THE ARMENIAN FUEL SECTOR
RECOMMENDATIONS FOR REFORM

Prepared for

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EXHIBITS

TERMS AND ABBREVIATIONS

ANPP	Armenian Nuclear Power Plant
Armenergo	Armenian State Energy Enterprise (electric power)
Armgasprom	Armenian State Natural Gas Industrial Enterprise
Armoilproduct	Armenian State Refined Product Enterprise
ArmRosGazprom	Armenian-Russian natural gas joint-venture company
Armturtrade	Armenian-Turkmenistan Trade Enterprise
ATM	one atmosphere (measure of pressure)
barter	non-monetary exchange of goods
bcm	billion cubic meters (gas)
CHP	combined heat and power plant
cm	cubic meters (gas)
CNG	compressed natural gas
EBRD	The European Bank for Reconstruction and Development
ERC	Energy Regulatory Commission
FSU	former Soviet Union
GDP	gross domestic product
give-and-take	agreement by which fuel supplier gives a power plant fuel and takes a percentage of the electricity that is produced
GoA	Government of Armenia
GWh	gigawatt hour (1 billion watt/hours)
Haigasard	Armenian spelling of Armgasprom
Haigas	Armenian Natural Gas Distribution Enterprise
Haitransgas	Armenian Natural Gas Transmission Enterprise
HPP	hydroelectric power plant
kcal	kilocalorie (1000 calories)
kg	kilogram (1000 grams)
KWh	kilowatt hour (1000 watt/hours)
MOE	Ministry of Energy
mm	millimeters
MW	megawatt (1 million watts)
MWh	megawatt hour (1 million watt/hours)
NIS	Newly Independent States
NPP	nuclear power plant
toe	tonnes of oil equivalent
tonne	metric ton (1 016 tons)
TPP	thermal power plant
TWh	terrawatt hours (1 trillion watts/hours)

EXECUTIVE SUMMARY

This report describes and assesses the conditions within the Armenian fossil fuel markets, as well as the government's fossil fuel policies, from the perspective of the thermal power plants The aim of this report is to provide the Government of Armenia (GoA) with fossil fuel market policy recommendations that can be implemented to support and enhance the progress of the electric power sector reforms As the single greatest cost in the production of electricity, fuel and fuel supply issues are central to the financial viability of Armenia's thermal power plants Access to adequate supplies of high quality, low cost fuel will be essential for the thermal power plants to operate as profitable companies in the restructured Armenian power industry Without significant improvements in the fuel markets, the thermal power plants will continue to struggle operationally and financially

This report analyzes the fuel needs of the thermal power plants and examines the markets for each of the major fossil fuels consumed by the power sector, namely natural gas and mazut (heavy fuel oil) Even though coal is not consumed by the power plants, a chapter is also devoted to the coal market in order to present a complete picture of the availability of all types of hydrocarbon fuels in the Armenian market Policy recommendations are presented at the end of the report for improvements in power plant fuel procurement and management as well as for the natural gas, mazut and coal markets

The need to analyze the fuel markets in Armenia stems from the major structural and functional reforms facing the energy industry as the country moves toward a market economy Furthermore, the reform of these two industries must be coordinated since the electricity and fuel industries are highly interconnected The electric power industry is the single largest consumer of fossil fuel in the economy, while fossil fuel is currently used to produce about 50% of the electricity generated in Armenia Thus, the successful reform of the power sector depends heavily on progressive reforms in the fuel sector However, the changes in the electric power sector and those in the fossil fuel market are not progressing in a parallel, coordinated manner In fact, the reforms in the fuel sector (and in the general economy) are lagging far behind those in the power industry This disparity in the progress of reforms between these two interconnected industries is creating a number of serious fuel related problems for Armenia's thermal power plants

The most serious fuel-related problem facing the Armenian energy industry is the power plants' inability to purchase fuel due to a lack of cash This particular problem is rooted in the payment collections and cash flow process within the electric power industry and is in turn a product of the larger non-payment issues plaguing the overall economy The result at the

power plants is a lack of cash to purchase the fuel needed to operate effectively within the electric power system Current bill collections in the power sector are about 65% of billings Without cash, the power plants are forced to buy fuel through non-cash instruments or to accumulate payment arrears and other debts to fuel suppliers The lack of cash at the power plants reduces their ability to procure the necessary quantities and qualities of natural gas and mazut In the past this has resulted in electricity supply and system frequency problems

Even with adequate cash reserves for fuel procurement, the thermal power plants currently do not have the authority to purchase their own fuel This is a major obstacle in the process of unbundling and corporatizing the power plants Without any authority over fuel procurement decisions, the thermal power plants are deprived of control over the single greatest factor determining their financial and operational viability The thermal power plants must have the ability to make their own fuel procurement decisions in order to operate as truly independent companies with full control over their current business operations as well as their long-term corporate planning

Within the fuel industries in Armenia themselves there are a number of barriers to the development of competitive and robust markets Nearly all of the fuel markets are dominated by state monopolies The natural gas market, for example, is still controlled by the Ministry of Energy The state also has considerable control over the mazut and refined product market through Armoilproduct and Armturtrade, the state-owned enterprises which handle much of the import and distribution of mazut and other refined products The state also continues to control the coal market through the Ministry of Energy's State Solid Fuel Enterprise While this enterprise is available for privatization, there is only a limited commercial future for the coal market in Armenia

Transportation constraints further limit the development of fuel markets by restricting fuel supply sources and reliability Currently, Armenia is connected to foreign fuel suppliers through a single transportation corridor - the neighboring Republic of Georgia A single rail link and natural gas pipeline through Georgia are the only means of importing fuel to energy-scarce Armenia Mazut must be shipped to Georgian ports and natural gas must transit the Georgian pipeline system to reach Armenia Reliance on single mazut and natural gas transportation links reduces the reliability of fuel supplies to the Armenian market, as witnessed during the fighting in Georgia in the early 1990's, and limits fuel suppliers to those which can deliver fuel to Georgian ports or through the Russian gas pipeline network

In addition, mazut storage facilities are controlled largely by Armoilproduct This state-owned enterprise has refused to lease or otherwise provide access to its storage facilities Without storage facilities of their own, private mazut importers are forced to sell mazut shipments directly from the railroad tanker cars as they arrive in the country These deliveries must be prepaid and negotiated in advance The inability to sell mazut from stockpiles within the country limits the options for both private importers and buyers, further retarding the development of a large-scale mazut market

Recommendations

To ensure that the electric power industry is able to complete its progressive reform program, a number of governmental policies should be enacted to alleviate the problems in the fossil fuel markets These cross-cutting recommendations include

- The development of a comprehensive national energy policy clearly indicating the future direction of energy reforms in Armenia This national policy should focus on the process and scope of transforming state-owned energy enterprises into corporatized and privatized companies as well as outlining the development of fuel markets within the country The policy should begin by identifying the government's energy sector reform goals and program objectives Methods for achieving these goals and objectives must be identified and paired with financing sources, including international assistance In addition to this basic structure such a national energy policy should include

  - A re-evaluation of the current reform plans for the fuel sectors The efforts to reform the fuel sectors should be brought in line with the vision for the reform of the entire energy industry

  - An emphasis on reducing the role of the State in actual energy production and enterprise management in favor of the private sector Privatization of state energy industries should be seen as a method for improving the health, attracting investment, and promoting the industry's development

  - A plan to restructure the State energy institutions to reflect the focus of the government on policy formation and regulation instead of on setting production targets and directing investment decisions Past energy policies have mainly focused on identifying what is technically possible and then setting costs to achieve greater energy output

  - The improvement of energy policy coordination between the various energy sectors Grouping all state-owned energy enterprises (including Armoilproduct) under the Ministry of Energy before corporatizing and then privatizing them may be part of this process

  - The creation of a timeline establishing milestones and dates for achieving the goals outlined in the policy A timeline will help to visually organize the sequencing of reform activities and add to the coordination of the reforms between various energy sectors

  - Establish greater transparency in the reform process by publicizing forecasts and restructuring plans

- To develop competitive fuel markets, the GoA must increase cash collections from electricity consumers by enforcing the "user pays" principle while simultaneously improving cash flow within the industry to ensure that electricity producers are paid the full value for the power that they produce

- The GoA should continue to liberalize domestic fuel prices by removing any residual administrative pricing controls in favor of market pricing, or prices regulated by the independent Energy Commission

- To the extent government control of pricing continues, fuel should be priced according to its heat content, not according to its weight or volume

- The transportation industry, particularly the railroad, should also be corporatized and regulated to ensure that energy consumers are protected from monopoly abuse and to provide similar conditions for all suppliers

- The GoA should encourage the development of alternative transportation and import options to give energy traders and consumers more choices and energy options The current lack of supply options reduces competition within the fuel market and lowers reliability

- Continued cooperation with donors and international lending institutions can provide technical as well as financial capital for the reform of the fuel markets

Additional recommendations for each of the specific fuel and energy sectors discussed in this study are presented in Chapter 6

CHAPTER 1
INTRODUCTION

1 1 OVERVIEW OF POWER AND FUEL SECTOR REFORMS

Over the past several years, the Government of Armenia has embarked upon an ambitious restructuring program to transform the ailing, state-owned electric power industry into a financially viable group of unbundled enterprises, and to encourage market reform in this sector of the economy This effort has resulted in significant progress toward transforming the power sector into a market-driven industry However, the continued success of the power sector restructuring may be hampered by the myriad problems existing in the country's fossil fuel markets

While a governmental policy has been established for the reform of the Armenian electric power industry, similar plans for the restructuring of the country's fuel markets have yet to be fully developed The establishment of an efficient electricity industry in Armenia will rely on the existence of competitive domestic fuel markets with reliable access to multiple fuel suppliers

This report will assess the Armenian fossil fuel markets and analyze them from the perspective of Armenia's largest fuel consumers the country's two major fossil fuel power plants The report will also present recommendations to assist the Government of Armenia in reforming the fossil fuel market to further support the restructuring of the electric power sector

1.2 GENERAL FOSSIL FUEL MARKET ISSUES

To examine the fossil fuel markets from the perspective of the thermal generating companies, it is necessary to consider a number of issues specific to the fuel markets, such as fuel supply, price, quality, and transportation These are discussed below

