361	34.7	1134	15.0	315	35.0	917
May	1453	34.7	1063	15.0	295	35.0	859
Jun	1631	34.7	946	15.0	263	35.7	781
Jul	2076	43.5	931	21.0	289	54.3	934
Aug	2370	83.0	1556	21.0	253	88.7	1337
Sep	3067	83.0	1202	21.0	196	88.7	1033
Oct	3647	83.0	1011	21.0	165	88.7	869
Nov	4705	225.0	2126	230.8	1402	230.8	1752
Dec	6008	225.0	1665	230.8	1098	230.8	1372
Jan-93	6578	297.5	2010	230.8	1002	350.0	1900
Feb-93	7249	297.5	1824	230.8	910	350.0	1724
Mar	8801	388.8	1963	230.8	749	397.3	1612
Apr	11000	429.0	1733	230.8	599	438.8	1425
May	12399	429.0	1538	230.8	532	438.8	1264
Jun	13168	429.0	1448	230.8	501	438.8	1190
Jul	13553	352.6	1156	315.0	664	387.0	1020
Aug	13673	352.6	1146	315.0	658	387.0	1011
Sep	14250	352.6	1100	315.0	632	387.0	970
Oct	15289	338.0	983	315.0	589	378.0	883
Nov	16328	338.0	920	315.0	551	378.0	827
Dec	17344	338.0	866	315.0	519	378.0	778

***) Real prices indexed at 1990=100**
****) Actual prices converted to litai before July '93 @ 100 tl-rb = 1 litas**

Source: Lithuanian authorities

Development in Lithuanian Energy Prices 1990-93

	Consumer Price	Crude Oil Import Price Lt/tonne		Gasoline A-76 Lt/litre		Gasoline A-92 Lt/litre	
	Index	Actual**)	Real*)	Actual**)	Real*)	Actual**)	Real*)
Dec-90	100	0.3	100	0.003	100	0.004	100
Jan-91	107	0.7	218	0.004	125	0.005	117
Feb-91	116	0.7	201	0.004	115	0.005	108
Mar	136	0.7	172	0.004	98	0.005	92
Apr	173	0.7	135	0.004	77	0.005	72
May	189	0.7	123	0.004	70	0.005	66
Jun	202	0.7	116	0.004	66	0.005	62
Jul	213	0.7	110	0.004	63	0.005	59
Aug	222	0.7	105	0.004	60	0.005	56
Sep	229	0.7	102	0.004	58	0.005	54
Oct	243	0.7	96	0.004	55	0.005	51
Nov	311	0.7	75	0.004	43	0.005	40
Dec	476	0.7	49	0.004	28	0.005	26
Jan-92	733	13.2	600	0.035	159	0.040	136
Feb-92	1044	30.0	958	0.090	287	0.100	240
Mar	1233	30.0	811	0.090	243	0.100	203
Apr	1361	45.0	1102	0.110	269	0.130	239
May	1453	45.0	1033	0.110	252	0.130	224
Jun	1631	62.0	1267	0.140	286	0.180	276
Jul	2076	75.0	1204	0.190	305	0.230	277
Aug	2370	75.0	1055	0.190	267	0.230	243
Sep	3067	190.5	2070	0.300	326	0.350	285
Oct	3647	190.5	1741	0.300	274	0.350	240
Nov	4705	375.0	2657	0.657	465	0.736	391
Dec	6008	375.0	2081	0.657	365	0.736	306
Jan-93	6578	375.0	1900	0.657	333	0.736	280
Feb-93	7249	375.0	1724	0.657	302	0.736	254
Mar	8801	375.0	1420	0.657	249	0.736	209
Apr	11000	625.0	1894	0.780	236	0.900	205
May	12399	625.0	1680	0.780	210	0.900	181
Jun	13168	625.0	1582	0.880	223	1.010	192
Jul	13553	537.5	1322	0.900	221	1.020	188
Aug	13673	537.5	1310	0.900	219	1.020	186
Sep	14250	537.5	1257	0.900	211	1.020	179
Oct	15289	525.0	1145	0.810	177	0.940	154
Nov	16328	525.0	1072	0.810	165	0.940	144
Dec	17344	525.0	1009	0.810	156	0.940	135

Development in Lithuanian Energy Prices 1990-93

	Consumer Price Index	Diesel Fuel Lt/litre		Residential Heating Oil Lt/tonne		Industrial Heating Oil Lt/tonne	
		Actual**)	Real*)	Actual**)	Real*)	Actual**)	Real*)
Dec-90	100	0.003	100	0.4	100	0.7	100
Jan-91	107	0.004	125	1.3	337	1.3	184
Feb-91	116	0.004	115	1.3	311	1.3	170
Mar	136	0.004	98	1.3	266	1.3	145
Apr	173	0.004	77	1.3	209	1.3	114
May	189	0.004	70	1.3	191	1.3	104
Jun	202	0.004	66	1.3	179	1.3	98
Jul	213	0.004	63	1.3	170	1.3	93
Aug	222	0.004	60	1.3	163	1.3	89
Sep	229	0.004	58	1.3	157	1.3	86
Oct	243	0.004	55	1.3	149	1.3	81
Nov	311	0.004	43	1.3	116	1.3	63
Dec	476	0.004	28	1.3	76	1.3	41
Jan-92	733	0.030	136	4.0	151	18.8	388
Feb-92	1044	0.080	255	4.0	106	41.7	606
Mar	1233	0.080	216	4.0	90	41.7	512
Apr	1361	0.080	196	4.0	81	62.4	695
May	1453	0.080	184	4.0	76	62.4	651
Jun	1631	0.110	225	4.0	68	94.1	874
Jul	2076	0.140	225	8.0	107	128.7	939
Aug	2370	0.140	197	8.0	94	128.7	823
Sep	3067	0.250	272	8.0	72	264.8	1308
Oct	3647	0.250	228	8.0	61	264.8	1100
Nov	4705	0.566	401	60.0	354	532.2	1714
Dec	6008	0.566	314	60.0	277	532.2	1342
Jan-93	6578	0.566	287	60.0	253	532.2	1226
Feb-93	7249	0.566	260	60.0	230	532.2	1112
Mar	8801	0.566	214	60.0	189	532.2	916
Apr	11000	0.700	212	60.0	152	550.0	758
May	12399	0.700	188	60.0	134	550.0	672
Jun	13168	0.940	238	60.0	127	650.0	748
Jul	13553	0.910	224	60.0	123	650.0	727
Aug	13673	0.910	222	60.0	122	650.0	720
Sep	14250	0.910	213	60.0	117	650.0	691
Oct	15289	0.910	198	650.0	1181	650.0	644
Nov	16328	0.910	186	650.0	1106	650.0	603
Dec	17344	0.910	175	650.0	1041	650.0	568

***) Real prices indexed at 1990=100**

****) Actual prices converted to litai before July '93 @ 100 tl-rb = 1 litas**

Source: Lithuanian authorities

Development in Lithuanian Energy Prices 1990-93

	Consumer Price	Coal Import Price Lt/tonne, Yearly Avg.		Residential Coal Lt/tonne		Industrial Coal Lt/tonne	
	Index	Actual**)	Real*)	Actual**)	Real*)	Actual**)	Real*)
Dec-90	100	0.5	100	0.1	100	0.4	100
Jan-91	107	1.0	187	0.4	316	0.7	172
Feb-91	116	1.0	172	0.4	292	0.7	158
Mar	136	1.0	147	0.4	249	0.7	135
Apr	173	1.0	116	0.4	196	0.7	106
May	189	1.0	106	0.4	179	0.7	97
Jun	202	1.0	99	0.4	168	0.7	91
Jul	213	1.0	94	0.4	159	0.7	86
Aug	222	1.0	90	0.4	153	0.7	83
Sep	229	1.0	87	0.4	148	0.7	80
Oct	243	1.0	82	0.4	139	0.7	76
Nov	311	1.0	64	0.4	109	0.7	59
Dec	476	1.0	42	0.8	134	0.7	39
Jan-92	733	45.0	1227	1.7	174	5.7	210
Feb-92	1044	45.0	862	1.7	122	5.9	152
Mar	1233	45.0	730	1.7	104	5.9	129
Apr	1361	45.0	661	1.7	94	25.9	515
May	1453	45.0	620	1.7	88	25.9	482
Jun	1631	45.0	552	1.7	78	25.9	429
Jul	2076	45.0	434	3.3	122	37.6	490
Aug	2370	45.0	380	3.3	107	37.6	429
Sep	3067	45.0	293	3.3	83	38.1	336
Oct	3647	45.0	247	3.3	70	38.1	282
Nov	4705			35.0	572	40.0	230
Dec	6008			35.0	448	40.0	180
Jan-93	6578			35.0	409	43.0	177
Feb-93	7249			35.0	371	43.0	160
Mar	8801			60.0	524	60.0	184
Apr	11000			50.0	350	50.0	123
May	12399			55.0	341	55.0	120
Jun	13168			55.0	321	55.0	113
Jul	13553			55.0	312	55.0	110
Aug	13673			55.0	309	55.0	109
Sep	14250			55.0	297	55.0	104
Oct	15289			100.0	503	100.0	177
Nov	16328			100.0	471	100.0	166
Dec	17344			100.0	444	100.0	156

Development in Lithuanian Energy Prices 1990-93

	Consumer Price Index	Residential Electricity Lt/MWh		Industrial Electricity Lt/MWh		LSPS Residential Heat Lt/Gcal	
		Actual**)	Real*)	Actual**)	Real*)	Actual**)	Real*)
Dec-90	100	0.4	100	0.3	100	0.03	100
Jan-91	107	0.50	117	0.50	156	0.03	93
Feb-91	116	0.50	108	0.50	144	0.03	86
Mar	136	0.50	92	0.50	123	0.03	74
Apr	173	0.50	72	0.50	97	0.08	174
May	189	0.50	66	0.50	88	0.08	159
Jun	202	0.50	62	0.50	83	0.08	149
Jul	213	0.50	59	0.50	78	0.08	141
Aug	222	0.50	56	0.50	75	0.08	135
Sep	229	0.50	54	0.50	73	0.08	131
Oct	243	0.60	62	0.70	96	0.12	197
Nov	311	0.60	48	0.80	86	0.12	155
Dec	476	0.60	32	0.90	63	0.12	101
Jan-92	733	3.50	119	4.00	182	0.48	262
Feb-92	1044	3.50	84	5.30	169	0.48	184
Mar	1233	3.50	71	5.30	143	0.48	156
Apr	1361	5.00	92	14.00	343	0.48	141
May	1453	5.00	86	14.00	321	0.48	132
Jun	1631	5.00	77	14.00	286	0.48	118
Jul	2076	7.00	84	20.00	321	1.00	193
Aug	2370	7.00	74	20.00	281	1.00	169
Sep	3067	35.00	285	35.00	380	1.00	130
Oct	3647	35.00	240	35.00	320	1.00	110
Nov	4705	54.00	287	58.00	411	3.00	255
Dec	6008	54.00	225	58.00	322	3.00	200
Jan-93	6578	54.00	205	58.00	294	3.00	182
Feb-93	7249	54.00	186	58.00	267	3.00	166
Mar	8801	54.00	153	58.00	220	3.00	136
Apr	11000	65.00	148	65.00	197	3.00	109
May	12399	80.00	161	80.00	215	15.08	486
Jun	13168	80.00	152	80.00	203	15.08	458
Jul	13553	80.00	148	80.00	197	15.08	445
Aug	13673	80.00	146	80.00	195	15.08	441
Sep	14250	80.00	140	80.00	187	15.08	423
Oct	15289	80.00	131	80.00	174	18.56	486
Nov	16328	80.00	122	80.00	163	18.56	455
Dec	17344	80.00	115	80.00	154	18.56	428

*) Real prices indexed at 1990=100 — Source: Lithuanian authorities
**) Actual prices converted to litai before July '93 @ 100 tl-rb = 1 litas

Development in Lithuanian Energy Prices 1990-93

	Consumer Price	Siluma Residential Heat Lt/Gcal		LSPS Industrial Heat Lt/Gcal		Siluma Industrial Heat Lt/Gcal	
	Index	Actual**)	Real*)	Actual**)	Real*)	Actual**)	Real*)
Dec-90	100	0.05	100	0.12	100	0.18	100
Jan-91	107	0.05	93	0.2	187	0.6	298
Feb-91	116	0.05	86	0.2	172	0.6	275
Mar	136	0.05	74	0.2	147	0.6	235
Apr	173	0.08	80	0.3	156	0.3	99
May	189	0.08	73	0.3	142	0.3	90
Jun	202	0.08	69	0.3	134	0.3	84
Jul	213	0.08	65	0.3	127	0.3	80
Aug	222	0.08	63	0.3	122	0.3	77
Sep	229	0.08	61	0.3	118	0.3	74
Oct	243	0.12	91	0.5	186	0.5	117
Nov	311	0.12	72	0.5	150	0.5	95
Dec	476	0.12	47	0.6	108	0.6	68
Jan-92	733	0.48	121	2.1	249	3.6	269
Feb-92	1044	0.48	85	3.1	261	5.0	264
Mar	1233	0.48	72	7.4	518	5.0	224
Apr	1361	0.48	65	7.4	470	9.6	387
May	1453	0.48	61	7.4	440	9.6	363
Jun	1631	0.48	54	7.4	392	9.6	323
Jul	2076	1.00	89	17.0	712	52.2	1382
Aug	2370	1.00	78	18.8	690	52.2	1210
Sep	3067	1.00	60	18.8	533	52.2	935
Oct	3647	1.00	51	18.8	448	52.2	786
Nov	4705	3.00	118	85.0	1571	85.0	993
Dec	6008	3.00	92	85.0	1230	85.0	777
Jan-93	6578	3.00	84	88.0	1163	88.0	735
Feb-93	7249	3.00	77	88.0	1056	88.0	667
Mar	8801	3.00	63	88.0	869	88.0	549
Apr	11000	3.00	51	75.4	596	75.4	377
May	12399	15.08	225	75.4	529	75.4	334
Jun	13168	15.08	212	75.4	498	75.4	315
Jul	13553	15.08	206	75.4	484	75.4	306
Aug	13673	15.08	204	75.4	480	75.4	303
Sep	14250	15.08	196	75.4	460	75.4	291
Oct	15289	18.56	225	75.4	429	75.4	271
Nov	16328	18.56	210	75.4	402	75.4	254
Dec	17344	18.56	198	75.4	378	75.4	239

LITHUANIA

Energy Sector Review

Restructuring Plan of Action for Lithuania State Power System

REFORM OF THE LEGAL AND REGULATORY FRAMEWORK (RLR) AND RESTRUCTURING AND PRIVATIZATION OF ENTERPRISES (RPE)

PHASE I

1. RLR: The Government of Lithuania (GoL) issues its Energy Policy and Strategy Statement which sets a general framework for the sector (April 1994).

   RPE: Actions are taken to separate LSPS from the Government and allow LSPS to carry out its activities under commercial law, including direct borrowing in capital market, and be able to implement all the steps included in the RPE part of the Action Plan (July 1, 1994).

2. RLR: Based on the recommendations of the Energy Pricing Council (EPC), sector tariffs are established on economical basis, except heat energy tariffs for households; the last one will be subsidized from other sources (May 1, 1994).

   RPE: Sector service units or companies will sign medium-term contracts with LSPS or its units (July 1, 1995).

PHASE II

3. RLR: The Ministry of Energy (MoE), with technical assistance, prepares a draft Electricity Law (July 1, 1995).

   RPE: LSPS, with technical assistance, prepares a program for the transfer of district heating systems to district, municipal, and/or private ownership (July 1, 1995).

4. RLR: EPC sets economically-based tariffs for electricity and heat for all customers (after at least three years).

   RPE: LSPS will perform the best efforts to transfers district heating systems to districts or municipalities or to private investors.

PHASE III

5. RLR: MoE and EPC set electricity distribution regulations (July 1, 1996).

   RPE: LSPS creates electricity distribution utilities (EDUs) and sets a single cost center for transmission facilities and the national dispatch center (July 1, 1996).

6. RPE: LSPS starts to sell its shares.

PHASE IV

7. RLR: EPC will show the best efforts to establish transmission toll system.

   RPE: LSPS will show the best efforts to create National Electricity Transmission Company (NETC).

8. RLR: MoE and EPC will show the best efforts to set regulations for open transmission access, cogeneration and independent power producers (IPPs). MoE and EPC will show the best efforts to open electricity trade for major consumers to open competition.

   RPE: NETC will show the best efforts to open access to all interested parties and EDUs sign purchase contracts with cogenerators and IPPs.