In addition, it is important to note the impact of regional political instability which undermines the entire economy The countries and enclaves in the Caucasus region have experienced nearly continuous outbreaks of political violence, from civil unrest to full-scale war since the collapse of the Soviet Union in 1991 During the 1990's, some of the bloodiest ethnic fighting in the former communist world, aside from Bosnia-Herzegovina, has occurred in the Caucasus regions of Georgia (Abkhazia, Southern Ossetia), Russia (Chechnya, Northern Ossetia), and Azerbaijan (Nagorno-Karabakh) While Armenia has not suffered any major fighting on its territory during this period, the country has been deeply involved in the Nagorno-Karabakh conflict with Azerbaijan The fighting in the region contributed to serious fuel supply problems, increased fuel

prices, and reduced fuel quality A major step for the long-term development of fossil fuel markets in Armenia will be a cessation to the hostilities in the region, or the establishment of feasible ways to bypass the problem areas

Electricity Non-Payment

Underlying the analysis of any fuel market is the assumption that consumers — in this case the thermal power plants — have the ability to pay for the fuel they purchase The collections rate for electric service, both in cash and in total, has steadily improved over the past few years following the Nagorno-Karabakh cease-fire in 1994 and the adoption of aggressive collection programs by the country's electricity distribution utilities The bill collection rate increased from 20 percent in 1994 to about 70 percent in 1997 Despite this improvement in collection, Armenia's power plants are suffering from low payments by Armenergo and do not receive their fair share of revenues collected

This lack of cash in the power sector drains the working capital from the power plants, resulting in inadequate salaries, the postponement of important maintenance and repair programs, and an inability to buy fuel The latter problem creates severe fuel supply shortages within the power industry that have led to major electricity curtailments and large fluctuations in system frequency in the past

Given adequate cash reserves, the power plants could implement competitive fuel procurement tenders, tapping into larger domestic and foreign fuel markets The competition among fuel suppliers to fill large fuel procurement orders backed by cash would ensure that the power plants receive lower cost and higher quality fuel The power plants would be in a superior position in terms of negotiating delivery schedules, quality specifications, and performance penalties Thus, improved collections and flow of cash to the power plants would in turn support successful development of a reliable Armenian fuel industry

Fuel Supply and Stockpiling

Access to reliable fuel supplies is necessary for a thermal power plant to meet its customers' demand for electricity The availability of a variety of fuel supply sources and transportation options allow a power plant to continue operating in the event of an unexpected fuel supply interruption

Since fuel deliveries can be interrupted without warning, or electricity demand can suddenly rise with changes in the weather or other factors, it is necessary for thermal power plants to maintain adequate fuel reserves While maintaining a large stockpile of fuel is a significant expense for the plant, it is insurance against the need to reduce power generation or even shut down the plant for lack of fuel deliveries The amount of fuel stockpiled should be in proportion to the supply risks

in the fuel market Typically, power plants in the United States maintain anywhere from 30 to 90 days of fuel reserves In countries that experience more serious fuel supply problems, power plants should maintain reserves to cover at least 30 days of operation, to protect themselves against the increased supply risks

Fuel Price

The price of fuel is the single largest factor in the cost of producing electricity at thermal power plants Any increase in the price of fuel has an immediate impact on the cost of generating electricity and, subsequently, on the profitability of a thermal power plant In Armenia, where fuel costs reportedly make up over 87% of the variable cost of generating electric power, the power sector is particularly sensitive to changes in fuel prices [1] Liquidity constraints limit the ability of generating plants to internally finance short-run revenue deficits resulting from higher fuel prices Therefore, electricity tariffs must be able to respond quickly to fuel market changes

The general economic performance of the power sector (and the overall economy) can be improved under conditions where fuel prices reflect the actual costs of supply, as opposed to a system where prices are administratively fixed Fuel price flexibility will not present a problem as long as power producers can pass through the price of fuel to power consumers in a timely manner There is a tradeoff between stability of net revenue streams for power plants and electricity price variability for consumers Given that price flexibility is necessary for the financial health of the thermal power plants, the benefit of responsive electricity prices to the power sector should outweigh the inconvenience to the general public

Fuel Quality

Steam boilers in thermal power plants are massive pieces of machinery built to operate using fuel that conforms to strict specifications In order for a boiler to operate efficiently, it must be provided with the correct type and quality of fuel When substandard fuel is introduced into a boiler, the boiler's efficiency is dramatically reduced The decrease in efficiency reduces the boiler's ability to produce steam, reducing the amount of electricity that the generating unit can produce Thus, a 200 MW thermal power unit may be only able to operate at 160 MW when using poor quality fuel Poor fuel quality throughout the power sector significantly reduces the generating capacity of the system

The importance of fuel quality makes fuel testing a high priority for any thermal power plant Fuel suppliers, both in Armenia and in Western countries, are required to test and certify that the fuel they ship to thermal power plants meets quality requirements specified in the fuel supply

[1] Based on Energy Commission tariff calculation for the second half of 1997and estimates given by the general director of the Yerevan thermal plant

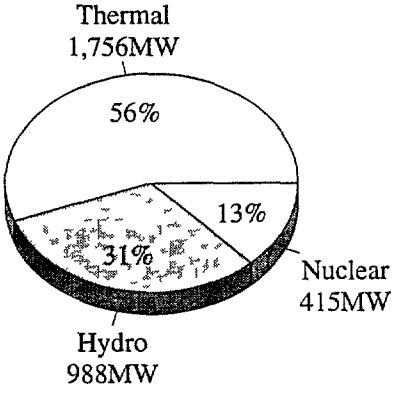
contracts However, the power plants should have the ability to independently verify fuel quality and ensure that the fuel meets contract specifications

CHAPTER 2
POWER GENERATION INDUSTRY

2.1 GENERATION CAPACITY AND DEVELOPMENT

The Armenian power generation industry has a small, but relatively diverse mix of generating assets The major generating facilities include two large thermal combined heat and power plants (TPPs), a nuclear facility, two major hydropower cascades, and numerous small-scale hydropower units Thermal power plants provide 1,756 MW of capacity and account for 56% of the over 3,100 MW of total installed capacity The remaining capacity is split between hydro (31%) and nuclear[1] (13%) generation (see Exhibit 2-1) [2]

Exhibit 2-1
Installed Capacity



Source World Bank and Ministry of Energy

As in many former Soviet republics, the available generating capacity in Armenia is far less than the baseplate installed capacity Reasons for the reduction of actual generating capacity include the advanced age of many of the generating units, "cannibalization" of existing units, and a general lack of maintenance

All of the thermal generating units in Armenia are between 20-35 years old, having been commissioned in the period from 1963-1976 Nearly all of the hydroelectric power plants are over 20 years old with some even surpassing the 50 year mark After decades of wear and tear, even with periodic overhauls and refurbishment, these units can no longer match their original baseplate capacity

[1] The Armenian Nuclear Power Plant (ANPP or Metzamor) provides 415 MW of capacity since only one of its two units is operational

[2] In terms of total installed capacity the Armenian power generation industry is roughly the same size as that of Kyrgyzstan and between 770 MW and 1 260 MW smaller than those of neighboring Georgia and Azerbaijan (see Exhibit 2-2)

Exhibit 2-2
NIS Installed Capacity

1	Russia	213 300 MW
2	Ukraine	55 300
3	Kazakhstan	17 380
4	Uzbekistan	11 690
5	Belarus	7 000
6	Lithuania	5 700
7	Azerbaijan	4 900
8	Georgia	4 410
9	Tadjikistan	3 800
10	Kyrgyzstan	3 660
11	Estonia	3 311
12	Armenia	3 159
13	Moldova	2 998
14	Turkmenistan	2 480
15	Latvia	2 032

Source 1996 CIA World Factbook Hagler Bailly Services 1997 DOE EIA Country Analysis Briefs

The shortage of working capital in the power sector for spare parts and maintenance further reduces available capacity by extending the period of time units are off-line for repairs and general maintenance Occasionally units are taken off-line and cannibalized for parts to keep other units operating While cannibalized plants are sometimes restored to operating condition when new parts arrive, generating capacity is temporarily lost Due to these constraints, and the fact that the Metzamor nuclear plant was closed for several years in the early 1990's, the total available capacity in Armenia was reduced to 1,700 MW in 1994 [3]

In addition to constraints imposed by the age of the generating units, the lack of spare parts and funding for general maintenance, fuel shortages limit electricity production from available generating capacity Without adequate fuel supplies many generating units are forced to run at reduced loads or shut down entirely This loss of capacity due to fuel constraints can lead to serious electricity supply problems For example, from 1992 to 1994 Armenia was in the grips of a major fuel crisis The economic embargoes by Azerbaijan and Turkey, the political instability in Georgia, and the fighting in Nagorno-Karabakh resulted in a severe fuel shortage within Armenia During the period from 1993-1994, available generating capacity was reduced from 1,700 MW down to only 1,000 MW because of fuel supply constraints, resulting in frequent blackouts [4] Since that time the fuel supply in Armenia has normalized due to increased political stability within the region, allowing Armenia to import more fuel through Georgia

Available capacity has improved in recent years due to more reliable fuel supplies Restarting Metzamor relieved some of the generating burden from the hydro and thermal power plants and increased the available capacity to meet system demand The addition of the second unit at Metzamor and improvements in the power sector have increased available capacity to over 2,286 MW, but this figure is still only 65% of the system nameplate capacity [5] These developments combined with other reforms in the power sector have allowed Armenia to provide continuous electricity service for the past year

[3] 1996 Update of Least Cost Power Investment Program Lahmeyer International GmbH, November 1996

[4] 1996 Update of Least Cost Power Investment Program ' Lahmeyer International GmbH, November 1996

[5] Ministry of Energy/World Bank estimates for 1997

Current forecasts by the Ministry of Energy and the World Bank estimate average reserve margins at 37% for the electric power system (see Exhibit 2-3) [6] With a high level of utilization at the hydro and nuclear plants, these reserve margins rely primarily on capacity provided by the thermal power sector In order to provide such high levels of reserve capacity the thermal power plants must have adequate access to fuel supplies Additional improvements in the domestic fuel markets will help to relieve some of the existing fuel supply constraints and ensure enough fuel is available to meet the needs of the power system