9. RLR: EPC approves generation tariffs on the basis of marginal costs. EPC sets anti-trust regulations for the sector.

PHASE V

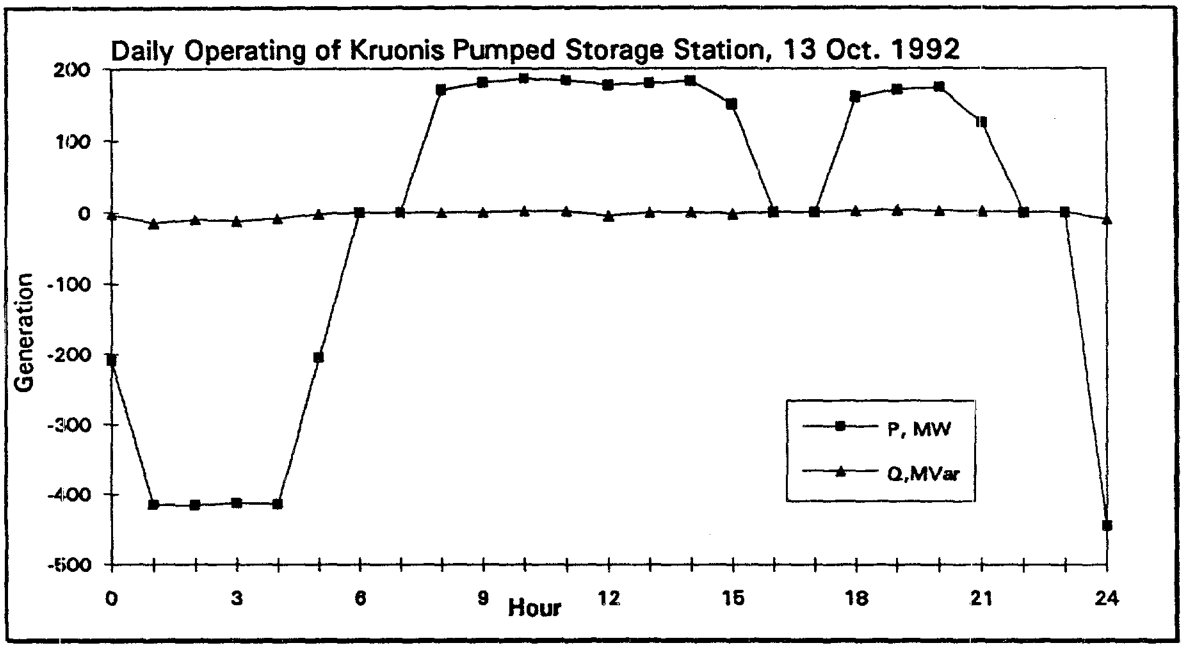
10. RLR: EPC will seek to open electricity generation to competition and sets electricity tariffs for regulated consumers on the basis of marginal costs as reflected by market forces.

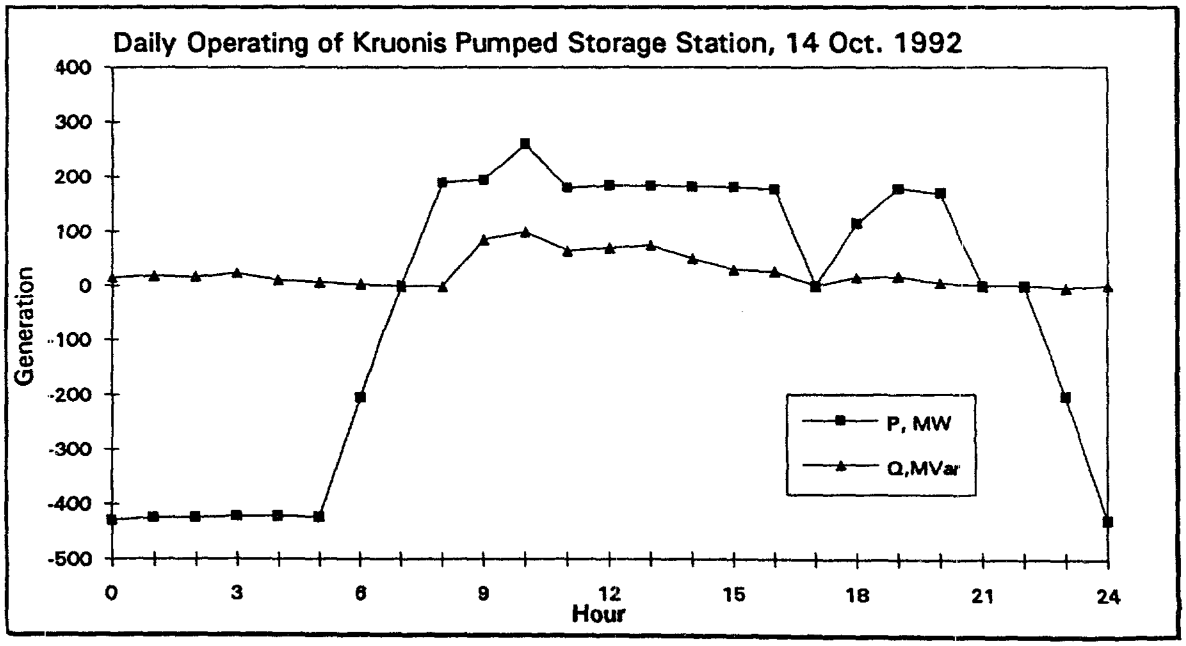
    RPE: LSPS sells some of Generation Stations to the private sector.

Minister of Energy A. Stasiukynas

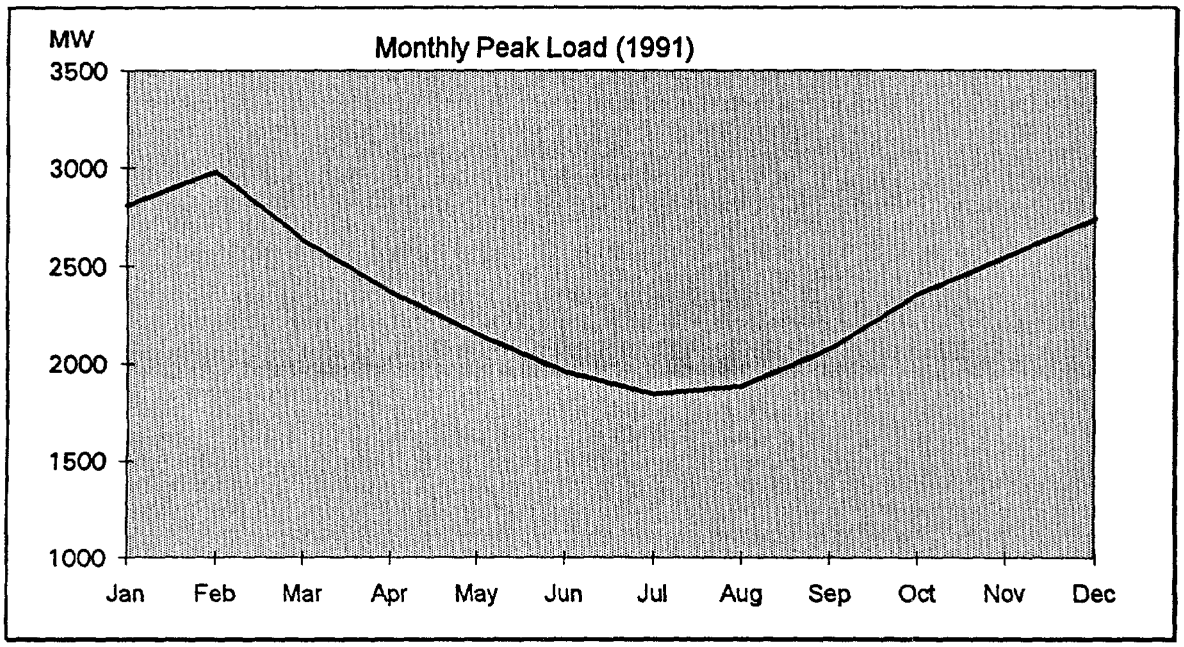
(Received on March 31, 1994 form Vilnius and negotiated during April 18-22, 1994 in Washington.)

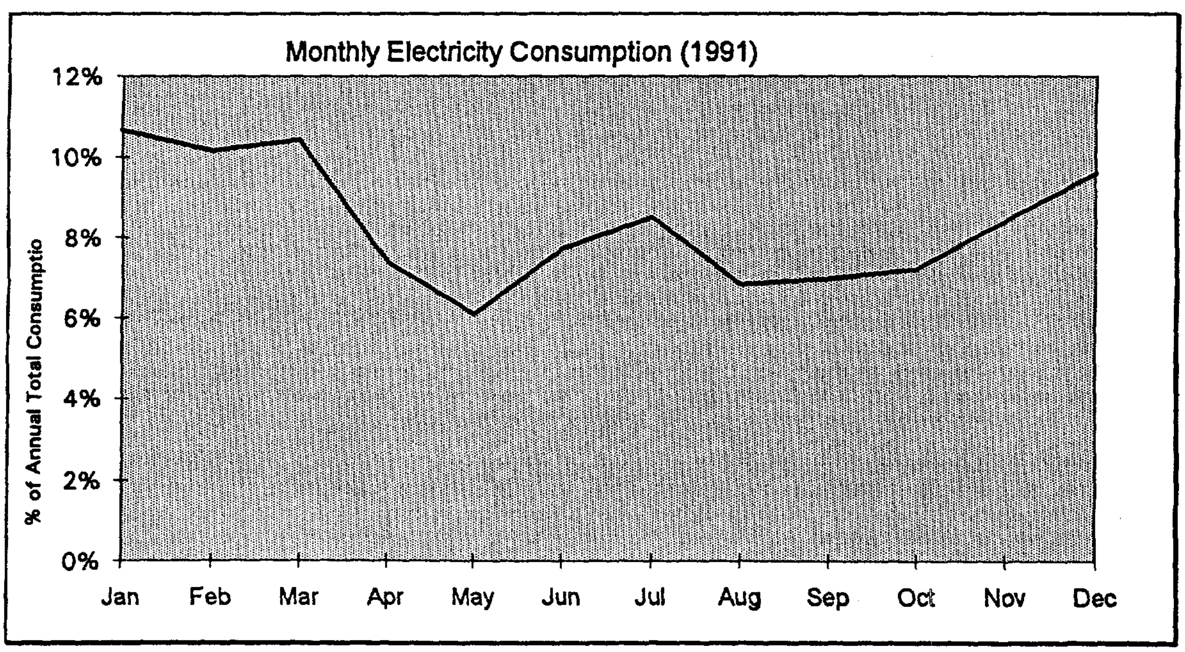
Kruonis Pumped Storage Power Station Data
(2 x 200 MW units operational in October 1992)



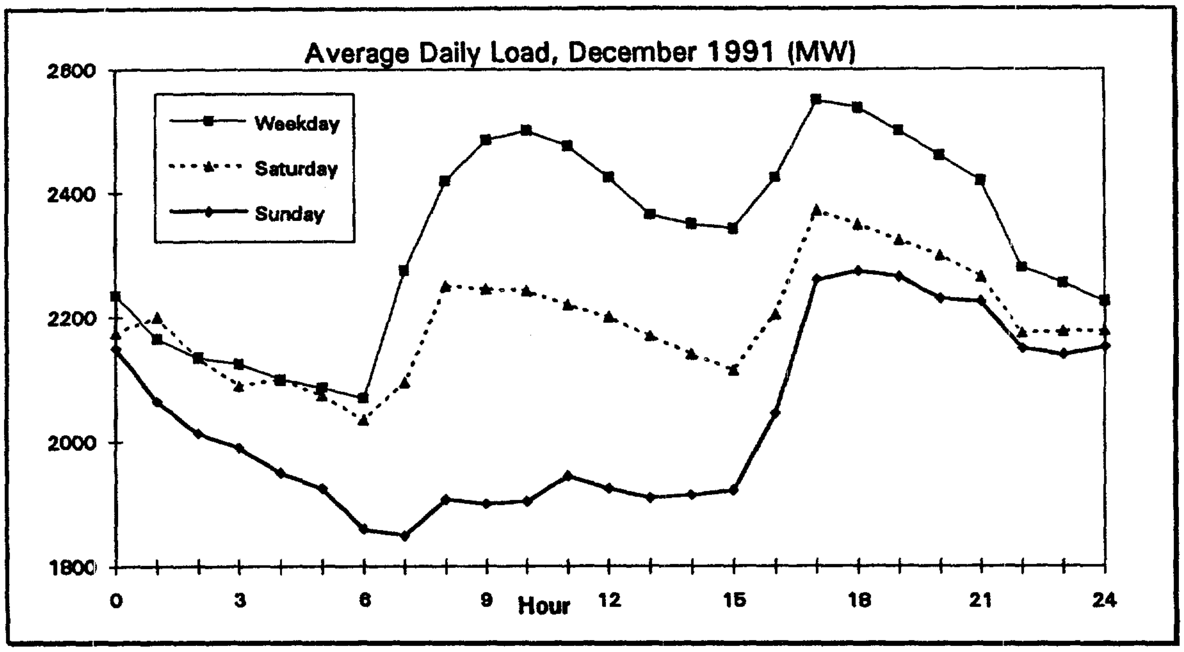


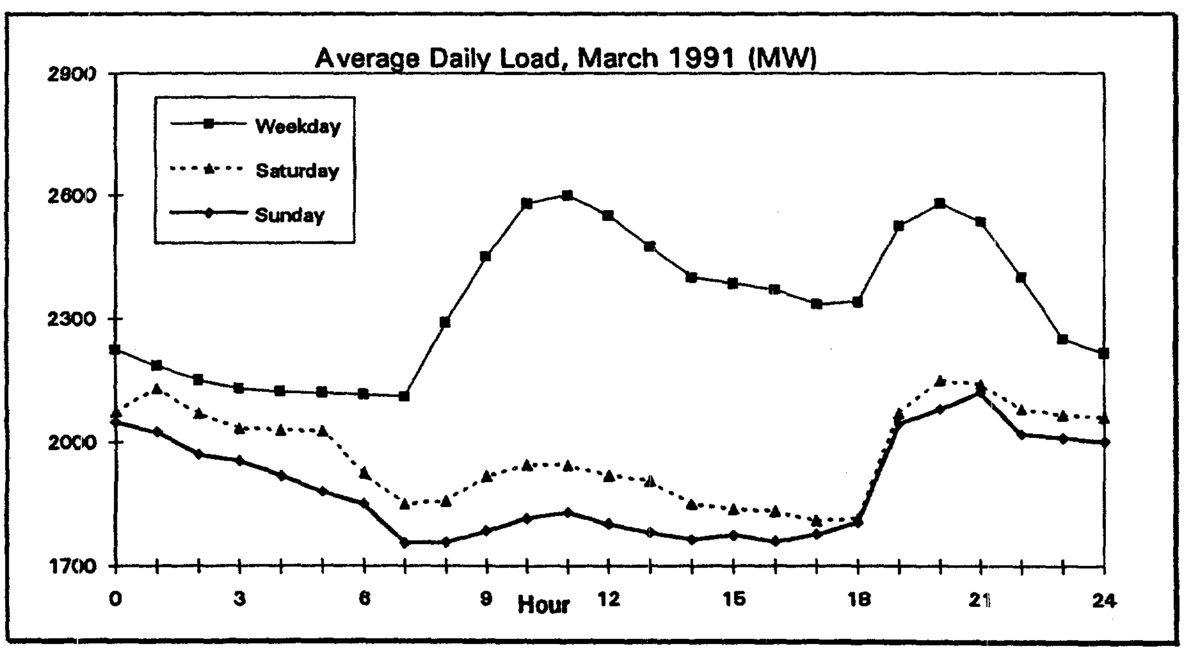
Seasonal Consumption Patterns and Monthly Peak Demand