Exhibit 2-3
Estimated 1997 Capacity Utilization and Reserves

	Average Capacity Utilized (MW)	Reserve Factor (%)	Reserve Capacity (MW)	Total Capacity (MW)
Sevan	373	15%	56	542
Vorotan	326	10%	33	390
Other Hydro	44	10%	4	56
Total Hydro	743	13%	93	988
Hrazdan	299	101%	301	1110
Yerevan	149	134%	201	550
Vanadzor	6	320%	18	96
Total Thermal	454	114%	520	1756
Nuclear	400	0%	0	415
Import	65	0%	0	65
Total	1673	37%	613	3224

Source Ministry of Energy

Thermal Power

The Armenian thermal power plants are all designed to consume either natural gas or mazut The Yerevan thermal power plant is located just outside of the capital, while the Hrazdan station lies only a few miles from Lake Sevan The Vanadzor thermal power plant is in the northwestern region of the country, midway between Hrazdan and the city of Gumri Presently, Vanadzor it is not operating These power plants provide steam for district heating and process heat for the manufacturing facilities and communities surrounding the plants

[6] Ministry of Energy/World Bank estimates for 1997

These three power plants — Hrazdan, Yerevan, and Vanadzor — are all over 20 years old, with several units at each station surpassing 30 years of service (see Exhibit 2-4) The age and poor condition of these generating stations is evidence of two separate developments in the Armenian power sector over the past two decades The first was the movement, during the last 10-15 years of the Soviet period, away from thermal power plant construction From the mid-1970s to 1986, nearly all available resources for electric power development were diverted to the construction of nuclear baseload power plants and hydroelectric peaking facilities Throughout the Soviet Union, nuclear and hydroelectric power plants were expected to serve as the backbone of the Soviet power generation industry

Exhibit 2-4
Armenia's Thermal Capacity

Thermal Power Plant	Installed Capacity (MW)	Units (# x MW)	Year Commissioned	Fuel Type
Hrazdan	1 110	2 x 50	1966-1967	Gas/Mazut
		2 x 100	1969	
		3 x 200	1971-1974	
		1 x 210	1974	
Yerevan	550	5 x 50	1963-1965	Gas/Mazut
		2 x 150	1966-1968	
Vanadzor	96	2 x 12	1964-1965	Gas/Mazut
		1 x 25	1970	
		1 x 47	1976	

Source Ministry of Energy

One of the reasons for this shift in generation development was the sharp rise in international fossil fuel prices during the 1970s The Soviet Union was able to supply its own fossil fuel needs, but the fuel price shocks presented an opportunity to sell fuel to energy markets in the West A vast network of pipelines and oil terminals was built to facilitate the export of petroleum and natural gas to Western Europe Nuclear and hydro facilities were constructed within the USSR to replace the country's existing thermal power plants and conserve fuel for export A gradual decommission was planned for the thermal power sector, with the retirement of power plants as they reached the end of their productive lifespan

However, the 1986 nuclear disaster at the Chernobyl power plant in Ukraine effectively stifled the rapid development of the Soviet nuclear power industry While the Soviet Ministry of Power and Electrification struggled to define a new direction for power development in the years following Chernobyl, the economic and social fabric of the USSR quickly unraveled By the end of 1991, the Soviet Union had collapsed as a political entity This event led to the second shock to the Armenian generating industry The dissolution of the Soviet Union triggered severe economic contractions in nearly all of the former republics This, in turn, caused sharp reductions in governmental tax revenues, leaving the newly-formed governments with little or no funds for

infrastructure investments, particularly in the power generation sector Nowhere was this phenomenon more evident than in Armenia, where the government was also struggling in a war with neighboring Azerbaijan

As a result of these two events, the shift in power development, which de-emphasized the construction of new thermal power plants, and the contraction of state financial resources following the collapse of the USSR, Armenia's thermal generation capacity is in dire need of rehabilitation if it is to play a major role in the future of the Armenian electric power system

Nuclear Power

The Armenian Nuclear Power Plant (ANPP/Metzamor) was one of the first nuclear power plants built in the USSR for commercial power production Unlike the graphite-based RBMK design of the Chernobyl facility, constructed around the same time, the ANPP represents an early version of the Soviet heavy water reactors (VVER series 440) The ANPP has two reactor units (see Exhibit 2-5) Each of these reactor units has two 220 MW generators, giving the plant an installed capacity of 880 MW Armenia has no domestic facilities for the production of nuclear fuel rods Thus, Armenia relies entirely on Russia for nuclear fuel imports

Exhibit 2-5
Armenia's Nuclear Capacity

Nuclear Power Plant	Installed Capacity (MW)	Units (# x MW)	Commissioned
ANPP	880	4 x 220	1976-1980

Source Ministry of Energy

The ANPP was completely shut down following a catastrophic earthquake in 1988 While the nuclear facility was not damaged in the earthquake, it was closed as a precautionary measure to ensure that it had not suffered unseen structural damage The electricity crisis in Armenia worsened with the escalation of hostilities in Nagorno-Karabakh in the early 1990s, resulting in severe power shortages The sector was able to supply only two hours of electricity per day, and limited heat during the winter These conditions led the Armenian authorities to restart the ANPP in November 1995 Only one of the reactors is currently functioning (reactor #2) There are no plans to restart reactor #1 due to its poor physical condition Due to the age of the second generating unit and other technical constraints, the maximum generating capacity of the unit has declined from 440 MW to 415 MW

The ANPP provides baseload power in the Armenian power system with the hydro and thermal units providing intermediate and peaking power The generating units associated with reactor #2 are typically shutdown in the summer (August and September) for maintenance and refueling when electricity demand is at its seasonal low point During the winter heating months, as fossil

fuels become scarce, the nuclear reactor is run at full capacity to shoulder the increased burden of electricity generation

Hydro Power

Armenia relied heavily on its hydroelectric power resources during the peak of the country's energy crisis (1992-1994) During this period, the hydroelectric facilities were operated at close to maximum output for extended periods of time as they struggled to make up for the lost nuclear and thermal generation in the system The restarting of the ANPP and the relative improvement in fossil fuel availability at the thermal power plants has recently relieved some of the generation pressure on the hydroelectric plants However, water resources in Armenia remain at critically low levels

Exhibit 2-6
Armenia's Hydroelectric Capacity

Hydro Power Plant	Installed Capacity (MW)	Units (facilities)	Commissioned
Sevan-Hrazdan	542	7	1936-1961
Vorotan	390	3	1970-1984
Small Hydros	56	n a	1930 n a

Source Ministry of Energy

The facilities at the Sevan-Hrazdan cascade, running from Lake Sevan to Yerevan, have the greatest total hydroelectric capacity in the country (see Exhibit 2-6) However, due to the advanced age of these facilities (35-50 years) and the depletion of the Lake Sevan water resources, these hydro plants currently produce less power than those in the Vorotan cascade located in the southern part of the country The Vorotan cascade represents a later stage in the development of the Armenian power sector and was designed to complement the ANPP facility with peaking power during periods of high electricity demand

Sector Development

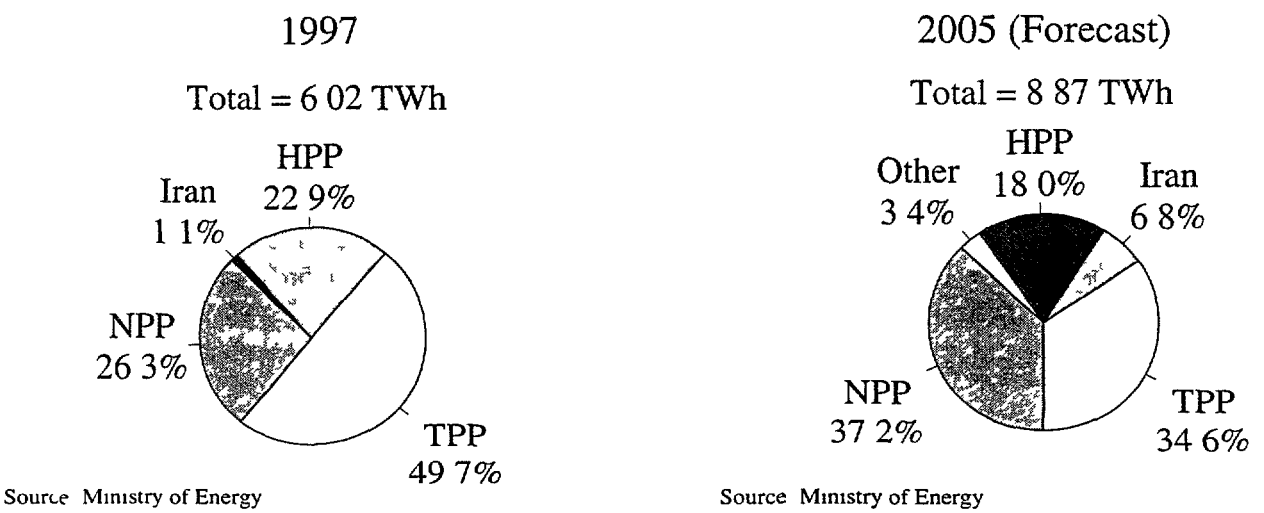
According to Armenian power sector officials, generating capacity will have to expand to meet the increase in electricity demand expected over the next ten years Electricity demand in 1997 was 6 02 TWh According to energy officials, electricity demand is expected to increase by 43% to 8 87 TWh by the year 2005 This increase assumes a strong recovery of the Armenian economy, which may be difficult to attain given the current political/economic problems with Armenia's neighboring countries

Armenian officials are looking at several possible development scenarios for the electricity generation sector These scenarios include events such as the closure of the entire ANPP or expansion of generation capacity through development of generation financed by electricity exports According to officials, it is unlikely that the nuclear plant will be closed in the near future although the Government has committed to the international community to shut down the plant in 2004 The development strategy which the Armenian power sector is currently pursuing includes expanding nuclear and thermal generating capacity while relying on transmission connections with Iran and Georgia to support electricity imports and exports

Armenian officials are currently investigating construction of a new reactor at the ANPP Analysis of the existing, but inoperable unit #1 has shown that rehabilitation would not be economic Armenian officials are contemplating building a new reactor at the plant with an installed generating capacity of between 500-600 MW Funds have already been set aside from the Armenian state budget to conduct a feasibility study of the cost of this new reactor The Government believes that the new reactor could be operational by 2005