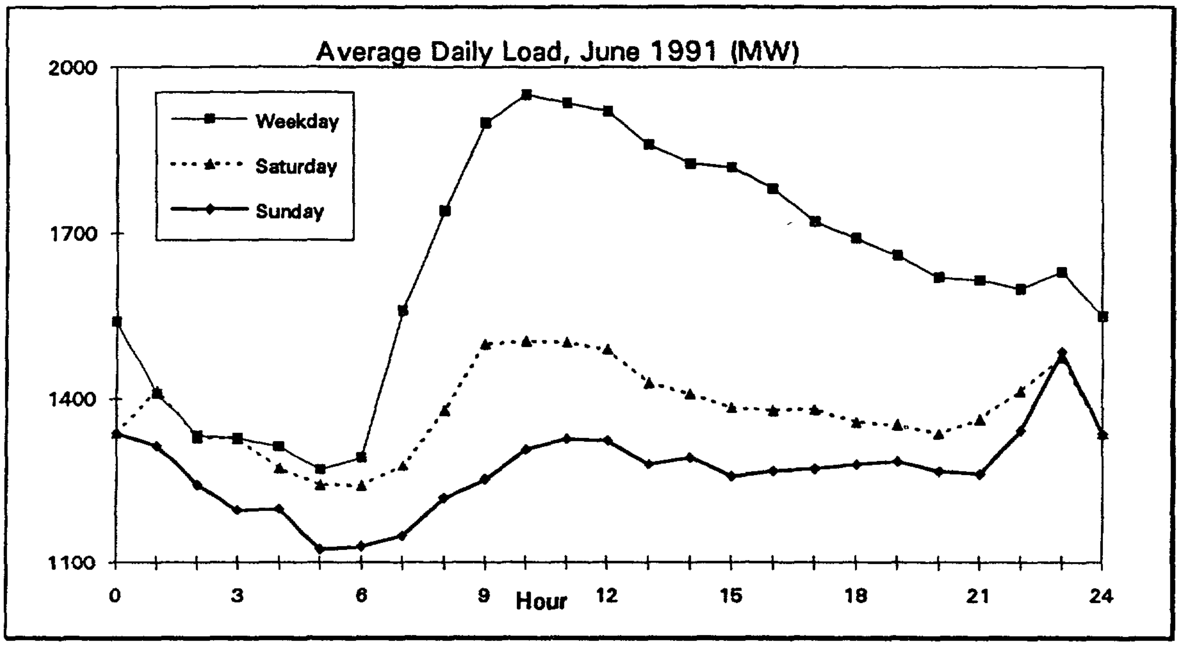


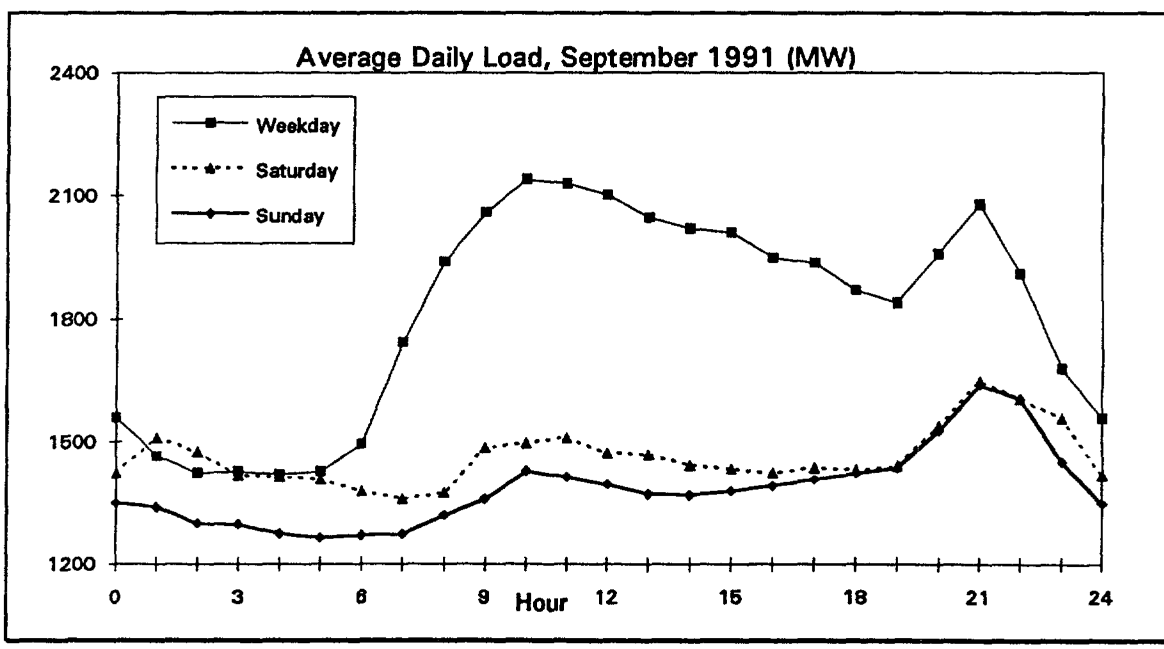


Daily System Load Profiles






Average Daily Load, June 1991 (MW)
2000
1700
1400
1100
Weekday
Saturday
Sunday
0
3
6
9
Hour
12
15
18
21
24


Average Daily Load, September 1991 (MW)
2400
2100
1800
1500
1200
Weekday
Saturday
Sunday
0
3
6
9
Hour
12
15
18
21
24

Key Data on the Transmission System

330-kV Lines In Lithuania

LINE NO	LOCATION	CONDUCTORS	LINE LENGTH IN LITHUANIA KM	THERMAL CAP, A	THERMAL CAP, MW
325	**KLAIPEDA - KALININGRAD**	ACO-2x300	92.6	1335	762
324	**KLAIPEDA - LATVIA**	ACO-2x300	53.8	1380	788
327	JURBARKAS - KAUNAS	ACO-2x300	86.2	1380	788
326	**JURBARKAS - KALININGRAD**	ACO-2x300	45.8	1380	788
306	SIAULIAI - KAUNAS	AC-2x400	134.4	1670	953
305	**SIAULIAI - LATVIA**	AC-2x300	59.9	1380	788
328	KAUNAS - KRUONIS	ACO-2x400	28.2	1650	942
329	KAUNAS - KRUONIS	ACO-2x400	28.2	1650	942
330	ALYTUS - LIETUVOS	ACO-2x300	60.7	1380	788
368	**ALYTUS - BELARUS**	ACO-2x300	59	1380	788
307	KRUONIS - LIETUVOS	ACO-2x400	29.6	1650	942
308	KRUONIS - LIETUVOS	ACO-2x400	29.6	1650	942
447	**KRUONIS - KALININGRAD**	ACO-2x300	142	1460	834
317	JONAVA - PANEVEZYS	ACO-2x300	80.2	1380	788
318	JONAVA - LIETUVOS	ACO-2x300	69.4	1380	788
316	**PANEVEZYS - LATVIA**	ACO-2x300	83	1380	788
455	PANEVEZYS - UTENA	ACO-2x400	100	1650	942
453	UTENA - IGNALINA	ACO-2x400	64.5	1650	942
456/454	NERIS - IGNALINA	AC-2x400	151.5	1650	942
331	NERIS - LIETUVOS	ACO-2x500	63.8	1890	1079
332	VILNIUS - LIETUVOS	ACO-2x300	40.9	1380	788
333	**VILNIUS - BELARUS**	ACO-2x300	34.1	1380	788
451	**IGNALINA - LATVIA**	AC-2x400	28	1650	942
450	**IGNALINA - BELARUS**	AC-2x500	0	1650	942
452	**IGNALINA - BELARUS**	AC-2x400	0	1650	942
705	**IGNALINA - BELARUS**	AC-5x300	0	1420	811
	TOTAL		1565.4		22525

Note: Bold lettering denotes interconnections to neighboring countries.

Power Stations Connected to the 11-kV System

Station	Generating Capacity (MW)
MAZEIKIU 1	80
MAZEIKIU 2	60
MAZEIKIU 3	80
KL. VRE 1	3.8
KL. VRE 2	7
TAIKA	12
PETRASIUNU	12
NEVEZIS 1	4
NEVEZIS 2	6
KAUNO HE 1	25
KAUNO HE 2	25
KAUNO HE 3	25
KAUNO HE 4	25
KAUNO TE 1	60
KAUNO TE 2	100
AZOTAS 1	6
AZOTAS 2	6
AZOTAS 3	12
VILNIAUS TE-3 1	180
VILNIAUS TE-3 2	180
GRIGISKES 1	2.5
GRIGISKES 2	2.5
VILNIAUS TE-2 1	12
VILNIAUS TE-2 2	12
TOTAL CAP	938

330-kV TRANSFORMERS and
330-kV POWER PLANT SWITCHGEAR

NAME	Transformer Capacity (MW)	Substation Capacity (MW)
KLAIPEDA 1	200	
KLAIPEDA 2	125	325
JURBARKAS 1	125	
JURBARKAS 2	125	250
SIAULIAI 1	200	
SIAULIAI 2	200	400
KAUNAS 1	120	
KAUNAS 2	120	240
ALYTUS 1	125	
ALYTUS 2	125	250
KRUONIS	200	200
LIETUVOS	0	
JONAVA 1	200	
JONAVA 2	200	400
PANEVEZYS 1	125	
PANEVEZYS 2	125	
PANEVEZYS 3	200	450
UTENA	200	200
NERIS 1	200	
NERIS 2	200	400
VILNIUS 1	125	
VILNIUS 2	125	250
IGNALINOS 1	200	
IGNALINOS 2	200	400
TOTAL	3765	3765

330-kV BREAKER TYPES AND RATING

STATION	TYPE	NUMB.	MAN. COUNTRY	MAN. YEAR	RATED SHORTCIRCUIT CURRENT kA	ACTUAL SH.CIRC. CURR. kA	ACTUAL EARTHF. CURR. kA
VILNIUS	VVN-330-15	3	RUSSIA	1964-67	20	14.7	11.6
NERIS	VV-330-20	4	RUSSIA	1973-85	20	12.7	10
KAUNAS	VVN-330-15/20	8	RUSSIA	1963-72	30	18.3	14.7
JURBARKAS	VV-330-31,5/2000	4	RUSSIA	1986-87	31.5	8.1	7
JONAVA	VVN-330-15/20	4	RUSSIA	1985-89	15,0/20,0	11.9	10
KLAIPEDA	VV-330-20	4	RUSSIA	1971-77	20	6.1	5.7
SIAULIAI	VVN-330-15	3	1962-65	15	8.8	7.4	
PANEVEZYS	VV-330-20	6	RUSSIA	1970-83	20	11.5	9.6
ALYTUS		4					
UTENA		3					
KRUONIS		8					
LIETUVOS		20					
IGNALINOS		17			50		
	TOTAL	88					

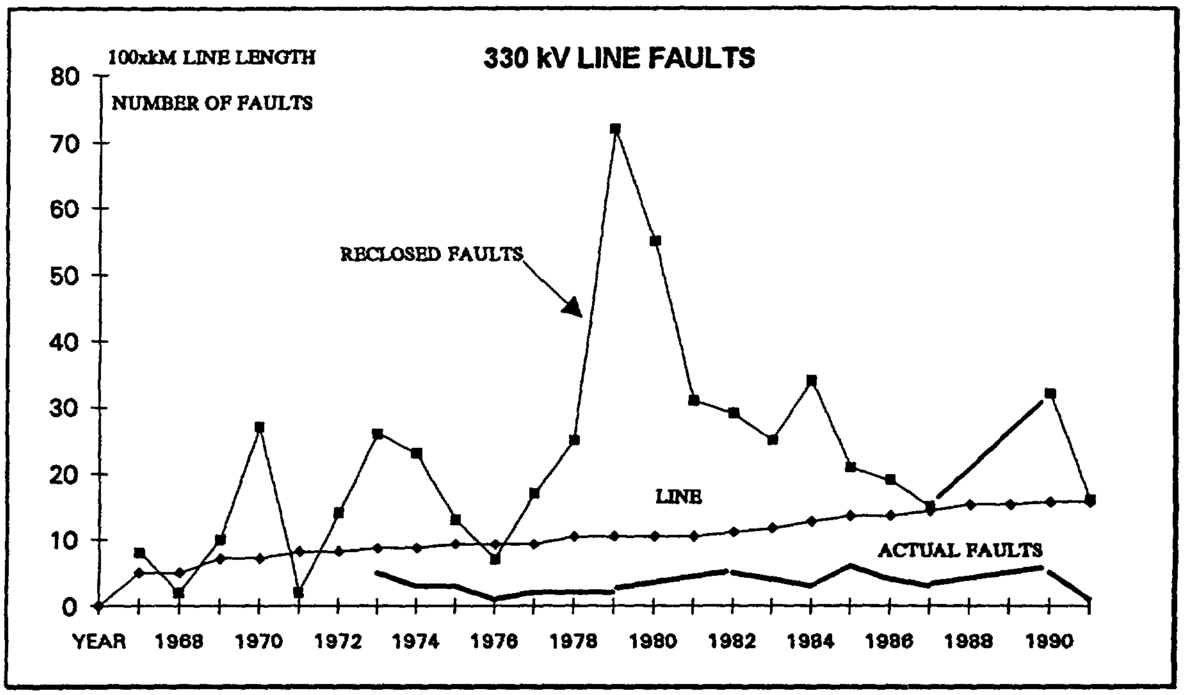
110-kV BREAKER TYPES AND RATING

STATION	TYPE	NUMB.	MAN. COUNTRY	MAN. YEAR	RATED SHORTCIRCUIT CURRENT kA	ACTUAL SH.CIRC. CURR. kA	ACTUAL EARTHF. CURR. kA
VILNIUS	VVN-110/6--31,5	17	RUSSIA	1969-88	31.5	25.3	25.5
NERIS	VVN-110-31,5	11	RUSSIA	1973-78	31.5	22.1	22.9
KAUNAS	VVN-110-6	16	RUSSIA	1965-74	31.5	27.4	29.8
JURBARKAS	HLD-145/125DC,SF6	7	SWEDEN	1977	25	9.2	10.1
JURBARKAS	MMD-110/20--31,5	6	BULGARIA	1985-86	20/31,5	9.2	10.1
JURBARKAS	VMT-110-25/1250	2	RUSSIA	1988	25	9.2	10.1
JONAVA	y-110-2000-50	8	RUSSIA	1975-78	50	20.9	22.6
JONAVA	HLR-145/2500	6	SWEDEN	1977	40	20.9	22.6
JONAVA	MMD-110/1600-31,5	1	BULGARIA	1987	31.5	20.9	22.6
KLAIPEDA	VVN-110-6/--/31,5	16	RUSSIA	1971-74	31.5	12.8	13.9
SIAULIAI	VVGM-110-31,5	13	RUSSIA	1974-76	31.5	15.3	6.4
PANEVEZYS	VVN-110/6--31,5	21	RUSSIA	1968-88	31.5	16.2	17.6
ALYTUS		13					
UTENA		8					
KRUONIS		10					
LIETUVOS		0					
IGNALINOS		17					
	TOTAL	172					

Transmission System Loading Development

	MAX POW. MW	ENERGY/Y GWh	UTILIZATION TIME h	LOAD FACTOR	LOSSES %
YEAR 1991					
330/110 kV TR CAP	3765				
330/110 kV TR LOAD	2692	11.55	4290	0.71	
110 kV GEN. CAP	938				
110 kV GEN. PROD.	444	3.60		0.47	
110 kV SYST LOAD	3136	13.45	4290		
NETWORK LOSSES		1.69			11.16
GENERATING STNS					8.8
YEAR 1995					
330/110 kV TR CAP	3765				
330/110 kV TR LOAD	1832	6.75	3683	0.49	
110 kV GEN. CAP	938				
110 kV GEN. PROD	368	2.37			
110 kV SYST LOAD	2200	8.10	3683		
NETWORK LOSSES		1.02			11.16
GENERATING STNS					8.80
YEAR 2000					
330/110 kV TR CAP	3765				
330/110 kV TR LOAD	1922	8.13	4227	0.51	
110 kV GEN. CAP	938				
110 kV GEN. PROD	378	2.82			
110 kV SYST LOAD	2300	9.72	4227		
NETWORK LOSSES		1.22			11.16
GENERATING STNS					8.80

Note: [ ] indicates input data values as given by the country representatives. Other data is calculated.


330 kV LINE FAULTS
100xkM LINE LENGTH
NUMBER OF FAULTS
80
70
60
50
40
30
20
10
0
RECLOSED FAULTS
LINE
ACTUAL FAULTS
YEAR
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990

LITHUANIA

Energy Sector Review

Current Dispatching System

A. Overview of Architecture

1. The current dispatch system consists of a four level hierarchy. The Dispatch Center (DC) at Riga is the highest level and is responsible for coordinating the energy balance of Lithuania, Latvia and Estonia and for energy exports and imports to Kaliningrad (Russia) and Belarus.

2. The second level of the hierarchy is the Dispatch Center at Vilnius which is responsible for the operation of the 330-kV and some of the 110-kV network as well as the generation schedules and system security. All decisions affecting the operation of the interconnection are coordinated with DC Riga.

3. One of the important coordination functions is the scheduling of the next day's generation. Based on the demand forecasted by DC Vilnius, DC Riga develops a hourly generation schedule for every generating plant specified as being available in Lithuania. This schedule is sent DC Vilnius and is the generation schedule that is followed on the next day.

4. The third level consists of seven enterprise dispatch centers which are responsible for the actual operation of the 330-kV and 110-kV networks. The fourth level consist of district dispatch centers (approximately 50) responsible for the 35-kV and 10-kV systems.

5. At present all 330-kV substations and the critical 110-kV substations are manned. Switching at these stations is done manually - no remote supervisory capability exists and is not considered necessary. However, there is the ability to remotely control some of the 10 and 35-kV devices.

6. The real and reactive power flows on all 330-kV and 110-kV lines are monitored as are the voltage magnitudes. For the lower voltage network, mostly the status of switching devices is monitored; there are only a few flow and voltage measurements.

B. Vilnius Center

7. The DC at Vilnius consists of dual redundant (primary and backup) EC 1010 computers manufactured in Hungary. The data acquisition front ends are RPT-80s also built in Hungary. The RPT 80 are also used at Riga and at the enterprise centers and can exchange data directly with each other. Also available are EC 1045 computers which are used for the more computationally demanding applications.

8. Color CRTs are used for man machine interface and are located within the control room and at several remote locations. There is a very large map board (also called mimic board, and wall board) that displays the entire Lithuanian 110-kV and 330-kV system. The map board dynamically shows the status of the circuit breakers and via digital displays shows the line flows and generation. The mapboard driver is independent of the main control computers and in the event of the failure of both computers would continue to show the current status of the system. Digital displays also show system frequency, total demand, and system time.

9. DC Vilnius has no responsibility for frequency or interchange regulation.

10. A new PC based system is being developed to replace the existing system and portions of this have been implemented. A LAN based PC network being the ultimate goal.

C. Communication System

11. An extension communication system exists to support the dispatching, monitoring, and control functions. This includes a private telephone system with automatic dialing, a power line carrier system and a small amount of radio. The data acquisition system is limited to 200 baud because of modem and other limitations. Data is obtained on a 15 second basis.

Remote Terminal Equipment

12. A large number of remote terminal units of several types, all of Russian manufacture are used in the system. Of all of these, the MKT-s is used extensively in the high voltage network and at generating plants. These are quite old as evidenced by the fact that they use discrete transistors and not integrated circuits and microprocessors. Originally, a pair was needed for each link one in the field and one at the dispatch center. The MKT-2's are relatively large and would have required the installation of about 60 units at the DC Vilnius. However, the RPT 80 can handle multiple MKT-2's and have therefore been used since about 1985 at the Dispatch Center.

Assessment

13. Almost all of the equipment is obsolete and in some cases lacking in critical functions. The communication system is low speed compared to most modern systems which use 1200 or 2400 baud links. The MKT-2's are no longer manufactured and the data are of poor accuracy.

14. There is no ability for frequency and interchange regulation. Frequency is still regulated by Russia and exports are essentially whatever they happen to be. No attempt is made to regulate net interchange. While under the current operation, this is not a deficiency, in the future this is likely to become a requirement as it is in all UCPTE and North America interconnections.

15. Network Security assessment is limited. In the old system, there was state estimation capability and this is now being ported to the new PC system. However, the PC's are under powered, there is only one 386 system, the rest are 286's. This will limit the ability to run contingency cases.

16. There is no generation optimization function. This is perhaps not needed at present given the low demand which is essentially being satisfied via Ignalina (in January 1993 almost 90% of the total energy was supplied by Ignalina). Nevertheless, in the future the possibility of having such functions as well as hourly demand forecasting should be considered. This would be particularly valuable if economy energy transactions become a reality in the IPS and Baltic Interconnections.

17. There is a need for the capability for training dispatchers. A dispatcher training simulator would be very useful. It could also provide training in system restoration which is difficult to do by other means.

18. There appears to be a substantial amount of manual work that could be easily automated. For example, the generation schedule for DC Riga is sent via telex and has to be entered into the dispatch computer by hand. The actual interchange data is sent every five days by DC Riga via FAX and could be easily sent via computer-computer link and hopefully on a more frequent basis i.e., daily.

19. The generating units within Lithuania cannot be controlled from the dispatch center because they lack the interfacing equipment at the plant. This would have to be added.

20. While it may be argued, perhaps with some justification, that, under the current operating philosophy, there is not an urgent need for correcting these deficiencies, they represent a serious impediment to operating the Lithuanian system at the highest level of efficiency. It should also be recognized, that as an interconnected system, all members of the interconnection (Lithuania, Latvia, IPS, Belarus) must agree to certain operating and control standards, no one member can unilaterally adhere to different standards.

21. One option that should be seriously explored is the formation of a strong Power Pool consisting of Lithuania, Latvia, Estonia and perhaps Belarus similar to pools in the US such as PJM, MAPP, NEPEX, etc. This would formalize the current procedures as well as other possible interconnection partners. The pool could optimize the total pools resources and enter into various energy transactions with the neighbors. The members of the pool would remain in control of their systems but would adhere to the pool requirements for optimal operation. The pool structure can provide for optimal operation without infringing on the rights of the members to have physical control of their generation and transmission.

District Heating Systems in Lithuania

(Annual heat production calculated with a load duration factor of 3,500 hours)

	Energy Saving TJ/year	Investment US $ million	Capacity MJ/s	Demand MJ/s	Demand Forecast MJ/s	Substations Number	Production Annual TJ
Vilnius							
Vilnius City	7,491	295	2,474	1,859	1,487	6,135	23,423
Elektrenai	354	13	130	46	37	152	580
Kaunas							
Kaunas City	3,144	151	957	1,003	802	3,310	12,638
Jonava City	623	25	81	81	65	267	1,021
Panevezys							
Panevezys City	3,014	84	522	392	314	1,294	4,939
Utena City	961	29	197	125	100	413	1,575
Rokiskis City	415	13	81	54	43	178	600
Kedainiai City	631	16	93	82	66	271	1,033
Alytus							
Alytus City	2,553	67	348	332	266	1,095	4,183
Marijampole City	1,361	38	197	177	142	581	2,230
Druskininkai City	707	24	81	92	74	304	1,159
Varena City	361	14	46	47	38	155	592
Siauliai							
Siauliai City	3,014	85	615	392	311	1,294	4,939
Radviliskis City	346	13	41	45	36	149	567
Mazeikiai City	1,207	32	681	157	126	518	1,978
Klaipeda							
Klaipeda City	3,805	112	774	558	446	1,841	7,031
Tauraga City	308	12	46	40	32	132	504
Palanga City	346	12	81	45	36	149	567
SILUMA	2,794	231	1,149	924	739	3,049	11,642
TOTAL	33,435	1,266	8,594	6,451	5,160	21,287	81,201

Siluma District Heating Systems

(Annual heat production is calculated with a load duration factor of 3,000 hours)

SILUMA	PLANTS	BOILERS	PRODUCTION CAPACITY MJ/s	CAPACITY DEMAND MJ/s	TOTAL PIPE LENGTH km	ANNUAL PRODUCTION TJ
Birstonas City	1	3	26.40	21.10	14.40	228
Palanga City	13	49	44.00	26.00	19.80	281
Neringa City	3	12	14.80	13.00	9.10	140
Birzai Region	2	7	68.60	44.40	22.60	480
Ignalina Region	4	23	29.20	15.30	19.30	165
Joniskis Region	5	26	32.00	22.20	14.20	240
Jurbarkas Region	1	5	55.30	39.40	9.60	426
Kaisiadorys Region	2	8	49.20	47.20	21.20	510
Kelme Region	5	25	25.90	20.30	11.30	219
Klaipeda Region	3	10	39.50	35.00	22.60	378
Kretinga Region	4	15	23.90	27.00	13.50	292
Kupiskis Region	1	6	8.00	1.40	25.30	15
Lazdijai Region	4	9	36.30	22.50	11.30	243
Moletai Region	4	9	39.40	20.60	16.30	222
Pakruojis Region	6	17	25.30	21.30	13.50	230
Pasvalys Region	5	21	12.30	17.60	16.40	190
Plunge Region	3	10	56.40	48.00	22.80	518
Prienai Region	10	35	48.40	32.20	14.60	348
Raseiniai Region	5	19	36.00	18.10	18.80	195
Skuodas Region	5	28	27.60	18.00	11.00	194
Sakiai Region	2	11	23.40	15.10	10.30	163
Salcininkai Region	3	12	41.90	33.40	28.20	361
Siauliai Region	3	11	17.20	10.80	5.60	117
Silale Region	4	14	26.30	19.30	20.30	208
Silute Region	1	3	49.60	56.40	30.70	609
Sirvintos Region	3	15	30.90	34.80	16.00	376
Svencionys Region	3	12	18.60	27.00	17.50	292
Telsiai Region	4	17	56.70	54.60	28.30	306
Traksi Region	4	8	50.50	52.10	25.30	563
Ukmerge Region	4	16	50.60	42.30	46.20	457
Vilkaviskis Region	3	15	40.30	36.10	18.50	390
Vilnius Region	4	13	14.50	6.70	5.70	72
Zarasai Region	3	16	30.00	24.50	15.80	265
TOTAL	127	500	1149.00	923.70	596.00	9,693

Heat Production in LSPS District Heating Systems

City Heat Plant Name	Water Production Annual TJ	Steam Production Annual TJ	People Supplied Number	Square Meters Supplied	Industries Supplied Number
Vilnius District Heating	21,876	1,730	585,000	8,776,516	201
Kaunas DH	13,442	4,722	346,000	5,195,048	200
Klaipeda DH	7,140	1,689	242,000	3,624,915	71
Siauliai DH	6,251	5,853	210,000	3,145,312	56
Panevezys DH	6,662	2,510	222,000	3,325,341	115
Alytus DH	6,335	3,440	130,000	1,950,209	101
TOTAL	61,706	19,944	1,735,000	26,017,341	744

LITHUANIA

Energy Sector Review

Proposed District Heating Project

A. Vilnius and Alytus District Heating Systems

1. The district heating (DH) systems in Vilnius and Alytus are typical of DH systems in Lithuania, with high production costs, high heat losses in distribution and lack of control equipment in substations.

2. The total investments are expected to be US$ 30 million, of which US$ 8 million will be in local currency. The investment is likely to include the following components:

   New boilers or conversion of boilers
   Water treatment equipment
   Preinsulated pipes
   Temperature regulating valves
   Pressure differential valves

3. The present annual heat production in Vilnius and Alytus is about 27 PJ, which requires annual fuel expenditures of about US$ 80 million. This imposes a heavy burden on the balance of payments of the country, since all the primary fuel has to be imported. The rehabilitation of the DH systems would bring about considerable energy savings, perhaps up to 5-30 % of present fuel consumption and would improve the economic performance of the systems considerably.

4. The total investment required to modernize fully the DH systems in Vilnius and Alytus is estimated to be about US$ 350 million. For the proposed project, however, the most necessary and economically justifiable items had to be selected.

5. A Master Plan Study for the DH systems of Lithuania as a whole and for the DH systems of Vilnius and Alytus specifically was prepared by the Danish Energy Consultants (DEC) in 1993, under financing from the Danish grant aid Agency, to identify the most urgently needed and viable projects and to elaborate a plan for future investments. This study has provided important input into the development of the World Bank's DH component in the proposed second energy project.

B. Boiler Conversion/Utilization of Indigenous Fuels

6. Almost all the heat supplied to Lithuanian DH systems is produced in heat-only-boilers (HOB), fueled with heavy fuel oil (HFO) or natural gas. These fuels have to be imported, and their prices have largely reached world market levels.

7. The most obvious indigenous fuel in Lithuania is wood, which is available in large quantities throughout the country. Because wood is one of the major resources in Lithuania, covering about 33% of the country's territory, its production is expected to increase considerably in the next ten years reaching productivity levels comparable to those of some western countries with a

substantial wood production industry. The following table summarizes the wood production volumes in 1993 and future years:

		1993	1994-2003	2004-
Production	(mill M^3)	3.0	4.9	5.8
Fuel wood	(mill M^3)	1.9	3.1	3.6
Energy Content	(PJ)	18.0	31.0	36.0
Fuel Equivalent	(Mtoe)	0.47	0.78	0.92

8. The proposed investment of US$ 10 million is expected to finance construction of 30 MW of new wood-chip-fired boilers and conversion of 150 MW of existing fuel-oil-fired boilers to wood chips. Of the total investment of US$ 10 million, US$ 3 million is expected to be in local currency. To make sure that the viability of the investment will be as high as possible, the size of each boiler is expected to be within the range of 5 - 10 MW.

9. With the wood-chip-fired boiler as base load in the district heating systems, an annual operation of 5000 hours might be expected. With 5000 hours operational time the annual heat production will be about 3.2 PJ and the corresponding fuel consumption 4.1 PJ, which is equivalent to between 25% and 10% of the available wood fuel.

10. With an oil price of US$ 2.0/GJ, increasing to US$ 2.8/GJ and a price of wood chips of US$ 1.0/GJ, increasing to US$ 1.8/GJ, which is equal to the world market price of coal, the annual savings in fuel cost would be US$ 4.1 million.

11. It should also be noted, that, in addition to the fuel savings, an important benefit to Lithuania would be that the total fuel cost of US$ 4.1 - 7.4 million per year could be paid in local currency and will create employment in Lithuania.

12. A study which would locate the wood resources, estimate the annual production, locate boilers suitable for conversion from fuel oil to wood chips and provide standard designs for the boiler conversions is currently being carried out.

C. Subcomponent Cost Summary.

19. The discussion in the above paragraphs is summarized in the following preliminary cost table. More accurate cost information is expected once the detailed feasiblity studies are revised and finalized.

District Heating Component
Preliminary Cost Estimate

	US$ million		
	FC	LC	Total
DH of Vilnius and Alytus	22	8	30
Boiler Conversion	7	3	10
Total	29	11	40

LITHUANIA

Energy Sector Review

Strategy for Emission Reduction

A. Reducing Sulfur Oxides Emissions

1. One strategy to reduce sulfur oxide emissions would be to reduce the sulfur content of imported heavy fuel oil. World prices for low sulfur Heavy Fuel Oil (HFO) are reportedly about one dollar per barrel higher than for high sulfur HFO. In addition to the price differential, oil-unloading port facilities, possibly dredging a deeper channel and some land transportation infrastructure would have to be constructed.

2. A second strategy would be to import low-sulfur crude oil for refinery feedstock. Low-sulfur crude oil also commands a modest price premium. In addition to the price differential, oil unloading port facilities, possibly dredging a deeper channel and some land transportation infrastructure would have to be constructed.

3. A third strategy would be to hydrodesulfurize heavy fuel oil produced for domestic boiler fuel at Mazeikiai Refinery. The technology for desulfurizing HFO has been proven over the last couple of decades and is in widespread commercial use in the U.S., Canada, Kuwait, Germany and Japan. Proven process technology can be licensed from Texaco and Exxon, and probably other major oil companies. The process utilizes two basic stages. The first stage is demetallizing to remove metal species such as vanadium which would otherwise poison the hydrodesulfurization catalyst in the second stage. In addition to removal of catalyst poisons in the first stage, the catalyst in the second stage is physically designed to resist catalyst poisoning. One rough cost estimate received by the Mission suggests that a residual oil demetallizing-hydrodesulfurization process for a large refinery could require US$ 4,000 per daily barrel processed. It is suggested that a comparison be made on costs for installing flue gas desulfurization equipment at power stations as compared with a single investment at the refinery which results in removal of both sulfur and vanadium.

4. Several alternative flue-gas desulfurization (FGD) processes are commercially proven and available for use in power and district heating stations.

(i) Lime or limestone wet scrubbers are the most costly and most efficient. For U.S. construction their installed cost can approximate US$ 250/kW of gross generating capacity. Limestone scrubbers are routinely guaranteed for 90% SO_2 removal efficiencies and lime scrubbers can operate at 95% SO_2 removal efficiencies.

(ii) In so-called dry scrubbers, a lime slurry is injected into the flue-gas stream utilizing a reacting vessel immediately downstream of the air preheater and operating basically as a chemically reacting spray dryer. A fabric filter (preferably) or an electrofilter is installed to collect the dried calcium sulfate, unreacted lime and any other particulates in the combustion-gas stream before discharge to the atmosphere. The estimated retrofit installed cost of lime spray dryers in the U.S. for a medium-difficulty installation may approach US$ 150/kW (gross). Such scrubbers have been utilized in the U.S. mostly for low-sulfur western (lignite or sub-bituminous) coal burning power boilers, but recently their lower installed cost has attracted the attention of the U.S. Electric Power Research Institute (EPRI) and U.S. electric utilities and independent power producers (IPP) who have access to relatively low cost, but medium-to-high sulfur eastern bituminous coals and who would like to take advantage of the lower construction costs of dry scrubbers. The efficiencies of dry scrubbers are very much a function of the quantities of lime injected. For hard coal, a prudent estimation would probably assume twice as much lime would be injected as the theoretical amount required to react with all the SO_2 in the flue gas stream, and would be cautious about guaranteeing SO_2-removal efficiencies as high as 90% although such performance can be demonstrated under carefully controlled conditions.

(iii) Various lower installation cost and lower SO_2 removal efficiencies (approximating 50%) which involve furnace injection of limestone, duct injection of lime, and combinations of these (with efficiencies approaching 80%) are also available at costs recently estimated at or under US$ 100/kW (gross).insert particulate emissions

B. Reducing Nitrogen Oxides Formation and Emissions

5. Nitrogen Oxides Emission. The oxides of nitrogen are, in fact, a family of compounds which includes nitrous oxide (NO), Nitric Oxide (NO_2), N_2O_3, and others. The oxides of nitrogen found in combustion gases are about 90% nitrous oxide and the remaining 10% is mostly nitric oxide. Nitric oxide, a brownish, acid gas is the immediate precursor of nitric acid and is widely believed to be an important contributor to the acid-rain problem. Nitrous oxide is a colorless gas which oxidizes in the atmosphere to form more nitric oxide and nitric acid. Oxides of nitrogen are formed in the combustion process through at least two mechanisms. The first is the burning of organic nitrogen compounds which are present in the fuel which results in oxides of nitrogen. The second is the high-temperature chemical "fixation," or chemical combination of the nitrogen gas in the air with the oxygen also present in the air used to provide oxygen for the combustion process. Nitrogen oxides are chemically unstable and will dissociate back to their constituent molecular nitrogen and oxygen gases if allowed to cool slowly enough to permit the relatively sluggish dissociation reaction to proceed.