There are several obstacles to constructing the proposed reactor by this date The primary obstacle to this development project is the cost (currently optimistically estimated at between $700-$900 million) and the corresponding need to seek external financing, given the Armenian government's tight budgetary constraints Nonetheless, both Russia and France have expressed interest in supporting development of a third reactor at the ANPP

Exhibit 2-7
Generation Mix



Source Ministry of Energy

Source Ministry of Energy

The Ministry of Energy projects that by 2005, nuclear power will increase total generation output, producing roughly 3 3 TWh This figure represents an increase of 1 7 TWh over the current production output of 1 6 TWh, suggesting that the two reactors would operate concurrently Under the current schedule, the third reactor would come on line as the second reactor reaches the end of its expected life (20 years) It is unlikely that the demand for power will be enough in Armenia to warrant baseload production from two nuclear reactors [7]

In addition to the development of a new nuclear unit, several projects in the hydro sector are also planned for completion by the year 2010 A new 1 2 MW hydroelectric plant, Her-Her, has just come on-line An additional 185 MW of hydroelectric capacity is planned for completion by 2010, including Megri (89 MW), Shnokh (75 MW), Argichi (16 MW), and Gegh (5 MW) The Armenian government also anticipates the construction of between 75-80 MW of privately owned hydroelectric facilities In spite of the addition of 260-265 MW of new hydro capacity, total generation by hydroelectric plants is anticipated to remain at 1 6 TWh It has been determined that 1 6 TWh is the maximum output that can be achieved from the hydro plants without draining Lake Sevan and other water reservoirs in Armenia (in a year with an average amount of rainfall) Therefore, the Ministry of Energy intends to hold hydroelectric production steady at the 1 6 TWh level

The thermal sector is expected to experience development of new units and the retirement of a number of older generators and CHPs The completion of a fifth unit at Hrazdan TPP, possibly funded by the EBRD, may be completed within the next three years In addition, the Ministry of Energy plans to install a 167 MW combined cycle gas unit at the Yerevan TPP At the same time, many of the CHP units at the three thermal power plants will be closed due to the decline in demand for district heating A number of the oldest generating units at these plants will also be retired Production from thermal units was 3 0 TWh in 1997, compared to a forecast by the Ministry of 2 5 TWh and a 1996 output of 2 3 TWh The unexpectedly high 1997 thermal generation total was partly due to the extended repair of the ANPP for two and a half months

Armenian officials are also looking at several other generation alternatives The construction of a transmission line between Iran and Armenia was finished in May, 1997 This transmission line is designed to provide Armenia with up to 0 6 TWh (or 200 MW of capacity) of electric power [8] In addition, the Government is considering the development of several small geothermal power plants A small pilot plant may be constructed to test the economic feasibility of geothermal power in Armenia According to Ministry estimates, geothermal plants could produce up to 0 3 TWh of electricity by 2005 A recent study by GeoThermEx call this projection seriously into

[7] Due to the expected restoration of natural gas supplies to the residential sector by 2001 demand for electricity will be reduced

[8] In July Iran stopped the export of electricity to Armenia due to non-payment

question GeoThermEx reviewed the potential geothermal sites and concluded that the water temperatures are too low (40-70 degrees Celsius) to support electricity generation

2.2 INDUSTRY STRUCTURE

Until recently, Armenergo, the state-owned, vertically integrated electric utility, was responsible for all power generation, transmission, and distribution During the Soviet period, Armenergo was affiliated with, and reported to, the Soviet Ministry of Power and Electrification After the declaration of independence in 1991, ownership and control of Armenergo was transferred to the newly-independent Armenian government under the Armenian Ministry of Energy In 1994 Armenergo became a "state concern" and was required to be self-governing and self-financing, but was still subordinate to the Ministry of Energy In the past few years, however, the Armenian power industry has been dramatically restructured The once vertically integrated utility has been functionally unbundled Each of the new power sector enterprises have been given more independence as they move towards corporatization and eventual privatization

In March 1995, the Government and the Ministry of Energy issued a set of orders (Decree 114 and Ministry Mandate 39) initiating the reorganization of the power sector These orders called for the unbundling of the power industry through the establishment of separate generation and distribution enterprises, transmission, system dispatch and wholesale marketing functions were to remain within Armenergo The mandates also required the establishment of contractual and pricing arrangements between the generation enterprises and Armenergo, and between Armenergo and the distribution enterprises As part of this restructuring effort, the government ordered the development of bylaws and a reorganization plan to guide the further separation of electricity generation, transmission, and distribution and sales functions

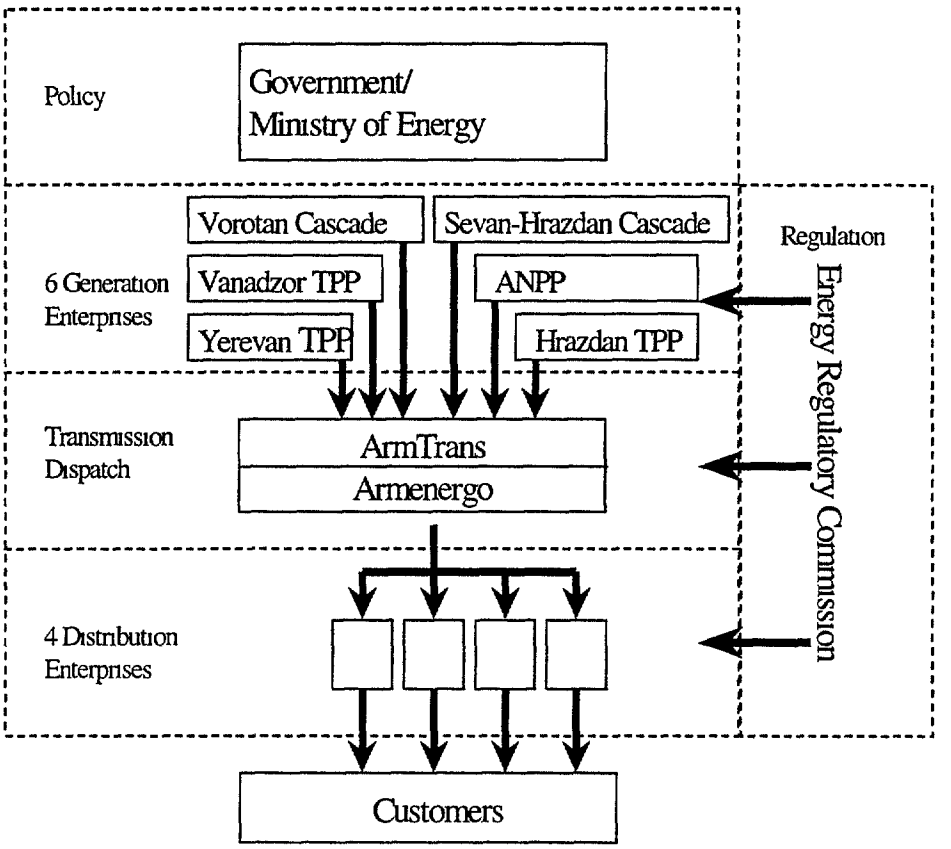
In December 1995, the Ministry of Energy unveiled a plan (Mandate 346) to further restructure Armenergo The plan called for the separation, from Armenergo, of two generation stations (the Sevan-Hrazdan cascade and the Hrazdan thermal power station) Armenergo was to be established as a state enterprise responsible for transmission and dispatch, along with limited generation capabilities

By the summer of 1997, the electric power sector was fully unbundled A total of six independent generation companies were created Three thermal generation companies were created from the three thermal power plants The ANPP remained the lone nuclear generation company, and two hydroelectric power companies were formed from the Sevan-Hrazdan and Vorotan cascades (several small hydroelectric plants continue to operate outside of these six main generating companies) The country's 60+ distribution enterprises were grouped into 11 distribution companies, one in each of Armenia's ten political regions, and one in Yerevan Recently, Armenergo was restructured further Transmission was separated from Armenergo and a new enterprise, ArmTrans, was created Also, the distribution sector consolidation was completed as the 11 previously-existing distribution utilities were reorganized into four companies The entire

power sector is still controlled by the Ministry of Energy, which continues to perform annual production planning, coordinate fuel supply, and formulate industry policy Exhibit 2-8 shows the structure of the power sector at present

Exhibit 2-8

Present Structure of the Armenian Power Sector



2 3 INDUSTRY OUTPUT

Armenia's electric power sector was developed during the Soviet period as part of the integrated Trans-Caucasian Power network This network coordinated power supply among Armenia, Azerbaijan, Georgia, and Russian territories in the North Caucasus region The Armenian network was designed to operate in conjunction with the Trans-Caucasian power system, and the Soviet grid as a whole This allowed for electricity flows between the Caucasus republics as well

as between the Trans-Caucasian system and the entire Soviet power grid [9] System planning decisions were made largely in Moscow This system-wide perspective tended to disregard country-specific energy resources in favor of regional supply objectives As a result, mazut and natural gas-fired plants were constructed in Armenia, even though the country has virtually no hydrocarbon resources During the Soviet period this was not a problem, as oil and natural gas were readily supplied to Armenian power plants by pipeline and rail links to oil and gas fields in Azerbaijan, Russia, and Turkmenistan

Following the collapse of the Soviet Union, however, these fuel supply links quickly deteriorated In 1991, due to the outbreak of hostilities between the newly independent countries of Armenia and Azerbaijan, all Azeri oil shipments to Armenia were officially suspended, as part of an economic blockade along Armenia's eastern border In 1994, Turkey also instituted an economic blockade of Armenia, effectively closing the country's western border This left only the northern rail, pipeline and road links with Georgia open for energy imports [10] However, civil war in Georgia led to the frequent disruption of oil and gas deliveries along this route The theft of oil and gas and occasional sabotage of the pipelines through Georgia greatly increased the cost and risk of importing fuel along this route

In the period from 1988 to 1995, Armenia's electricity production fell 63% (see Exhibit 2-9) The dramatic decline is largely marked by two major events the closure of the ANPP and the fuel crisis resulting from the Azeri/Turkish blockade From 1988 to 1990 power generation in Armenia fell by 4 9 TWh Nearly all of this decline in electricity supply (4 8 TWh) was due to the closing of the ANPP