6. Modification of the combustion process to minimize formation of oxides of nitrogen is based on:

(i) minimizing the amount of oxygen available to the nitrogen for formation of NO_x;

(ii) reducing the combustion temperature (and therefore the thermodynamic driving force for NO_x formation), and increasing the cooling period needed for dissociation of NO_x compounds. Combustion modification technology, including burner design modifications, use of overfire air and natural gas reburn, are capable of reducing NO_x emissions only by about half.

If deeper reductions in NO_x emissions are required, it is likely that a chemically based process, either selective catalytic reduction or selective non-catalytic reduction of NO_x as described below would be required to meet the more stringent requirements.

7. Selective Catalytic Reduction (SCR) of NO_x utilizes a fixed bed catalyst in the hot combustion-gas stream to stimulate the reaction between ammonia and oxides of nitrogen. The products of the reaction are nitrogen gas and water. The ammonia is injected into the gas stream ahead of the catalyst bed and reacts with the NO_x as the hot mixed gases pass through the catalyst bed. The installed cost of the SCR process is estimated at about US$ 80 per kW of capacity. Post-combustion non-catalytic chemical reduction of NO_x refers to the process of injection of either ammonia or urea into the hot combustion gas stream to achieve a similar reaction without requiring the presence of a costly catalyst.

8. Installing HFO gasifiers at thermal power and CHP stations will provide a clean non-polluting fuel to avoid the requirements for flue-gas desulfurization installations. HFO gasifier technology has decades of commercial experience behind it. Technology licenses are available from major oil companies such as Shell and Texaco, and gas turbines operate on a commercial basis utilizing the produced gas. There appears to be a trend toward gasifying HFO to generate electric power in low investment gas turbine-steam combined cycle plants. The economics appear attractive, of course, because of the relatively low cost of HFO combined with very low investment requirement and high thermal efficiencies of the combined cycle generating plant as compared to the coal alternative. At some time in the relatively near future, Lithuania will have to make choices among interacting approaches and technologies involving control of sulfur emissions, rehabilitation of power and CHP stations and whether or not to move toward more flexibility in sources of refinery feedstock, and possibly refinery upgrading or modifications. The economics of repowering a steam power station with an efficient gas turbine serving as a topping turbine so that the gasified HFO is utilized efficiently in the combined cycle mode could be relatively attractive if natural gas is not an option because of supply constraints or cost. The combined benefits of the added capacity and improved fuel economy should be evaluated.

C. Reducing Particulates, Soot and Vanadium Oxide Emissions

9. The burning of HFO produces particulates, soot, and vanadium compounds in the flue-gases. Since HFO is not a close specification fuel, its contents reflect the quality of crude oil from which it is derived. Much of the sulfur, vanadium, alkali metals and ash-forming minerals in the crude oil remain with the refinery distillation residues, the highest viscosity and otherwise lowest quality of which are variously classified as Number 6 Oil, Bunker "C", Mazut or HFO.

10. Soot is basically a poor quality carbon black. It is a solid hydrocarbon with a very high carbon content. Some of the hydrocarbons often associated with soot are carcinogens. Soot is formed during combustion by the lack of availability of oxygen to portions of the fuel, usually as a result of inadequate mixing of fuel and combustion air. It can be formed during burning of either HFO or natural gas, but burning of HFO is more likely to produce soot than is the case for natural gas.

11. HFO fired boilers are particularly prone to soot formation and emission during start-up. Some HFO-fired industrial boilers minimize this problem by utilizing distillate fuel for start-up. Experience would suggest that soot emissions, particularly from the smaller heat-only boilers, may be a problem, but the complaint level may be relatively low as this did not appear to be a high priority problem with Ministry of Energy staff.

12. In addition to SO_2 emission problems and soot formation and emission problems, HFO burning results in formation of particulate vanadium and complex sodium-vanadium compounds most of which are entrained with the combustion gases and carried into the atmosphere.

13. In the event that the Government of Lithuania determines that vanadium emissions must be reduced, the options would appear to be:

(i) water washing of the oil as is done to remove vanadium from HFO before the oil is fired in gas turbines;

(ii) installation of fabric filters or high efficiency electrofilters to remove the vanadium dust from the combustion gases before discharge to the atmosphere.

14. It is worth noting that high-efficiency particulate removal equipment is an integral part of the most economical FGD process. Unless vanadium compounds were washed out prior to burning, the vanadium compounds would be collected along with the much larger quantities of calcium sulfate formed during sulfur-dioxide capture.

LITHUANIA

Energy Sector Review

The Ignalina Nuclear Power Plant

A. Overview and General Observations

1. The Lithuanian electric power system consists mainly of a large nuclear power station at Ignalina with two units 1,500 MW each, and a number of smaller thermal power stations, burning heavy fuel oil (HFO) and natural gas, dispersed in the country to provide heat and power to consumers. Total installed capacity is about 5,680 MW but available capacity is lower, about 5,200 MW since the nuclear power plant was derated to 2,500 MW (1,250 MW each of the two units) to increase safety margins. Peak domestic load, which was about 2,900 MW prior to 1992, fell to about 2,100 MW in 1993 owing to the economic contraction and industrial restructuring. The nuclear plant represents 53% of total installed capacity and 48% of available capacity; in any case, nuclear generation is a large part of the total system. It is also important to note that this large fraction is concentrated in one location.

2. The considerable excess capacity, provided by the nuclear plant, allows Lithuania to be a net exporter of electrical energy. Thus in 1990, out of a total net generation of 28.4 TWh, 16.5 TWh were consumed in the domestic market and 11.9 TWh, or about 42% of total generation, were exported. Exports from Ignalina were natural in the context of the Former Soviet Union (FSU), since Lithuania was part of the northwestern Interconnected Power System (IPS) of the FSU. However, owing to economic contraction and payment difficulties, electricity exports shrank to 5.3 TWh in 1992 and 2.7 TWh in 1993. Exports are likely to remain between 2-6 TWh per year for the remainder of the decade.

3. Lithuania, as well as Latvia and Estonia, are part of a unified electric energy system (yedinaya energeticheskaya sistema) of the FSU. The Baltics, together with the Kola peninsula, Karelia, Leningrad and Pskov administrative districts, Belorus, and Kaliningrad are part of the interconnected electricity grid of north-western FSU. The planning (siting and phasing) of the power plants and transmission lines was made by Soviet authorities for a larger geographical region. This preexisting condition poses special problems now that the planning is done on a national or smaller regional basis.

B. Nuclear Power Plant Ignalina

4. The Ignalina Nuclear Power Plant (Ignalina), with 3,000 MW of installed capacity, has produced about 17 TWh of gross electrical energy consistently in the period 1989-91. This amount represented about 60% of total generation in the country and was equal or larger than the amount of electricity exported to neighboring countries each year.[1] With the sharp increases in petroleum and gas prices from Russia and large disruptions in supply, the role of Ignalina increased even further in 1992 with a share of total generation of 78% and in 1993 it was nearly 90%. The plant's significance for the electricity supply system and for the Lithuanian economy is therefore very great.

[1] The value of this energy, at the international price of about US$ 52 per MWh, is close to US$ 1 billion per year.

5. The plant's management was, up until recently reporting directly to the Nuclear Power Ministry of the former USSR and was directed from there. This situation changed after independence with the decision by the Lithuanian Government that the plant is a Lithuanian enterprise reporting to the Ministry of Energy. At the same time, a Lithuanian Nuclear Power Safety Inspectorate (VATESI) was created as an "independent" agency, although it is still connected to the Ministry of Energy.

6. The units at the Ignalina Nuclear Power Plant belong to the RBMK class of reactors designed and constructed by the USSR's Ministry of Nuclear Power Construction; thirteen 1,000-MW units, and two 1,500-MW units (at Ignalina) are in operation.[2] The accident at Chernobyl unit 4 in April 1986, and the fire at unit 2, which are not included in the above count, brought forth serious safety concerns regarding the design and operation of these reactors. These have been identified and analyzed extensively in the technical literature. They include the positive steam reactivity coefficient, the susceptibility of the graphite moderator to graphite-steam (endothermic but potentially explosive) and graphite-air (highly exothermic) reactions, the lack of consideration by Soviet safety analyses of accidents considered credible by international standards, i.e., rupture of reactor exit piping and main steam piping, rapid reactivity excursions, and accidents initiating in the core itself, such as blocked flow channel or multiple channel ruptures; in addition, all Soviet units were not designed with adequate fire detection and protection systems. Many of the above occurrences were, as is well known, part of the accident sequence at the Chernobyl unit 4. Finally, the reactors do not have an adequate containment structure that could contain the radioactivity from being released in case of a severe accident, thus omitting a most important element of the concept of defense-in-depth that is of paramount importance in international standards.

7. The operation of the 1,500-MW units at Ignalina at the higher power output level with essentially the same core as the 1,000-MW units, brings these units closer to the so-called "boiling crisis" condition, i.e., reduces their operational safety margin; this concern has been reduced by the decision to derate each unit to about 1,250 MW. In addition to their design deficiencies, some units are known to have construction defects (for example, defective concrete walls and pipe welds) and the operation of the units is in the hands of operators who do not have the necessary rigorous training and strict safety culture or clear instructions for operating the units under normal or off-normal conditions. It must be noted, however, that two inspections by teams of the International Atomic Energy Agency (IAEA), in 1988 and 1989, found the conditions at the Ignalina plant satisfactory.

International Activities

8. In view of the large value of the produced energy, the difficult conditions encountered by the countries of Eastern Europe in a period of transition and economic adjustment, and the existing potential for improving the safety level of these reactors to a point acceptable to the international technical and political community, serious efforts are being mounted: the IAEA has initiated a safety review of the RBMK units, similar to that undertaken for the VVER-440/model 230 reactors; the Commission of the European Union has allocated substantial sums of money (about ECU 14 million in 1992 and four times that in 1993) to an assistance program for the improvement of the RBMK units; Sweden has instituted and is implementing an assistance program to Lithuania to improve the safety of the Ignalina plant both in hardware and operational terms; finally, the US and Canadian Governments have established assistance programs to improve the operating procedures, personnel training,

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[2] The two remaining units at Chernobyl were scheduled for permanent closure in 1993 but the Government of Ukraine reversed that decision in the Autumn of 1993. There are also 11 units in Russia (at Sosnovy Bor, Smolensk, and Kursk) and two in Lithuania (Ignalina).

regulatory procedures, and other safety methods that have been learned from the extensive experience of these two countries in operating large nuclear systems.

Safety Upgrades

9. The consensus of the international nuclear safety community is that the effort, in terms of human and financial resources, should be oriented toward cost-effective investments that would allow the plant to operate for the short-to-medium term or as considered absolutely necessary by the Lithuanian authorities but not for the long term. Thus, the most effective improvements can be obtained in (a) management restructuring and strengthening, (b) personnel training, testing and qualification, and (c) rewriting of operating procedures in a complete and unambiguous manner to cover the widest possible operating conditions and accident scenarios; it has been estimated that improvement in safety level of a factor of up to 10 could thus be obtained. It is only in the context of institutional improvements that the hardware upgrades that have already been implemented or are planned can have lasting effect. The development of a "safety culture", the most important, all-encompassing feature in the operation of a nuclear plant, is the central objective toward which all activities should be focused.

10. Based on a number of seminars held at the International Atomic Energy Agency (IAEA) on the safety of the RBMK reactors, the most frequently mentioned technical improvements are: reduction of the positive steam reactivity coefficient, possibly by further increasing the fuel enrichment and other core modifications, an additional and separated high-pressure injection system, increased pressure suppression capability, improved fire detection and protection systems, and improved containment function, possibly through the construction of a filtered-vented facility. Another facility that would be needed in about two years is an additional spent fuel storage facility to take the fuel to be discharged from the reactors. The available space inside the reactor building is fast filling up while the previously assumed option of transferring the spent fuel to the FSU is no longer available. The additional spent-fuel facility has been designed at a Russian design center and its implementation is being planned with foreign assistance. This project has a high priority. The purchase of spent fuel casks for dry storage of cool fuel is also being planned and a contractor was selected in a competitive bidding process.

11. A safety improvement program has been started and partially implemented by the Russian designers of the plant. A conference in November 1992 at the IAEA showed that impressive strides had been made in the right direction. Further actions are being planned, organized, and executed with the technical advice of the IAEA and the active assistance of the World Organization of Nuclear Operators (WANO)[3] or other international, experienced consultants. In the specific case of Ignalina, the close technical cooperation of the formerly Soviet designers of the units and the utilization of the acquired operational experience in similar units is also essential. The presence in the country of foreign experts of Lithuanian descent, could be very advantageous to the country at a very critical moment. They should be utilized mainly in setting up: an Action Plan, a training program, and the regulatory structure and in assembling a set of nuclear safety rules, regulations and guidelines. Their assistance in transferring analytical codes for the analysis of normal and accident conditions and training of local staff, both at the plant and at the Inspectorate (VATESI), would very valuable.

12. In February 1994, an agreement was reached between GoL, Ignalina management and EBRD for the safety upgrading of the units with a grant of ECU 33 million from the Nuclear Safety Account.

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[3] This organization, created in the mid 1980s, aims at the close cooperation among owners and operators of nuclear plants, exchanges of information on operating experience and effective mutual assistance programs. It has offices in Atlanta (USA), Paris, Moscow, and Tokyo and a coordinating office in London.

The GoL agreed to plan the retirement of unit 1 at about the middle of 1998 if the energy requirements of the country allow it and unless the plant is relicensed by VATESI. The course of action will be based on the recommendations of an in-depth safety assessment to be completed by the end of 1995. The assessment may also propose alternative operating regimes for the two units. An additional grant to complete the necessary safety upgrades of the Ignalina units would be sourght from the Nuclear Safety Account.

Nuclear Regulation

13. An effective Nuclear Regulatory Agency is an absolute necessity for the disciplined functioning of nuclear installations and for ensuring public health and safety. A Lithuanian Nuclear Power Safety Inspectorate (VATESI) has been created and efforts are mounted to bring it to a high level of effectiveness. Owing to the heretofore prevailing structure and dearth of Lithuanian personnel trained in nuclear matters, it is understandable that the existing arrangements are incomplete. However, urgent attention to this question is needed. In intensifying the effort for the strengthening of the nuclear regulatory authority, the following would be high-priority items:

(i) a strong organizational structure that is adequate for the needs of Lithuania and takes into account similar structures in other countries;

ii) a large degree of independence for VATESI to ensure its objective function, avoid undue interference, and gain credibility with the public;

(iii) a Nuclear Law of Lithuania;

(iv) real enforcement authority for VATESI;

(v) the allocation of the adequate resources to allow VATESI to perform its functions with effectiveness and credibility;

(vi) introduction of nuclear safety regulations and guidelines, based on the regulations of other countries with nuclear programs, conditions, and traditions similar to those of Lithuania; and

(vii) a strong monitoring program around the plant to ensure adequate measurement of radioactivity under routine operations and in the case of an accident.

Training Needs

14. The training needs of the electric power system in Lithuania and in particular of the Ignalina nuclear power plant are quite large owing to the long isolation of the country from international contacts and the requirements posed by the reform program. Training in nuclear plant operations and in acquiring the "safety culture" that is needed for the safety of Ignalina, is one of the most important and urgent training needs. Some exchanges have already begun and staff have been sent abroad for training in various disciplines. Bilateral aid programs and aid from the European Communities are providing timely and effective assistance in this area.

LITHUANIA

Energy Sector Review

Crude Oil Reserves in Lithuania

A. Introduction

1. Lithuania possesses few oil reserves, both onshore and offshore. At present, exploration activities are limited to onshore fields. According to the most recent information from the State Geological Service (SGS), total recoverable oil is estimated at a maximum of 90 Mt. The current production is limited to the onshore fields from which a maximum production of 1.5 million tonnes per year is expected at peak. This would account for 25% of the present oil consumption in Lithuania. Thus indigenous oil development would play an important role in the future of the Lithuanian oil subsector.

B. Institutional Arrangements

2. SGS has inherited institutional functions from the Ministry of Geology in the former Soviet Union. SGS positions are at the same level as the other ministries of Lithuania. Under SGS five state enterprises (SE) were formed, namely, (i) Gargdai SE of Petroleum Geology (GPE) for exploration and production of petroleum; (ii) Vilnius SE of Geology for geological and geophysical mapping exploration and development of mineral resources; (iii) Vilnius SE of Hydrogeology for ground water exploration and quality, and regime investigation and monitoring; (iv) Kaunas SE of Hydrogeology for ground water exploration; and (v) Siauliaise Hydrogeology for ground water exploration. In addition, the Lithuanian State Geological Institute and Vilnius University work closely with the above state enterprises. It is planned that GPE is to become to a national oil company in accordance with the natural resources law now being drafted. At present SGS is the centerpiece of all geological programs and contacts with potential foreign investors. However, the Government is the single authority to make agreements with foreign investors.

C. Oil Reserves

3. Oil exploration activities in Lithuania started in 1963. Since then about 300 exploration and 7 production wells have been drilled. The current oil production is limited to the onshore oil fields at about 200-300 CM/day per well and 700-800 CM/month in total. Today proven reserves are mostly limited to the western part of the state. Individual oil reserves are small, averaging 1.2 million tons of oil per field. From 15 onshore fields, about 47 million tons of recoverable oil is expected. At present two Russian-made rigs are working although the progress is impaired due to inefficient and obsolete technologies.

4. There are three prospective offshore oil fields from which a total of 40 million tons of oil recovery are expected. Water depth ranges from 30 to 50 meters. Currently no rig activity or production is taking place.

5. Source rock and reservoir rock of the current onshore and offshore oil reserves are composed of Canbrian sandstone and limestone respectively. The depth of oil reserves is about 1,700 to 2,000 meters. Based on about 20,000 Km of seismic lines investigated so far by the former Soviet Ministry of Geology, 15 oil fields were found onshore. The oil reservoir characteristics are: (i) low gas-oil ratio with 40 to 50 m^3/m^3; (ii) lighter oil with specific gravity of 0.81; (iii) low sulfur oil with

0.1 to 0.2%; and (iv) natural flow with atmospheric pressure of 2-3 at wellheads.

D. Development Plan

6. According to SGS' prediction, oil production will increase from the present level of 70,000-80,000 tons per year to a maximum 1.5 million tons per year using today's modern technologies. (See Map IBRD 24407 for detailed oil and gas production prospects.) The average production cost is estimated at $5-8 per barrel of oil. This means that about 30% of the potential oil revenue would be used for the cost recovery at the present international oil prices.

7. To attract foreign investors, 3 oil concessions were scheduled for tendering during 1992-93. In practice, a maximum 50% share-holding is allowed for foreign investors. Development cost for a typical oil concession with 4 to 5 small oil fields is estimated to be in excess of $100 million.

LITHUANIA

Energy Sector Review

Klaipeda Oil Terminal

A. Introduction

1. Lithuania possesses a single oil terminal in the city of Klaipeda, on the west cost of Lithuania. At its peak the petroleum cargo handling reached 11 mt/y. However, at present the oil terminal is used for exporting 6 mt/y fuel oil from neighboring countries (90% of which is Russian). The maximum accessible tankers are in the range of 28,000 DWT. Petroleum products are transported to the port by rail. The present facilities are all obsolete and the Lithuanian authorities are considering a plan to construct a completely new oil imports/exports port at another location.

B. Institutional Arrangements and Port Operation

2. Klaipeda State Oil Terminal Company (KSOT) is a single arm of the Ministry of Energy for export trading of petroleum products. Present cargo operation is limited to a total 6 mt/y of two grades of fuel oils transported from Russia, Belarus, and Poland. In addition 0.5 mt/y of diesel oil and a small quantity of lube oil are handled.

3. At present KSOT charges US $5-9 per ton of petroleum products handled. The actual payment is made in rubles, although KSOT is planning to introduce hard currency payment in the near future. The current contracts are all based on a one-year period. About 20-25 contracts are signed each year, mostly with The Russian Oil Producers Association.

C. Present Oil Terminal Facilities

4. The port is a typical river port with all the commercial activities located to the east bank of the river. The port is divided into two major districts, the merchant port and the fishing port. The port stretches from 0.8 to 12 Km from the mouth of the river. The oil terminal is located near the mouth, where the depth is about 10.5 m. The shallow depth restricts access to tankers beyond a maximum weight of 28,000 DWT. At the port entrance, about 1 mt/y of sand has to be dredged. Although two water breakers are provided at the port entrance, protection of the oil terminal is inadequate. According to KSOT's information, the oil terminal cannot be operated for approximately one-third of the year due to insufficient water breaker.

5. There are three jetties installed in series along the river flow, all of which are designed for tankers in the range of 16,000-28,000 DWT. Three jetties can be operated at the same time and fuel-oil loading to a 28,000 DWT tanker can be completed within 8-10 hours. Near the port, there are three tracks of railroad unloading facilities, each of which can handle up to 34 railway tankers at one time. There are no loading facilities for road tankers. Across the road in front of the port, there is a small tank farm in which 20 units each with capacity for 5,000 m^3 fuel oil are stored. Of these, 18 tanks are allocated for fuel oil and the others used for diesel oil. In addition, there are 11 of 100-ton lube oil storage tanks. All the fuel oil tanks are equipped with steam heating coils inside but are not insulated. Recently KSOT installed an emergency fuel-oil receiving line with a design capacity of 10,000 tons per day. It has not yet begun operating.

6. The Lithuanian Government and several energy institutions are exploring several

proposals for expanding Lithuania's port facilities, particularly the country's capability of importing oil and oil products. Among these proposals are a proposal to rehabilitate the Klaipeda port (for non-oil operations), a proposal to construct a single-point mooring facility at Butinge, and the possibility for expanding capacity at several Latvian ports. Design work is proceeding with the Butinge port and the accompanying oil pipeline to Mazeikiai, but no financing source has yet been identified.

LITHUANIA: Consumption of Major Petroleum Products , 1985-1991, by Sector (in '000 tons)

Product	Year	Industry	Transport	Electric Power	District Heating	Agriculture	General Public	Total	% of Total Products
Gasoline									
	1985	597.0	185.3	21.4	8.0	36.2	99.4	947.3	12.0
	1986	445.3	140.1	22.8	6.0	290.3	106.2	1010.7	13.1
	1987	229.5	179.6	22.9	8.4	420.7	181.0	1042.1	11.9
	1988	227.6	167.8	21.0	26.1	421.1	233.4	1097.0	12.9
	1989	205.7	155.7	20.6	25.6	431.1	283.6	1122.3	14.1
	1990	166.3	124.1	15.8	22.6	381.5	327.3	1037.6	16.1
	1991	198.9	124.3	19.7	26.7	324.1	434.9	1128.6	16.2
Diesel Oil									
	1985	381.2	127.5	51.9	6.4	615.1	-	1182.1	15.0
	1986	411.4	134.6	20.7	6.5	583.0	0.1	1156.3	15.0
	1987	422.2	139.5	21.6	7.3	662.4	-	1253.0	14.4
	1988	384.1	144.1	21.3	7.8	669.9	-	1227.2	14.4
	1989	405.8	145.2	19.2	9.1	659.9	-	1239.2	15.5
	1990	274.1	125.6	13.1	7.1	636.9	0.8	1057.6	16.4
	1991	360.8	125.5	17.4	10.6	553.8	4.1	1072.2	15.4
Lt. Fuel Oil									
	1985	102.8	90.5	-	91.0	2.1	100.5	386.9	4.9
	1986	104.3	1.6	-	104.1	76.2	116.3	402.5	5.2
	1987	81.7	1.3	-	103.4	85.8	132.1	404.3	4.6
	1988	64.4	1.6	-	109.1	70.2	150.3	395.6	4.6

Product	Year	Industry	Transport	Electric Power	District Heating	Agriculture	General Public	Total	% of Total Products
	1989	53.0	1.9	-	110.1	64.6	167.7	397.3	5.0
	1990	50.2	2.0	-	100.2	54.0	181.7	388.1	6.0
	1991	42.0	2.0	-	100.0	56.1	170.9	371.1	5.3
Ind. Fuel Oil									
	1985	1616.0	14.7	3169.1	38.1	148.8	-	4986.7	63.3
	1986	1224.0	14.1	3326.0	46.3	146.9	-	4757.3	61.6
	1987	1468.3	16.8	3711.4	55.2	318.5	-	5570.2	63.8
	1988	1428.8	17.9	3480.0	61.0	329.0	-	5316.7	62.4
	1989	1365.7	22.3	2906.6	67.8	352.2	-	4714.6	59.1
	1990	1220.6	22.6	1901.7	69.8	332.4	-	3547.1	55.2
	1991	1169.0	18.1	2258.4	75.2	331.8	-	3852.5	55.4
Kerosenes									
	1985	17.4	349.2	-	-	-	9.6	376.2	4.8
	1986	13.7	375.1	-	-	-	6.4	395.2	5.1
	1987	14.3	437.7	-	-	-	5.9	457.9	5.2
	1988	14.1	467.5	-	-	-	7.7	489.3	5.7
	1989	11.3	488.9	-	-	-	6.5	506.7	6.3
	1990	5.9	391.0	-	-	-	3.7	400.6	6.2
	1991	6.8	516.8	-	-	-	4.0	527.6	7.6
Total Major Products									
	1985	2714.4	767.2	3242.4	143.5	802.2	209.5	7879.2	100.0
	1986	2198.7	665.5	3369.5	162.9	1096.4	229.0	7722.0	100.0
	1987	2216.0	774.9	3755.9	174.3	1487.4	319.0	8727.5	100.0

Product	Year	Industry	Transport	Electric Power	District Heating	Agriculture	General Public	Total	% of Total Products
	1988	2119.0	798.9	3522.3	204.0	1490.2	391.4	8525.8	100.0
	1989	2041.5	814.0	2946.4	212.6	1507.8	457.8	7980.1	100.0
	1990	1717.1	665.3	1930.6	199.7	1404.8	513.7	6431.2	100.0
	1991	1777.5	786.7	2295.5	212.5	1265.8	613.9	6952.0	100.0
Memo: % of Total Major Products Consumption									
	1985	34.4	9.7	41.2	1.8	10.2	2.7	100.0	
	1986	28.5	8.6	43.6	2.1	14.2	3.0	100.0	
	1987	25.4	8.9	43.0	2.0	17.0	3.7	100.0	
	1988	24.9	9.4	41.2	2.4	17.5	4.6	100.0	
	1989	25.6	10.2	36.9	2.7	18.9	5.7	100.0	
	1990	26.7	10.3	30.1	3.1	21.8	8.0	100.0	
	1991	25.6	11.3	33.0	3.1	18.2	8.8	100.0	

Source: Lithuanian Fuels, and mission estimates

LITHUANIA - MAZEIKIAI REFINERY PRODUCTION, 1985-92

(in million tons)

	1985	1986	1987	1988	1989	1990	1991	Jan-July 1992
INPUTS								
Crude oil and other feedstocks	11.691	12.070	12.711	12.987	12.813	9.589	11.757	3.538
OUTPUTS								
LPG	0.179	0.187	0.213	0.207	0.248	0.240	0.285	0.095
Naphtha	0.045	0.223	0.479	0.365	0.336	0.154	0.139	0.074
Motor Gasolines	1.544	1.475	1.366	1.497	1.691	1.848	2.086	0.608
A-76	0.979	1.137	0.940	1.080	1.241	1.521	1.618	0.495
A-92	0.565	0.337	0.426	0.417	0.450	0.327	0.468	0.112
Kerosenes	0.946	0.977	1.002	1.038	1.037	0.653	0.914	0.188
Auto Diesel Oil	2.555	2.345	2.396	2.256	2.546	2.116	2.376	0.690
Heating Oil	0.018	0.317	0.314	0.302	0.318	0.418	0.362	0.203
Fuel Oil	5.739	5.823	6.128	6.424	5.665	3.134	4.434	1.275
Bitumen	0.188	0.239	0.275	0.318	0.339	0.243	0.320	0.058
Sulfur	0.015	0.019	0.020	0.020	0.020	0.027	0.029	0.009
Others	-0.006	0.004	0.038	0.074	0.025	0.057	0.018	0.007
Fuel and Losses	0.468	0.461	0.480	0.486	0.588	0.699	0.794	0.331
Total Outputs	11.691	12.070	12.711	12.987	12.813	9.589	11.757	9.538

Memo	1989	1990	1991
(i) Internal Fuel	0.469	0.527	0.598
-Off gases	(0.243)	(0.264)	(0.286)
-Fuel oil	(0.207)	(0.201)	(0.256)
-FCC coke	(0.019)	(0.062)	(0.056)
(ii) Losses (by diff.)	0.119	0.172	0.196
Total Fuel and losses	0.588	0.699	0.794

Source: Mazeikiai Refinery

ANNEX 8.4

LITHUANIA – SUPPLY/CONSUMPTION BALANCES OF MAJOR REFINED PRODUCTS, 1985-1991

(in million tons)

	1985	1986	1987	1988	1989	1990	1991
Gasoline							
Domestic Production	1.544	1.475	1.366	1.497	1.691	1.848	2.086
Imports	0.121	0.162	0.260	0.112	0.031	0.004	0.010
Exports	0.687	0.514	0.638	0.681	0.536	0.913	0.714
Apparent Consumption	0.978	1.123	0.988	0.928	1.186	0.939	1.382
Actual Consumption	0.947	1.011	1.042	1.097	1.122	1.037	1.129
Automotive Diesel Oil							
Domestic Production	2.555	2.345	2.396	2.256	2.546	2.116	2.376
Imports	0.164	0.305	0.384	0.421	0.074	0.013	-
Exports	1.499	1.474	1.404	1.424	1.340	1.107	1.118
Apparent Consumption	1.220	1.176	1.376	1.253	1.280	1.022	1.258
Actual Consumption	1.182	1.156	1.253	1.227	1.239	1.058	1.072
Kerosenes							
Domestic Production	0.946	0.977	1.002	1.038	1.037	0.653	0.914
Imports	0.023	0.020	0.021	0.023	0.017	0.008	0.011
Exports	NA	NA	NA	NA	NA	NA	NA
Apparent Consumption							
Actual Consumption	0.376	0.395	0.458	0.489	0.507	0.401	0.528
Home Heating Oil							
Domestic Production	0.018	0.317	0.314	0.302	0.318	0.418	0.362
Imports	0.318	0.132	0.124	0.120	0.113	0.026	0.036
Exports	0.618	0.043	0.030	0.025	0.006	0.041	0.007
Apparent Consumption	(0.282)	0.406	0.408	0.397	0.425	0.403	0.391

	1985	1986	1987	1988	1989	1990	1991
Actual Consumption	0.387	0.403	0.404	0.396	0.397	0.388	0.371
Fuel Oil							
Domestic Production	5.739	5.823	6.128	6.424	5.665	3.134	4.434
Imports	0.829	1.752	2.738	2.951	1.398	1.466	0.601
Exports	1.533	0.925	0.666	0.791	0.810	0.774	0.627
Apparent Consumption	5.035	6.650	8.200	8.584	6.253	3.826	4.408
Actual Consumption	4.987	5.174	5.570	5.317	4.715	3.547	3.853
Bitumen							
Domestic Production	0.188	0.239	0.275	0.318	0.339	0.243	0.320
Imports	0.075	0.080	0.068	0.044	0.021	0.018	0.020
Exports	0.025	0.048	0.067	0.061	0.053	0.041	0.049
Apparent Consumption	0.238	0.271	0.276	0.301	0.307	0.220	0.291
Actual Consumption	0.224	0.255	0.249	0.248	0.261	0.177	0.214

Source: Lithuanian Fuels, and Mission Estimates

Notes:

(i) Direct exports and direct domestic sales by Mazeikiai Refinery probably not taken into account. Very large differences between apparent and actual consumption in case of fuel oil and home heating oil. Needs checking.

(ii) Inventory changes not available, not possible to reconcile apparent and actual consumptions.

Lithuania - Mazeikiai Refinery Facilities

	Nominal Capacity ('000 t/y)	Year of Start up	Technology Source	Remarks
A. Process Units				
1. Atmospheric Distillation				
Train 1	6000	1980	LGNK (USSR)	
Train 2	7000	1984	LGNK (USSR)	
2. Vacuum Distillation				
Train 1	1250	1982	RGNK (USSR	For bitumen
Train 2	4000	1989	GGNK (USSR)	For FCC Feedstock
3. Naphtha Pretreater & Reforming				
Train 1	1000	1980	VNIINR (USSR)	Bimetallic Catalyst (French)
Train 2	1000	1984	VNIINR (USSR)	Monometallic Catalyst (USSR)
4. FCC	2000	1989	GGNK	Riser Cracker, promoted combustion with WHB
5. Visbreaker	1500	1989	GGNK	
6. Distillate Hydrotreating				
- Kerosene	2 x 600	1980/84	VNIINP	
- Gas oil to FCC	2200	1989	GGNK	
- Gas oil	2 x 2000	1980/84	VNIINP	
7. Gas Separation & Treatment				
- LPG Recovery	2 x 450	1980/84	LGNK	
- VB/FCC Gascon	1500	1989	GGNK	
- Sulfur Recovery	64	1989	Mod. Claus (USSR)	
8. Bitumen	350 (Product)	1982	RGNK	
9. MTBE	40 (Product)	1989		
10. Hydrogen	80 (Product)	1989	Czech	

B. Offsites & Utilities

1. Recirculating cooling water, m^3/hr.:4,300
2. Process & makeup water, m^3/day:293,300
3. Compressed air, m^3/hr.:16,000
4. Inert gas (N_2), m^3/hr.:1,200
5. Liquid Effluent Treatment, m3/day:36,200
6. Storage tanks
   - Crude oil, m^3 :160,000
   - Naphtha, m^3 : 60,000
   - Gasoline, m^3 :140,000
   - Jet fuel, m^3 : 60,000
   - Diesel oil, m^3 :120,000
   - Fuel oil, m^3 :140,000
   - LPG, m^3 : 50,000

7. Electric power (about 40 MW), and all steam (120 ata: 565°C) except small quantities produced from waste heat recovery, bought from power plant nearby with a total capacity of 210 MW and 2000 tph steam. This power plant was owned and operated by the refinery until 1991 when it was separated off as an autonomous enterprise.