The second major drop in generation resulted from the severe fossil fuel shortages in Armenia as a result of the Azeri and Turkish economic embargoes From 1991 to 1994, total generation fell by 3 9 TWh, with thermal generation falling by more than 5 8 TWh [11] In an effort to meet the demand for electricity in Armenia, output from the country's hydroelectric plants more than doubled over this period, greatly reducing Armenia's water reserves and posing a serious ecological threat

Even with increased production from the hydroelectric facilities, blackouts and power rationing were common The closure of the ANPP eliminated much of the operating reserve capacity in the Armenian power system, and the thermal power plants lacked fuel for generation Because the electric power grid functions as an integrated system, the loss or reduction of electricity

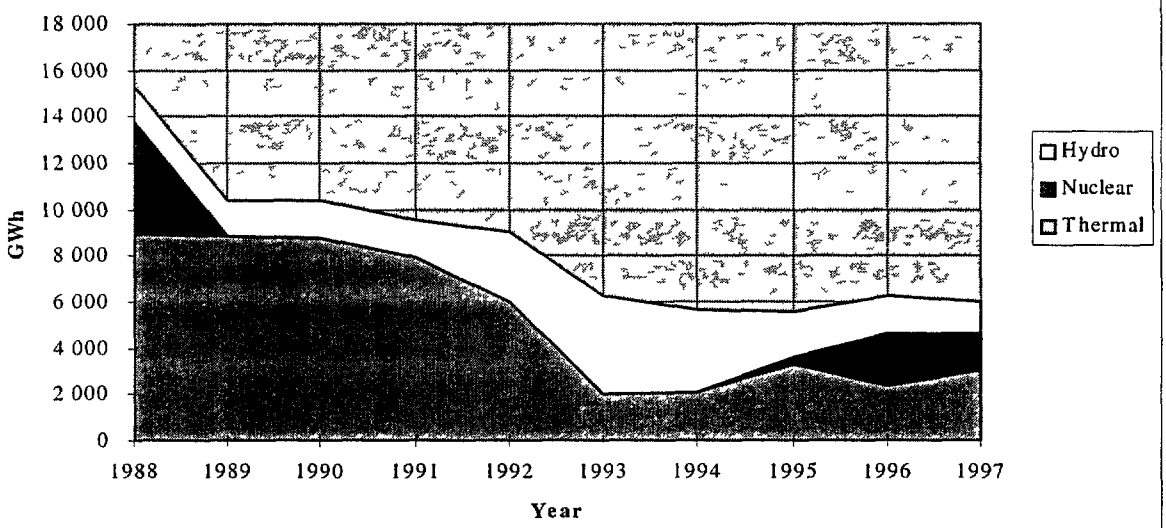
[9] The synchronized Soviet grid did not include the territories of the Russian Far East or certain isolated areas in Siberia These segments of the grid were operated separately from the rest of the Soviet power network

[10] While Armenia s short southern border with Iran is relatively stable there is no fuel transportation infrastructure linking these two countries

[11] The increase in hydro generation reduced the decline in total electricity production

production during periods when reserve generating capacity is low can cause wide fluctuations in the electrical frequency Electrical machinery and equipment are designed to operate at a set frequency (50 Hz in Europe and the former Soviet Union) When the frequency drops below this level, significant damage can result to machinery and other electrically-powered equipment, including equipment at generating plants To maintain the desired electrical frequency, more power must be quickly supplied from other generators, or electricity demand must be curtailed through rolling blackouts and other short-term measures In 1994, Armenian consumers only received two hours of electricity per day, and the frequency in the power system often fell as low as 43 Hz

Exhibit 2-9
Electricity Generation by Type



At the time, Armenia could not import power to balance the load on the system Armenia has transmission interconnections with Georgia, Azerbaijan, and Turkey However, the economic blockade by Azerbaijan and Turkey effectively eliminated power exchanges with these countries, and the civil war in Georgia created power supply and frequency problems more severe than those in Armenia Thus, the Armenian power sector was forced to operate as a closed system, able to consume only as much electricity as it produced

The isolation of the Armenian power sector made meeting electricity demand more difficult When Armenia was unified with the Soviet power system, the demand for electricity in the USSR was spread across 15 time zones, allowing daily energy exchanges to meet the peaks and valleys in daily demand In this system, Armenia's thermal power units were designed to run as constant base-loaded generation However, now that the country operates independently, a number of Armenia's thermal power units must be cycled (increase or decrease their output, as

demand rises and falls) Nuclear power plants cannot be cycled safely, as it is dangerous to fluctuate the intensity of the nuclear activity within each reactor Hydroelectric facilities are often used to regulate the power supply, but years of over dependence on the country's hydroelectric resources has greatly depleted the reservoirs of the hydroelectric cascades, reducing the amount of electricity they can safely generate Thus, the thermal power units are forced to assume the burden of cycling, even though cycling greatly increases wear and tear on the thermal units

Despite these problems, the power system in Armenia has stabilized since 1996 Electric power is now provided to paying customers 24 hours per day and system frequency is near 50 Hz The improvement in the system is due in to a combination of factors including the restarting of the Armenian nuclear power plant, a cease fire in Nagorno-Karabakh in 1994 and relative peace in Georgia resulting in more reliable fuel supplies, an increase in electricity payments enabling Armenergo to purchase more fossil fuel, and US Government and European Union grants for natural gas purchases over the last two years

Thermal power plants currently play a dual role in the power system, some units function as baseload capacity and others provide peaking power in combination with the hydroelectric plants The thermal plants primarily generate during daily peak hours, during the summer when the ANPP is off-line for maintenance and refueling, and the winter when seasonal demand is highest The ability of the thermal units to provide dependable generating capacity has been somewhat strengthened by the dramatic increase in electricity payments, from only 20% in 1994 to about 70% by 1997 However, the lack of a proper financial settlement process continues to plague the generation sector

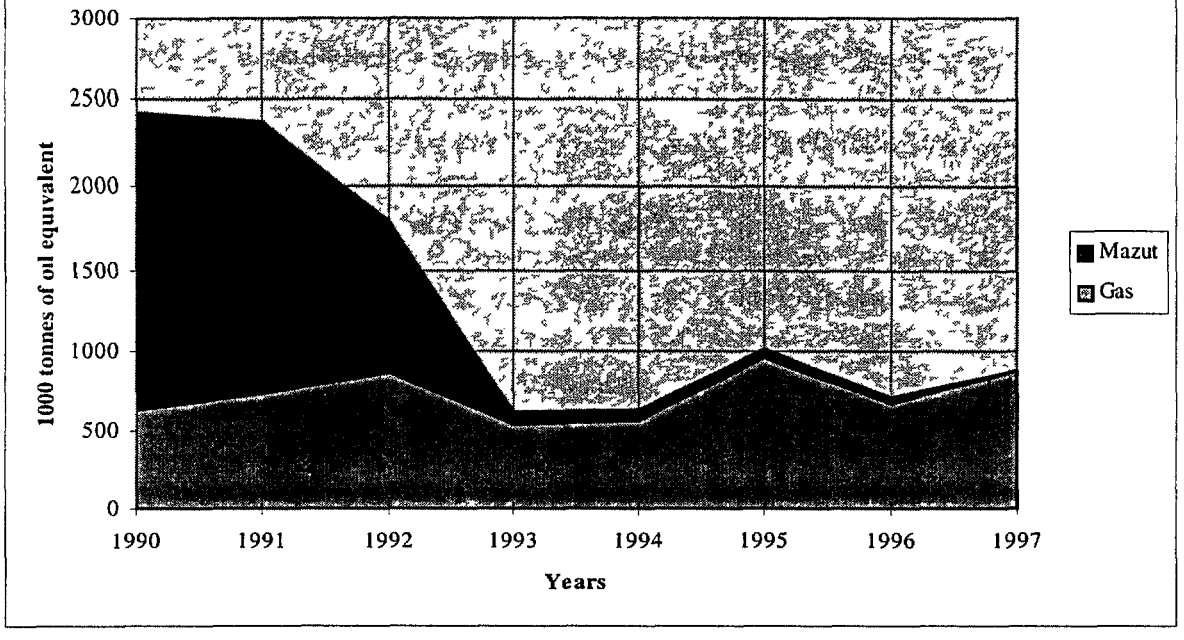
2.4 FUEL CONSUMPTION

The Armenian thermal power sector is a major fuel consumer Unlike other parts of the former Soviet Union, there are no coal-fired generating units in Armenia Nearly all of the fuel currently consumed by the power sector is natural gas (95%) Mazut (5% of fuel currently consumed for generation) is used only as a reserve fuel for short periods when natural gas supplies are interrupted

In general, fuel consumption in the power industry has declined rapidly since the collapse of the Soviet Union (see Exhibit 2-10) In addition, the fuel mix in the thermal power sector has changed dramatically over the same period The predominance of natural gas is a relatively recent development As late as 1992, mazut accounted for 68% of total fuel consumption by the thermal power plants During the period from 1988-1992, mazut was the primary fuel source for thermal generation, accounting for 53%-72% of total fuel consumption [12] However, this situation quickly changed as the Azeri energy blockade began to take its toll on the Armenian energy supply Because nearly all the mazut consumed by the Armenian thermal power plants previously

[12] Except in 1989 when natural gas accounted for 55% of total consumption

Exhibit 2-10
Fuel Consumption by TPPs



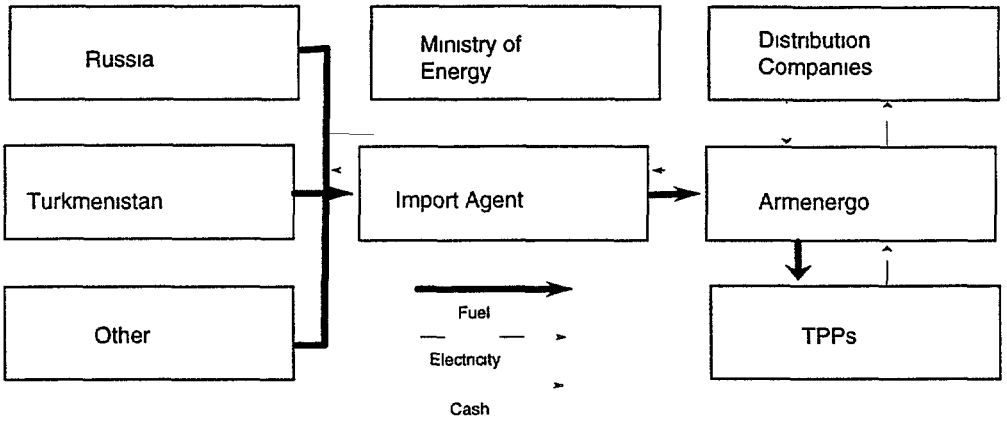
came from either Azeri refineries, or was transported on railroads running through Azerbaijan, the blockade has reduced the supply of mazut and petroleum products to a fraction of their former levels Natural gas has now replaced mazut as the primary fuel consumed by the Armenian thermal power plants

2.5 FUEL PROCUREMENT

All fuel purchases for the thermal power plants are conducted by Armenergo Armenergo is paid in cash by the electricity distribution companies for electricity supplied to them When enough funds are accumulated, Armenergo purchases fuel through an importing agent, either a government agency or a private importer The import agent contracts with foreign fuel producers and transports the fuel to Armenia The fuel is then distributed to the thermal power plants at the direction of the Ministry of Energy The Ministry controls the distribution of fuel to the various power plants, based on annual power generation targets set at the beginning of the year The power plants have virtually no control over fuel purchasing, even though the fuel is the most costly element of production The thermal plants generate electricity which is sold to Armenergo and resold to the distribution companies, starting the cycle over again (see Exhibit 2-11)

Armenergo purchases all of its natural gas from Armgasprom, the state gas monopoly Armgasprom, in turn, purchases gas from Itera, a private Russian-American company that acts as a gas broker for Russia's Gazprom in several NIS countries [13]

Exhibit 2-11
The Procurement Process



As with natural gas, all mazut purchases are handled by Armenergo However, unlike in the monopolistic natural gas market, there are a number of governmental and private mazut importers operating in Armenia When Armenergo has the funds to finance a significant mazut purchase a tender is held and winning bids are chosen

2 6 FUEL PRICE

According to power plant directors and other officials, fuel purchases account for about 86% of the total cost of producing electricity at Armenian thermal power plants [14] Thus the thermal power generating industry is extremely sensitive to any changes in fuel prices If electricity prices are not allowed to adjust to reflect increases in fuel costs, the profitability of the power plants

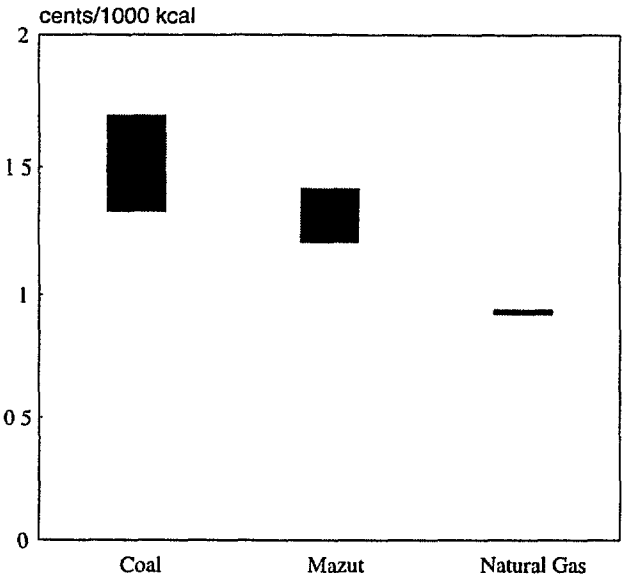
[13] Russia through Gazprom has complete control over most of the major gas pipelines that link the countries of the former Soviet Union Turkmenistan must receive approval from Russia to export natural gas to other countries through Russian pipelines Russia only allows the gas-rich countries of Central Asia to export natural gas to other NIS countries in order to reserve the Western European market for Russian gas exports

[14] This figure was given by the General Director of the Yerevan thermal power plant and it is the same in the tariff calculation According to Hagler Bailly calculations this cost is about 40-50 percent of the total cost (fixed and variable costs) of producing electricity

suffers almost immediately This has been the case during the past several years as fossil fuel prices have climbed higher and faster than electricity tariffs

Following the collapse of the Soviet Union, Russia began to increase energy export prices to the former Soviet republics The Russian government no longer felt compelled to provide the newly independent, and in some cases, increasingly nationalistic, republics with subsidized oil and natural gas The price of mazut increased as output in the Russian petroleum industry collapsed in the early 1990s, and natural gas prices to the former republics were increased shortly after those for oil

Exhibit 2-12
Comparative Fuel Cost



Source Hagler Bailly Ministry of Energy Armenergo Armgasprom State Solid Fuel Enterprise

For Armenia, the regional instability in the Caucasus and the embargos by Azerbaijan and Turkey exacerbated fuel price increases The embargos had the greatest effect on the price of mazut, since the rail links used to transport mazut from Azerbaijan were closed, leaving only a rail link with Georgia for mazut import Much of the mazut from Georgia came from the inefficient Batumi refinery As mazut prices increased, other fuels became attractive substitutes For the electric power industry the relative price of natural gas is now much less than the price of mazut The cost per 1,000 kilocalories of mazut ranges between 1 33 and 1 69 cents, depending on the contracted price and calorific value (see Exhibit 2-12) This is well above the price of 0 94 cents per 1,000 kilocalories for natural gas As mazut became relatively more expensive compared to natural gas, the thermal power plants began to consume more natural gas than mazut, today the power plants consume natural gas almost exclusively

One ongoing problem related to fuel pricing is that fuel prices are quoted on the basis of weight (or volume for natural gas), rather than on the basis of actual heat content Fuels, such as coal, are separated into categories according to quality Prices are set (usually by the government) for each fuel category based on weight (price per tonne) for coal and mazut or volume (price per 1,000 cubic meters) for natural gas These prices and categories are then used in fuel contracts between the fuel suppliers and the power plants However, there are no strict controls over the production process to achieve a product which adheres to fuel classification criteria Thus, delivered fuel often does not conform to implied quality and heat content characteristics of its stated fuel category

2.7 FUEL QUALITY

Issues related to fuel quality have arisen at several of the power plants in Armenia The most severe fuel quality problems involve mazut supplies, but natural gas deliveries also reportedly suffer from occasional problems such as foreign material contamination The ability of the power plants to accurately test and monitor fuel quality is compromised by the age of their testing facilities Thermal power plants typically have an onsite fuel testing laboratory where fuel samples are taken from incoming shipments These samples are tested for heat content and other characteristics The results are compared to specifications in fuel delivery contracts to determine if the fuel meets the contract requirements However, the equipment at the power plants is reported to be extremely antiquated, making accurate fuel testing difficult

In addition to a lack of modern testing equipment, the power plants lack their own metering equipment to measure the volumes of gas received An accurate determination of how much natural gas a plant is receiving and subsequently consuming is important for monitoring operational costs at the plants and to prevent diversion of gas or fraud There are currently gas meters at the thermal power plants, but these meters belong to Armgasprom, the state gas monopoly To verify gas delivery volumes, the thermal power plants will have to install their own gas meters

2.8 FUEL RESERVES

Limited fuel reserves at the thermal power plants are an area of great concern, since it makes them highly susceptible to any disruptions in supply The power plants consume their primary fuel, natural gas, as it arrives from the main gas trunk lines Because there are no natural gas storage facilities at the power plants, real time gas supplies largely dictate generation output Any fluctuations in gas supply directly result in increased or decreased electricity production

While the thermal power plants have no gas reserve capability, the pipeline company, TransGas, maintains several underground storage facilities in the Abovian district near Yerevan These storage facilities are made up of underground salt formations which can hold up to 250 million cubic meters of natural gas at maximum capacity [15] This yields a net working volume of approximately 210 million cubic meters of natural gas, or 25% of the annual gas consumption of the thermal power plants However, gas reserves are well below maximum capacity and can only be withdrawn slowly from the storage reservoir with the technology presently employed at the facility

[15] Organization and Structure of the Natural Gas Sector Review and Recommendations' Merklein & Associates 1997

Due to its higher cost relative to natural gas, mazut is currently used as reserve fuel for periods when gas supplies are interrupted The power plants each have their own storage facilities for mazut Hrazdan TPP has the capacity to store 220,000 tonnes of mazut Yerevan has facilities to store 90,000 tonnes of mazut, and Vanadzor can hold up to 40,000 tonnes [16] Actual mazut reserves are only a fraction of the maximum storage capacity In early summer 1998, Hrazdan only had 10,000 tonnes of mazut in storage At the time Hrazdan was operating one 50 MW unit The mazut in storage would only have provided 6-7 days worth of fuel to run the unit The situation at Yerevan TPP was even more severe Yerevan's mazut reserves equaled only 400 tonnes With only one of the plant's 50 MW units running, the mazut reserves could sustain operations for a mere 8-10 hours Thus, if natural gas supplies were suspended, Yerevan TPP would be forced to immediately begin shutdown procedures

Over the past several years the Armenian government has received foreign assistance from both the US Government and European Union to provide fuel to the thermal power plants in times of need While such programs provide the thermal power plants with short-term relief from their fuel supply problems, the plants must eventually improve their fuel supply options and procurement if they are to survive once such fuel assistance is discontinued

2.9 CONCLUSIONS

The lack of economic fuel supply options is forcing Armenia's thermal power plants into a reserve role in the electric power system The Armenian nuclear power plant is assuming more of the burden for providing the country with base load electricity as the thermal plants continue to struggle with fuel procurement obstacles In order for the thermal power plants to play a central role in the electric power system, fuel procurement and fuel management must be significantly improved [17] Issues such as authority over fuel procurement and distribution, fuel reserve management, testing, contracting, and working capital for fuel purchases must be resolved In addition, power plants must be given more authority over their own operations and finances and the flow of payments through the power system must be improved to enable the plants to cover fuel related costs and conduct competitive fuel procurement

[16] Figures from Hrazdan TPP Yerevan TPP and the Ministry of Energy

[17] In addition to fuel issues the issue of actual generation costs must also be addressed if thermal power is to be competitive in the future The nuclear power plant in Armenia has a decided advantage over the thermal plants because costs such as the storage of nuclear waste and decommissioning are not calculated into its overall cost of generation