LITHUANIA - Petroleum Products Storage Locations and Capacities

	GASOLINE				DIESEL OILS				FUEL OILS			
	Storage Volume '000 m^3	Consumption in Market Area (1991)		Storage volume, Equivalent No. of days of Consumptio n	Storage Volume '000 m^3	Consumption in Market Area (1991)		Storage volume, Equivalent No. of days of Consumption	Storage Volume '000 m^3	Consumption in Market Area (1991)		Storage volume, Equivalent No. of days of Consumption
		'000 tons	'000 m^3			'000 tons	'000 m^3			'000 tons	'000 m^3	
1. Vilnius	6.5	192.1	254.4	9.3	3.5	97.4	115.4	11.1	1.6	49.2	52.3	11.2
2. Kaunas	32.0	116.8	221.0	52.9	3.5	99.3	117.7	10.9	1.6	45.1	48.0	12.2
3. Siauliai	3.8	97.6	129.3	10.7	2.1	82.2	97.4	7.9	0.9	36.1	38.4	8.6
4. Klaipeda	14.0	95.5	126.5	40.4	5.0	68.8	81.5	22.4	3.0	37.6	40.0	27.4
5. Kleipeda Export Terminal	n.a.	n.a.	n.a.	n.a.	n.a.	49.0	58.1	n.a.	n.a.	n.a.	n.a.	n.a.
6. Kedainiai	6.4	38.8	51.4	45.4	5.0	37.7	44.7	40.8	1.8	18.9	20.1	32.7
7. Marijampole	2.6	47.2	62.5	15.2	1.6	40.2	47.6	12.3	0.8	25.0	26.6	11.0
8. Mazeikiai	2.4	59.6	78.9	11.1	2.1	45.5	53.9	14.2	1.4	33.2	35.3	14.5
9. Telsiai	6.8	46.4	61.5	40.4	4.0	41.0	48.6	30.0	4.0	26.1	27.8	52.5
10. Vidukle	5.0	46.5	61.6	29.6	3.2	43.1	51.1	22.9	2.1	31.9	33.9	22.6
11. Rokiskis	4.1	38.6	51.1	29.3	2.6	38.2	45.3	20.9	1.2	31.3	33.3	13.1
12. Panevezys	15.0	97.1	128.6	42.6	9.0	97.4	115.4	28.5	3.0	35.7	38.0	28.8
13. Utena	10.0	48.6	64.4	56.7	6.0	41.1	48.7	45.0	2.0	26.0	27.7	26.3
14. Subacius	160.0	n.a.	n.a.	n.a.	150.0	n.a.	n.a.	n.a.	12.0	n.a.	n.a.	n.a.
15. Alytaus	2.9	92.2	122.1	8.7	2.4	63.1	74.8	11.7	2.0	36.9	39.3	18.6

Notes: i) Assumed specific gravities: gasoline: 0.755; diesel oil: 0.844; F.O.: 0.94
ii) Kleipeda export terminal storage capacities unclear; also how much of it for domestic market additional to Kleipeda terminal.
iii) Lithuanian Fuel data shows large sales under this head, but from which terminal is not clear (Subacius?).

Source: Lithuanian Fuels

LITHUANIA: Investment Plan for Storage and Distribution of Refined Products
(Figures in US Million Dollars)

Supply Base	Investment Item	Capacity	Total Cost	Investment Phasing 1993	1994	1995	1996	1997-2000	Remarks
1. Vilnius	(i) New storage capacity at acceptable location nearby	96,000 tons	4.80	0.64	1.36	1.60	1.20	-	Existing 14,000 storage will be liquidated. New capacity includes 38,000 tons strategic reserve.
	(ii) Reconstruction of retail stations	10 nos.	0.60	0.04	0.09	0.06	0.06	0.35	
2. Kaunas	(i) Reconstruction of storage capacity	10,000 tons	0.72	0.24	-	-	-	0.48	
	(ii) Reconstruction of retail stations	11 nos.	0.65	0.12	0.11	0.06	0.12	0.24	
3. Klaipeda	(i) Reconstruction of existing storage capacity	-	0.99	0.03	-	-	-	0.96	
	(ii) Reconstruction and new retail stations	6 nos.	0.24	0.04	0.04	-	0.04	0.12	
4. Siauliai	(i) New storage capacity at environmentally acceptable nearby location	48,400 tons	4.71	0.56	1.36	1.60	1.20	-	Existing 10,000 tons storage to be liquidated. New storage includes 8,000 tons strategic reserve.
	(ii) Reconstruction of retail stations	3 nos.	0.14	0.02	0.04	0.04	0.04	-	
5. Alytus	(i) Relocation & creation of storage capacity	25,000 tons	2.80	-	-	-	0.64	2.16	Existing storage of 9,900 tons will be liquidated.
	(ii) Reconstruction of retail stations	5 nos.	0.20	0.04	0.04	0.04	-	0.08	
6. Kedainiai	(i) Modernization of existing storage	-	0.26	0.03	0.23	-	-	-	Existing storage of 7,000 tons
	(ii) Reconstruction of retail stations	-	0.32	0.14	0.06	0.04	0.04	0.04	
7. Marijampole	(i) Modernization and expansion of storage	25,000 tons	2.80	-	-	-	-	2.80	Existing storage of 6,600 tons to be liquidated.
8. Mazeikiai	-	-	-	-	-	-	-	-	Existing storage: 6,700 tons.
9. Telsiai	-	-	-	-	-	-	-	-	-

Supply Base	Investment Item	Capacity	Total Cost	Investment Phasing					Remarks
				1993	1994	1995	1996	1997-2000	
10. Vidukle	(i) Modernizing storage capacity (ii) Reconstructing retail stations	-	0.72 0.19	- 0.03	- -	- 0.04	0.32 0.06	0.40 0.06	Existing storage of 11,000 tons
11. Rokiskis	(i) Reconstructing storage capacity (ii) Reconstructing retail stations	- 5 nos.	0.72 0.20	0.32 0.04	0.40 0.04	- 0.04	- 0.04	- -	Existing storage: 10,000 tons
12. Panaverzys	(i) Reconstructing retail stations	8 nos.	0.32	0.04	0.04	0.04	0.04	0.16	
13. Utena	(i) Reconstructing retail stations	5 nos.	0.24	0.06	0.06	0.06	0.06	-	
14. Subaciaus	(i) Enlarging storage capacity	30,000 tons	1.70	0.88	0.82	-	-	-	Existing storage; 352,000 tons
Subtotal	(i) Storage capacity modernization and expansion (ii) Retail station modernization and new stations	254,000 tons 57 nos.							

Notes:

1. Current storage capacity is 586,000 tons, of which 40,300 tons will be retired. Additional capacity creation (254,000 tons) will provide 397,000 tons operational storage (about 18 days), plus 462,000 tons strategic reserve storage (60 days national consumption), both at 1991 consumption levels.

2. Storages for white products only: gasoline, kerosene, and diesel oil.

Source: Lithuanian Fuels

LITHUANIA: Mazeikiai Refinery Operating Costs

	1990			July 1992		
	Quantity	Unit Price	Total Cost (million rubles)	Quanitity	Unit Price	Total Cost (million rubles)
Own Crude Oil ('000 tons)	9587.7	30.5	292.4	511.1	6,578	3,362.0
Processing Crude Oil ('000 tons)	-	-	-	103.7	-	-
Catalysts/Chemicals/Additives	-	-	5.0	-	-	17.8
Purchased Power (MWh)	444	23,800	10.6	24.68	20,330	50.2
Purchased Steam (Gcal)	1,737,800	7,000	12.2	106,251	902.6	95.9
Maintenance	-	-	4.8	-	-	62.3
Labor/Management Overheads	-	-	6.7	-	-	34.6
Taxes	-	-	2.2	-	-	327.9
Depreciation	-	-	28.9	-	-	18.6
Loan Amortization	-	-	-	-	-	50.0
Others	-	-	1.7	-	-	17.7
Total			364.5			4,037.0
Memo:						
1. Subtotal Operating Costs			72.1			675
2. Operating costs per ton feedstock (Rb/ton)			7.52			1,098
3. Operating Cost/Feedstock Cost Ratio			0.246			0.167
4. Specific consumption of energy per million tons of feedstock (i) Purchased Power (MWh) (ii) Purchased Steam (Gcal) (iii) Internal fuel (tons)			46 181,247 54,970			40 172,822 78,434 (est.)

Notes:

(i) Operating cost efficiency cannot be calculated with any degree of accuracy because of poor cost disaggregation, and internal data inconsistencies. For example, unit prices for steam and power in 1992 shown to be less than in 1990.

(ii) While energy input coefficients (steam and power per unit of feedstock input) appear internally consistent for the two periods, there is signficant difference in the case of own internal fuel used for refining. Overall, energy efficiency is poor, higher by about 50% relative to a well operated refinery of similar configuration.

Source: Mazeikiai Refinery

LITHUANIA

Energy Sector Review

Gas Distribution Infrastructure

A. Introduction

1. Since the 1960s, the gas distribution network has been developing gradually. The current main gas lines in Lithuania are: (i) the Minsk-Vilnius supply line (constructed in 1989); (ii) the Vilnius-Panevezys transit line (1988); (iii) the Panevezys-Siaurai-Klaipeda transit line (1962-64); and (iv) the Vilnius-Kalinigrad transit line (1986). In addition, there is an additional unused gas supply line from Ivaceviciai, Belarus to Vilnuis, which was constructed in 1961. At first gas distribution was primarily intended for use at industrial factories as raw feed stock and/or fuel. Today, with the exception of newly developed areas, residential areas in major cities have been extensively covered by the distribution network. Inside Lithuania, only one gas compressor station[1] is provided at Panevezys. In each major city, there is a gas dispatch center from which gas is distributed to each consumer. During the former Soviet regime, all planning was carried out by the Leningrad State Engineering Institute, "Giprosgaz". All the equipment and materials were brought in from Russia.

B. Gas Compressor Station at Panavezys

2. The station was constructed in 1973 to transport gas in three directions; to Latvia and Klaipeda when gas is transferred from Minsk, and to Vilnius when gas is sent from Latvia. The station has seven 1,500 HP reciprocating compressors driven by gas engines, all of which were manufactured in Russia before World War II. The maximum gas-handling volume is limited to 7 BCMY while gas compression is being made, increasing pressure from 44 Bar G to maximum 53 Bar G. At present, the gas compressor is used to send gas to Siuliai and Klaipeda cities.

3. Despite their age, all the mechanical units are relatively well maintained. However, the station control panel has been out of order since 1977 and the compressor station lacks the monitoring function of the relevant pipeline stations. All the operations are done manually, including the operation of large diameter valves. Communications between stations by telephones requires operators at each station on stand-by 24 hours a day.

4. Gas flow measurements using Russian-made flow meters are not only inaccurate (more than +/- 1.5% errors) but also lack flexibility against flow rate turn-down. In addition, due to lack of metering units at each household or other small consumers, about 7% of the total gas volume sent from Minsk via Vilnius is over-consumed, in comparison with total gas consumption calculation based on 8.5 m^3 per person per month.

[1] At present, Silvintu gas compressor station is not used.

C. City Dispatch Center

5. To each gas dispatch center in large cities, gas is sent at a maximum pressure of 45 Bar G. At dispatcher centers, the gas pressure is lowered and regulated at about 12 Bar G. Gas is filtered and odorant is added. Under a dispatcher, there are many (in case of Vilnuis, 80) gas regulating stations where gas pressure is further lowered to about 3 Bar G to distribute to end-users. In cities, the gas distribution networks use underground steel pipelines with forced electric cathodic protection.

6. As with the gas compressor station, all the operations at dispatch centers are manual. Russian-made flow measuring units cause measurement errors (more than +/- 1%).

D. Environmental Aspects

7. Although no official report is available on gas leakages, as with the CIS republics, there is a high possibility of gas losses through leakages in small percentages of the total imported gas volume, at the Panavezys gas compressor station, gas dispatcher centers and pressure regulating stations in cities, and by individual gas consumers. In particular, the old pipeline facilities constructed in the 1960s, including the Ivaceviciai-Vilnius line, very possibly have lost their tight seals at valves and flanges. At some time in the near future, a thorough engineering survey would be required to identify precisely locations where rehabilitation is needed. The effectiveness of coating and cathodic protection would also need to be checked along the entire pipeline route.

8. Compared with other fossil fuels, natural gas is considered to be an environmentally friendly fuel, minimizing emissions to the atmosphere. However, further energy conservation measures would be required at various consumer levels to decrease a total emission volume of environmentally hazardous substances.

Major Gas Pipelines in Lithuania

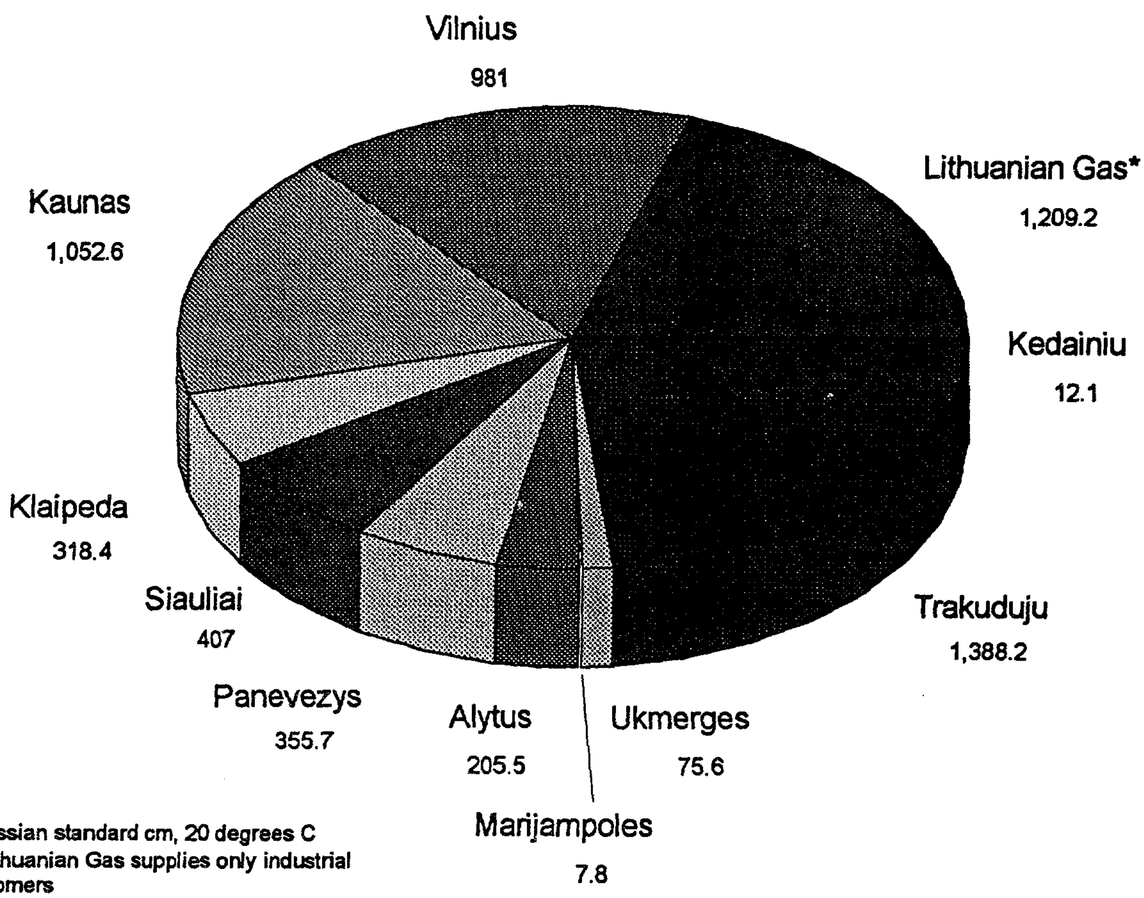
Name of Pipeline	Design Capacity (BCMY)	Diameter (mm)	Length (Km)	Year of Commission
1) Ivaceviciai-Vilnius	0.6	720	61.9	1961
2) Vilnius-Panevezys-Riga	4.0*	720	24.4	1988
First section from Panevezys		529	117.7	
Second section from Panevezys		325	3.5	
3) Riga-Panevezys-Vilnius (2nd line)	*			
Riga-Panevezys		720	59.5	
Panevezys-Sirvintos		720	126.2	
4) Vilnius-Kaunas	3.3			
Vilnius-Elektrenai		720	39.4	
Elektrenai-Kaunas		377	47.1	
5) Panevezys-Siauliai-Klaipeda	0.5	377	106.4	1962-64
6) Vilnius-Kaliningrad	0.9			1986
Branch to Jonava		820	22.1	
Branch to Jonava-Kaunas		720	78.8	
Kaunas-Kaliningrad		530	83.6	
7) Minsk-Vilnius	11.8			1989
Minsk-Sirvintos		1200	58.3	
Sirvintos-Vievis		1020	24.8	

Source: Lithuanian Gas

* 4 BCMY is the combined capacity of both lines.