CHAPTER 3
NATURAL GAS MARKET

3 1 HISTORY

The current natural gas system in Armenia reflects user and supply patterns that were relevant under the integrated energy system of the former Soviet Union With Armenia now operating as an independent energy unit, its natural gas pipeline and distribution system needs to be re-restructured and upgraded In addition, the current presence of one western petroleum explorer/producer who may well become a user of the Armenian gas pipeline system, the need to attract other exploration companies, and ongoing negotiations with a major international natural gas pipeline company mandate the establishment of an operating and tariff methodology that will inspire confidence among foreign investors [1]

In terms of energy consumption, the Armenian economy is highly gas-intensive On average, natural gas accounts for 35-50% of the total primary energy consumed in the country [2] However, Armenia has no significant natural gas deposits of its own and lacks a domestic gas production industry, forcing the economy to depend on imports from foreign gas producers Armenia imports all of its natural gas from former Soviet republics and Iran through the high pressure Trans-Caucasus gas pipeline system This system connects Armenia to large gas fields in Russia, Turkmenistan, Kazakhstan, Uzbekistan, and Iran through pipelines running through Azerbaijan and Georgia Natural gas imported into Armenia is then delivered to industrial and other customers through a relatively extensive medium- and low-pressure domestic distribution network

Armenia began to import natural gas in 1957 when the Yerevan administrative branch of the Trans-Caucasian Gas pipeline department began operations In 1970, this state-owned enterprise was renamed the "Armtransgas Industrial Association " The Association was responsible for gas import and pipeline operation and maintenance within Soviet Armenia Also in 1970, the Armgas State Committee on Gas Supply was created to manage gas distribution to industrial and residential end-users [3]

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[1] Natural Gas Tariffs Design and Implementation Hagler Bailly/Merklein and Associates Inc , July 1998

[2] Primary energy includes natural gas, coal petroleum renewable fuels nuclear and hydro electricity

[3] Organization and Structure of the Natural Gas Sector, Merklein and Associates Inc January 1997

Until 1972, much of Armenia's natural gas came from the large, highly-developed gas fields in Iran Iranian gas from the Sarajeh field south of Tehran was sent through Azerbaijan to Armenia along the Kazakh-Yerevan pipeline This large diameter (700 mm) pipeline was constructed during the 1960's and later expanded with the addition of a second 1000 mm pipeline During the same period, the domestic gas pipeline network was also expanded, linking many Armenian cities to the main gas import line In addition, a third (500 mm) import pipeline from Azerbaijan was constructed though the cities of Krasni Most, Alaverdi, and Kirovakan This branch was soon linked to Gumri and then Yerevan, creating a northern pipeline loop Many large industrial plants, including the large thermal power plants, were constructed along this loop

During the 1970's, disagreements on the price between the USSR and Iran, and the discovery of enormous natural gas fields in Soviet Turkmenistan and Siberia led to a shift in gas sourcing for Armenia Throughout the 1970s and 1980s, Armenia received ever-increasing quantities of natural gas from the Soviet gas fields in Siberia and Central Asia The Armenian gas network continued to expand during this period, with the construction of a 500 mm pipeline chain through the southern part of the country to the city of Kajaran as well as the construction of a third 700 mm import pipeline running from Evlakh (Azerbaijan) through Goris (Armenia) and Nakhichevan (Azerbaijani enclave) to Yerevan

Armenia had one of the highest levels of gas consumption among the Republics of the former Soviet Union In the residential sector, the market penetration was the highest of Soviet Republics, with 83 3% of all residents receiving gas in some form or other Of these, 61 5% used natural gas delivered by distribution systems and 21 8% used bottled gas

In the late 1980s, gas consumption in Armenia peaked at just over six billion cubic meters, accounting for roughly 50% of the energy consumed in the country However, following the collapse of the Soviet Union in 1991, rising tensions in the Nagorno-Karabakh region of Azerbaijan soon led to a major conflict between Armenia and Azerbaijan Azerbaijan imposed an economic blockade on all trade with Armenia, essentially severing all of Armenia's gas imports This embargo, coupled with the shock of the disintegration of the Soviet Union, threw the Armenian economy into crisis As the crisis intensified the domestic gas distribution network fell into serious disrepair due to mounting consumer debts for gas supplies The deterioration of the distribution network eventually caused the government to suspend residential gas distribution in 1994, only large industrial and commercial customers connected to the medium-pressure transmission/distribution lines were supplied with natural gas

The construction of the Northern Caucasus-Trans-Caucasus main gas pipeline, from Russia to Georgia, began in 1983 but was not completed until 1993 The line diameter is 1000-1420 mm (40-56"), depending on location A gas import pipeline from Krasni Most to Berd, to the North Caucasus gas pipeline, was completed in 1993 This pipeline created a strategic link

between Armenia and the Russian gas pipeline network through Georgia, completely bypassing Azerbaijan This 1000 mm pipeline quickly became Armenia's vital energy lifeline in the face of the Azeri blockade However, political instability in Georgia plagued the gas supplies along this route during its first few years of operation The civil war in Georgia resulted in numerous acts of sabotage and gas theft from this pipeline, causing tremendous instability in Armenian gas supplies

Today, the gas supply situation in Armenia is showing signs of improvement While the Azeri blockade of the country is still enforced, the political situation in Georgia has stabilized, allowing for increased gas shipments through the northern pipeline corridor Gas supply agreements with Gazprom have been formalized and a clear process for making payments has been established Gas supply has risen to well over 1 billion cubic meters per year, but is still only about 20% of the gas import volumes of ten years ago

3.2 INDUSTRY STRUCTURE

Armenia's natural gas industry is currently going through a major restructuring phase Until recently, the industry was organized as a state-owned, vertically and horizontally integrated natural gas monopoly, Armgasprom Armgasprom was subordinate to the Ministry of Energy, which directed general natural gas policy and performed gas supply planning and forecasting Armgasprom was one of the largest enterprises in Armenia, with over 1,900 kilometers of gas transmission pipelines and more than 6,500 employees Armgasprom was responsible for all gas operations and related services within the country, including negotiating gas supply contracts and importing gas purchased from foreign producers, operating gas transmission and distribution systems, monitoring gas storage facilities, marketing CNG for motor fuel and residential consumption, and manufacturing natural gas equipment Regional divisions of Armgasprom were responsible for the distribution of natural gas through local networks to consumers

On January 18, 1997, a letter of intent was signed between the Russian natural gas pipeline company Gazprom, its foreign marketing branch Itera, and the Ministry of Energy, seeking to establish a joint-venture company among these interests Negotiations continued throughout the year until December 19, 1997, when agreement regarding the merger was reached at a Founders' Meeting Ten days later, the newly formed company known as ArmRosGazprom was officially registered in the Republic of Armenia ArmRosGazprom is a Closed Joint Stock Company (CJSC) Gazprom and the State of Armenia each have a 45% interest in that company The remaining 10% interest is held by Itera This makes the Armenian gas industry a foreign-held organization and it sets the stage for a major restructuring and commercialization phase

While negotiations between Gazprom, Itera, and the Armenian Ministry of Energy proceeded in 1997, preparations were made to effect a smooth transition from the state-owned gas

industry towards the three-party Joint Stock Company envisioned in the letter of intent The first step in that direction was the breaking up of the state monopoly into essentially two state enterprises (the pipeline company and the distribution system) that would operate under a management company, Armgasprom State Concern The fate of various other subsidiary companies remained undefined at the time These included two pipeline construction companies, several manufacturing plants and a number of service companies

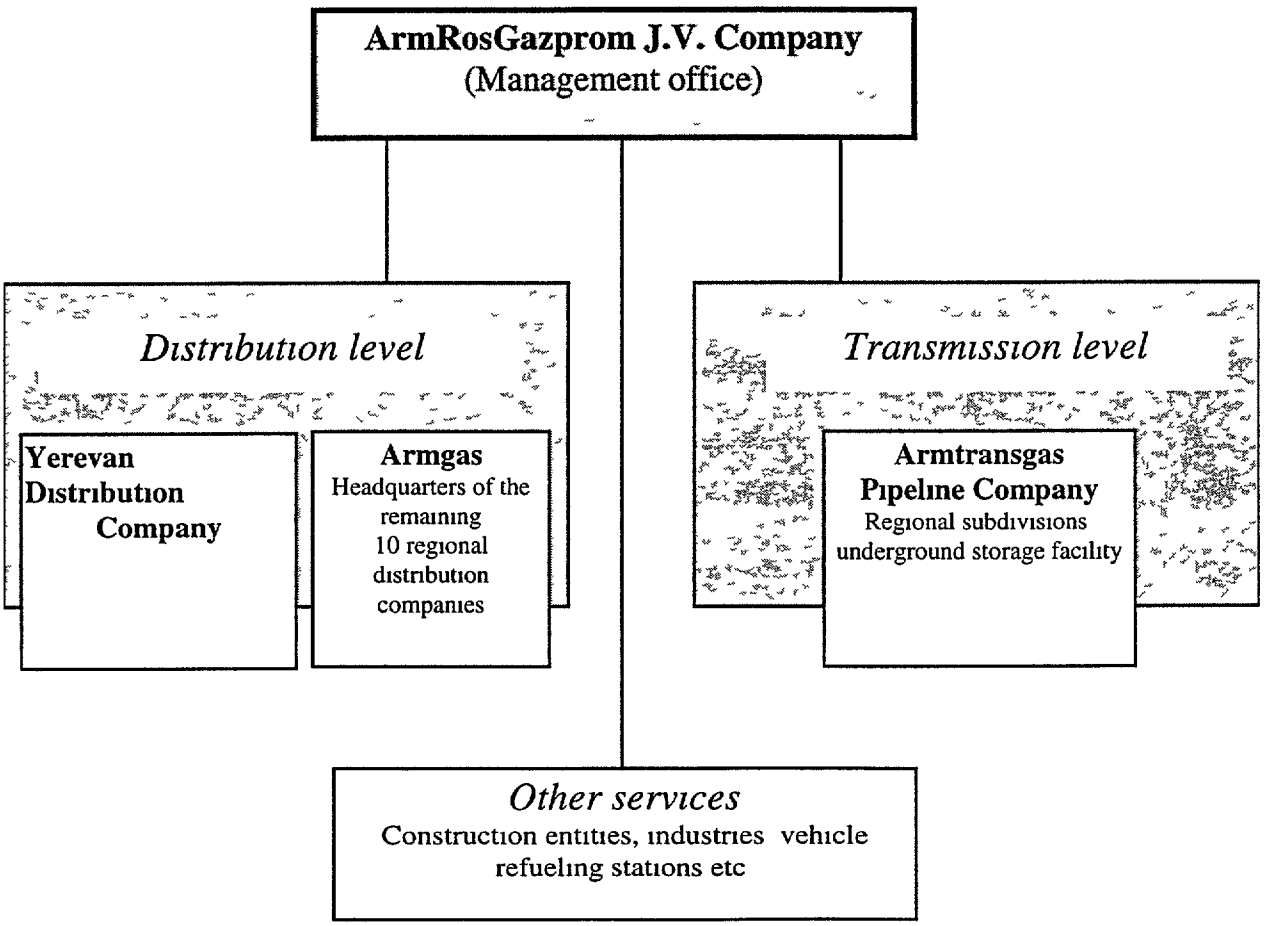
In May of 1998, the Armenian natural gas industry was restructured again, under the newly established ArmRosGazprom One pipeline company, Transgas, was retained as before, but it was converted from a State Enterprise into a CJSC The distribution industry was broken into two CJSCs, the Yerevan Gas Company which essentially serves the capital, Yerevan, and the Haygas company that serves all the distribution systems in the rest of the nation Haygas has several subsidiaries, including ten local distribution companies in various cities throughout Armenia, three technical service companies, one company selling compressed gas as automotive fuel, and two district heating companies Some of the remaining subsidiaries of the old Armgasprom State Concern have been spun off, but many remain nominally attached to ArmRosGazprom, pending a determination on how to structure ArmRosGazprom and what to do with the peripheral subsidiaries