Note: All pipes built with a design pressure of 50 Bar G

Gas Consumption by Region, 1991 Million Cubic Meters*



* Russian standard cm, 20 degrees C
** Lithuanian Gas supplies only industrial customers

Major Gas Consumers

1991, Bcm per year

Group of consumers	Gas Consumption		Share (%)
1. Household	**0.3**		**5.0**
2. Commercial	**0.2**		**3.3**
3. Agriculture	**0.2**		**3.3**
4. Industry *	**2.0**		**33.3**
of which			
Nitrogen Fertilizer Plant		1.2	
Cement Plant		0.1	
5. Electricity & Heat Production	**3.3**		**55.0**
of which			
Elektrenai		1.2	
Vilnius		0.7	
Kaunas		0.7	
Klaipeda		0.1	
Siauliu		0.1	
Panevezi		0.2	
Alytaus		0.2	
Total	**6.0**		**100.0**

Source: Lithuanian Gas

* Production of Ammonia 0.6m t/y, Urea 0.265m t/y, Ammonia Sulfate 0.45m t/y, Methanol 0.1m t/y, Carbon Glue 0.117m t/y, Cement 3.4m t/y

LITHUANIA

Energy Sector Review

Agreement of Cooperation between MoE/LG and DONG

General

1. An agreement of cooperation was made on February 18, 1992, between MoE/LG and the National Oil and Gas Company of Denmark (DONG) in an effort to modernize Lithuanian gas sector. The agreement consists of three TA components, i.e: (i) Gas Development Plan; (ii) Border Metering Station; and (iii) Management Training, using about $0.9 million by Danish grant fund. The validity of the agreement is for two years with an extension clause. The actual implementation of the TA is from 1993 and it is scheduled that all three components are completed within 5 to 9 months. DONG established similar agreements with Latvia and Estonia. All three TA programs in the three countries are intended to take place almost simultaneously, starting from the TA for Lithuania. DONG's position is considered to be an in-house consultant for the countries and the access to other international agencies including the Bank is widely left open.

Gas Development Plan

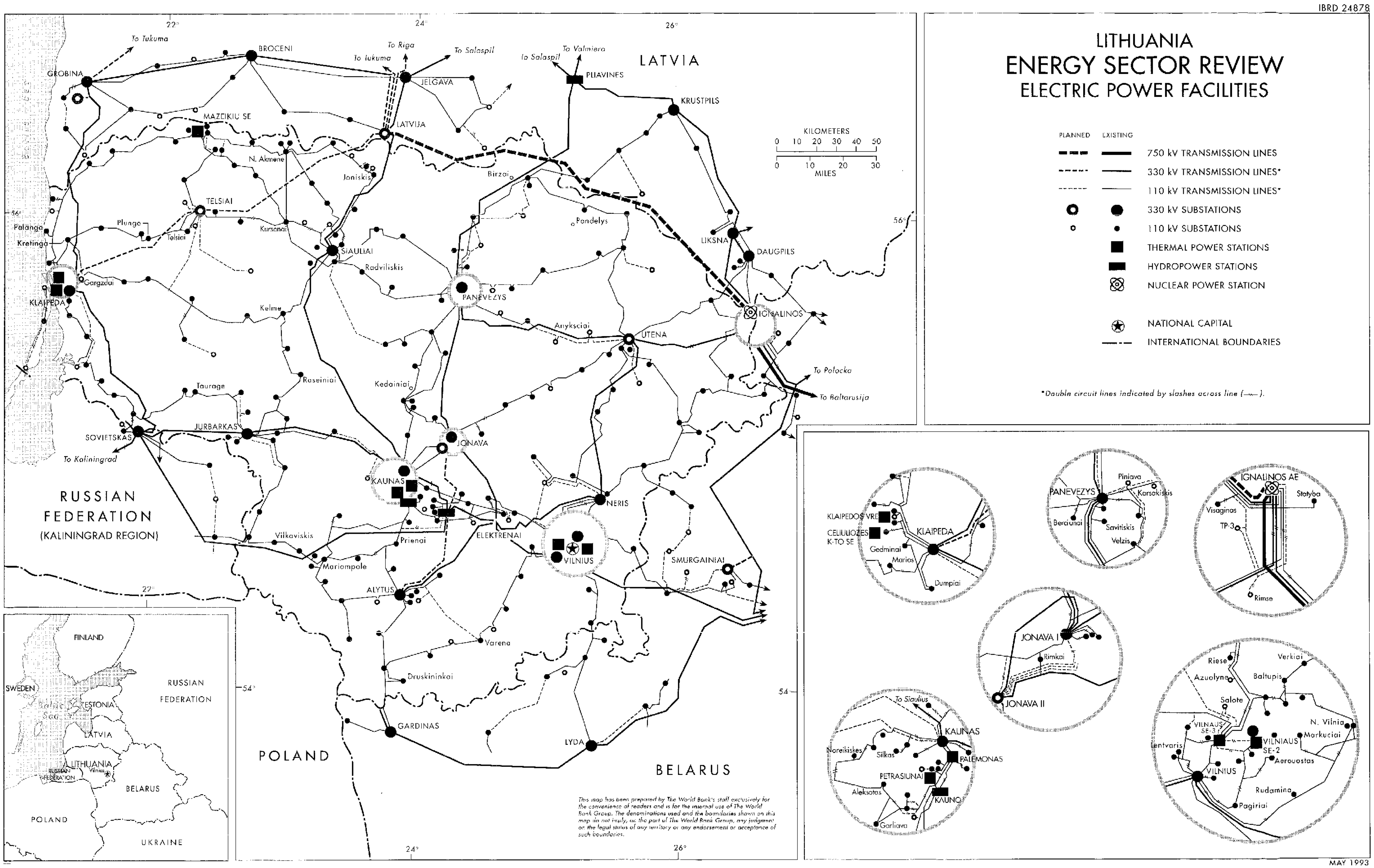
2. The objectives of this component is establishing a management tool in MoE and LG for continuous decision making for the gas sector growth rather than formulating specific goals for five to ten years. The scope of work includes review and assessment of: supply; demand; transmission/distribution; pricing; and institutional arrangements. At the end of the TA, recommendations will be made on optimum allocation of gas among different users, and an investment strategy and financing plan for the gas sector development.

Border Gas Metering Station

3. The emergence of new national borders after independence of Lithuania call for new meter stations at the borders for international gas supply transactions. This TA component is very specific and intended for procurement preparation of the metering units. The scope of work includes: review of the existing facilities; conceptual design of rehabilitation and new facilities; engineering of the meter functions; planning for construction of the meter stations; and preparation of tender documents.

Management Training

4. The objective of this TA component is to support a rational development of the gas sector through management training for selected staff in Lithuania. The training targets are to upgrade managerial skills and to enhance modern corporate management, covering: organizational model; marketing; economic and financial management; corporate and project management techniques; labor regulation and personnel management; and planning of operations and maintenance. The scope of work included in the present TA component is limited to formulation of a framework for future training requirements at various level of staff in Lithuanian gas sector.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LITHUANIA
ENERGY SECTOR REVIEW
ELECTRIC POWER FACILITIES
PLANNED EXISTING
750 kV TRANSMISSION LINES
330 kV TRANSMISSION LINES*
110 kV TRANSMISSION LINES*
330 kV SUBSTATIONS
110 kV SUBSTATIONS
THERMAL POWER STATIONS
HYDROPOWER STATIONS
NUCLEAR POWER STATION
NATIONAL CAPITAL
INTERNATIONAL BOUNDARIES
*Double circuit lines indicated by slashes across line.
KILOMETERS
0 10 20 30 40 50
0 10 20 30
MILES
LATVIA
RUSSIAN FEDERATION
(KALININGRAD REGION)
POLAND
BELARUS
To Tukuma
BROCENI
To Riga
To Iukuma
To Salaspil
To Valmiera
JELGAVA
PLIAVINES
KRUSTPILS
GROBINA
MAZEIKIU SE
LATVIJA
N. Akmene
Joniskis
Birzai
TELSIAI
Plunge
Telsiai
Kursenai
Palanga
Kretinga
SIAULIAI
Radviliskis
Pandelys
LIKSNA
DAUGPILS
Gargzdai
KLAIPEDA
PANEVEZYS
Kelme
Anyksciai
UTENA
IGNALINOS
To Polocka
To Baltarusija
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Taurage
JURBARKAS
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JONAVA
KAUNAS
NERIS
Vilkaviskis
Prienai
ELEKTRENAI
VILNIUS
SMURGAINIAI
Mariompole
ALYTUS
Varena
Druskininkai
GARDINAS
LYDA
22°
24°
26°
56°
54°
FINLAND
SWEDEN
Baltic Sea
ESTONIA
RUSSIAN FEDERATION
LATVIA
LITHUANIA
Vilnius
RUSSIAN FEDERATION
BELARUS
POLAND
UKRAINE
KLAIPEDOS VRE
CELIULIOZES K-TO SE
Gedminai
Marios
Dumpiai
PANEVEZYS
Piniava
Karsakiskis
Berciunai
Savitiskis
Velzis
IGNALINOS AE
Statyba
Visaginas
TP-3
Rimse
JONAVA I
Rimkai
JONAVA II
To Siauliu
KAUNAS
Noreikiskes
Silkas
PALEMONAS
PETRASIUNAI
Aleksotas
KAUNO
Garliava
Riese
Verkiai
Azuolyna
Baltupis
Salote
VILNAUS SE-3
VILNIAUS SE-2
N. Vilnia
Markuciai
Lentvaris
Aerouostas
VILNIUS
Rudamina
Pagiriai
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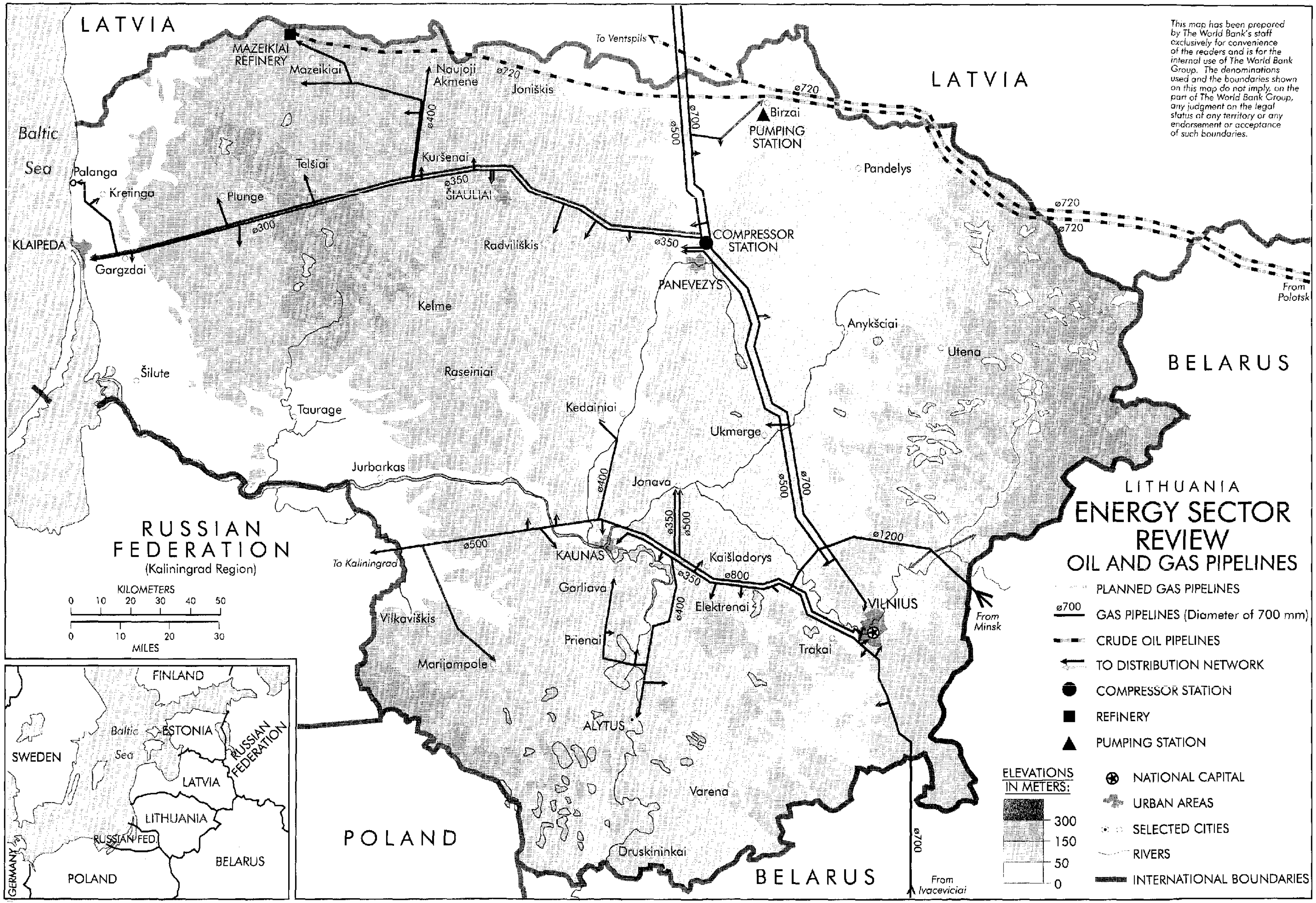

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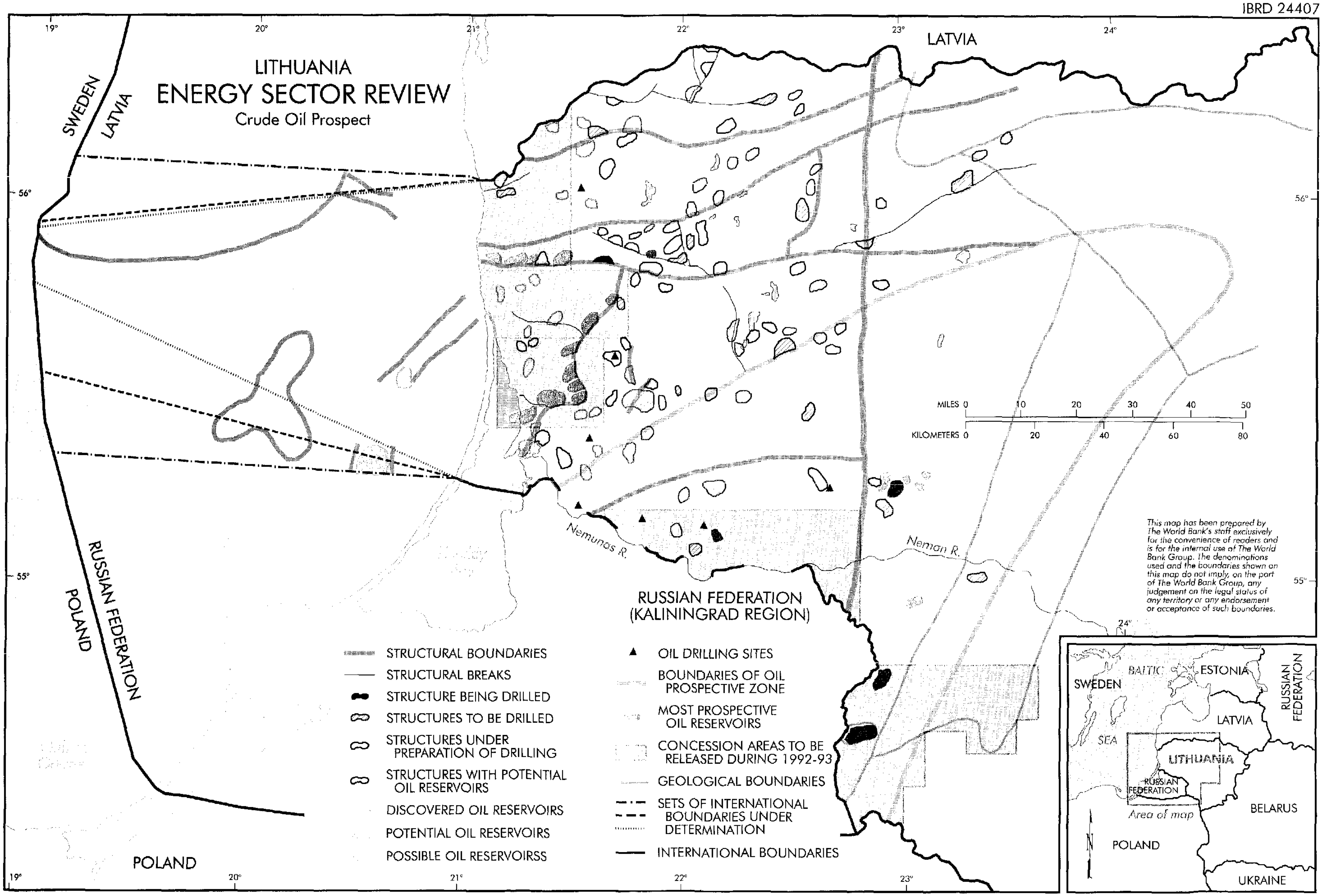

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