Even though required under their respective Charters, neither of the CJSCs has issued any shares The number and assigned value of the authorized shares reflect a valuation of the respective companies ("Charter Capital") somewhere between one fifteenth to one twentieth of the assessed value For example, the combined shares of the two distribution companies add up to about $4 2 million, compared to the assessed value of the system of $72 2 million ArmRosGazprom also has a Charter Its authorized shares, not yet issued, add up $280 million (the assessed value of the entire gas system of $270 million plus a cash infusion of $10 0 million), which closely matches the assessment that served as the basis of negotiations That value includes about $32 9 million for the peripheral companies whose fate will be determined at a later point in time

We do not know, and we suspect ArmRosGazprom does not know at this time, how the new gas industry is to be structured The low valuation of the pipeline and distribution companies may suggest that their value is carried as their buildings and other directly used equipment, with ArmRosGazprom owning the shares and the assets of the essential pipelines and distribution systems If so, that would spell confusion in developing meaningful pipeline and distribution tariffs that should include among their many components a reasonable allocation for depreciation, for the allowable rate of return, and for property taxes All that is clear at the time of this writing is that a meeting has been set for mid-October, for the purpose of dealing with and, hopefully, resolving any outstanding issues such as the respective allocations of charter capital, whether to establish individual company boards for each of the major constituent companies, and what to do about the peripheral subsidiary companies Hopefully,

these questions will be resolved by the end of 1998, at which time the future direction of the sector, and its potential impact on the power sector, will become clearer

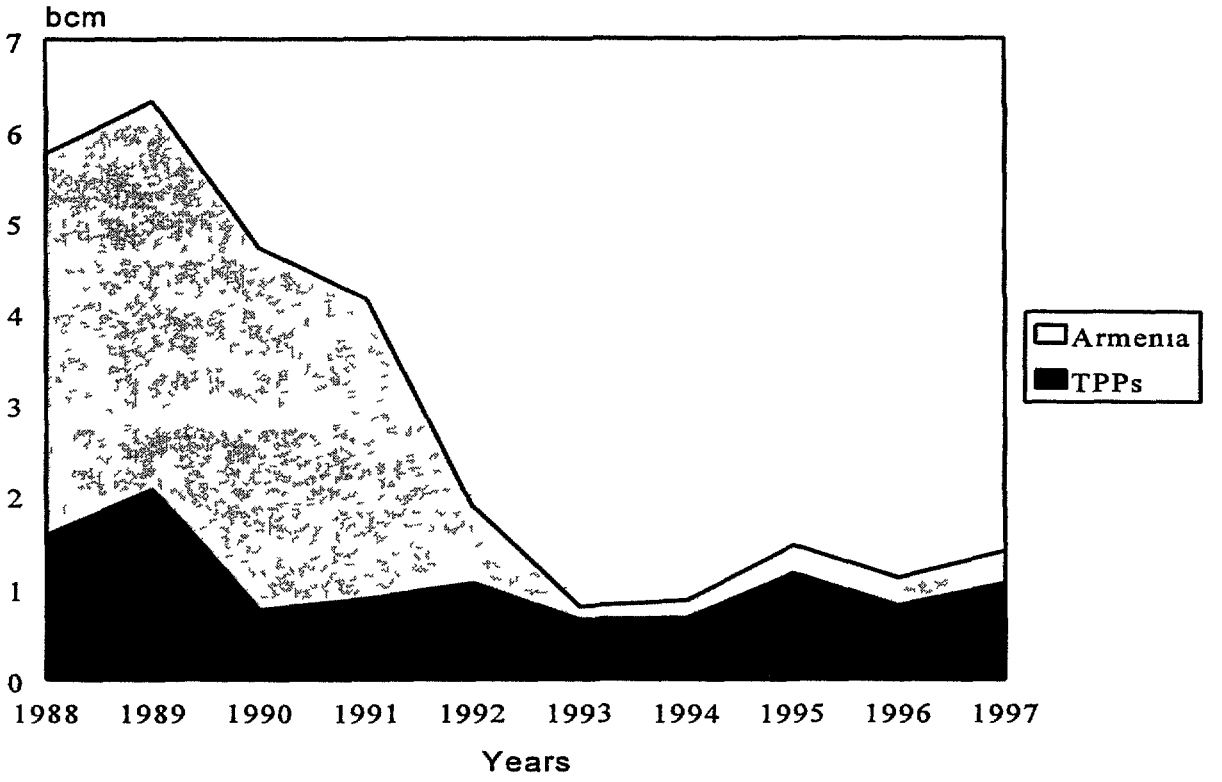
Exhibit 3-1
Structure of ArmRosGazprom



3.3 NATURAL GAS PRODUCTION AND CONSUMPTION

At the time of its collapse in 1991, the Soviet Union possessed the largest gas reserves in the world The Soviet Union also produced more natural gas than any other country in the world, except the United States In the Soviet Union, natural gas was seen as the energy source of the future and many industrial enterprises, including thermal power plants, were converted to consume natural gas instead of mazut or coal As noted earlier, among the republics of the former Soviet Union, Armenia had one of the highest levels of natural gas consumption The extensive gas distribution network in Armenia once linked many small villages and rural areas to major gas pipelines, making many residential consumers dependent on natural gas for heating and cooking Natural gas consumption in Armenia increased throughout the 1980s, reaching an apex of 6 3 bcm in 1989 Armenia's three thermal power plants themselves consumed nearly 33% of the total gas supply in the country However, since 1989 the escalation of the Nagorno-Karabakh conflict has resulted in numerous supply interruptions in gas transported through Azerbaijan

Exhibit 3-2
Natural Gas Consumption in Armenia

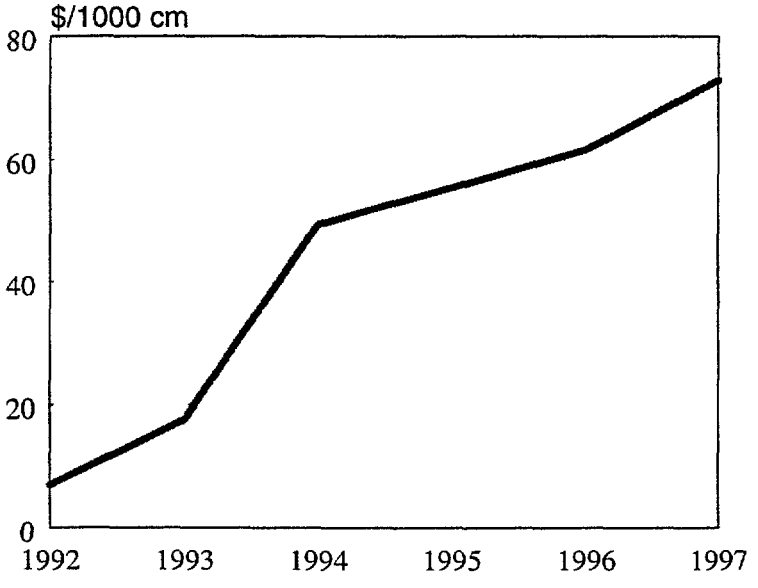


As a result of the embargo, natural gas consumption in Armenia plummeted 83% between 1990 and 1993 (see Exhibit 3-2) However, the amount of natural gas consumed by the country's thermal power plants remained relatively stable during this period, nearly all of the decline in consumption occurred in the industrial and residential sector The frequent gas supply problems, and eventual closure of the residential gas distribution network, forced residential consumers to search for other fuel sources Industrial production was crippled by the economic blockade and the loss of traditional markets following the collapse of the Soviet Union, and as production declined, the demand for natural gas by the industrial sector also fell sharply The Armenian thermal power plants have been the major consumer of natural gas in Armenia since 1993, accounting for more than 80% of total gas consumption

3.4 NATURAL GAS PRICING

Natural gas prices have increased over tenfold since 1992 (See Exhibit 3-3) Nonetheless, gas consumption by the thermal power plants has remained fairly steady, since the prices of substitute fuels to natural gas rose at an even greater pace [4]

Exhibit 3-3
Recent Natural Gas Prices



Source Razdan TPP Yerevan TPP

In an attempt to secure more reliable gas supplies from abroad, Armenia signed a Gas Purchase Agreement with Turkmenistan in 1994 The purchase agreement provided Armenia with a specified amount of gas and allowed Armenia to pay for gas supplies with cash or a combination of cash and bartered goods The use of barter as payment for natural gas was favored by both parties Turkmenistan has little domestic industry and relies heavily

[4] The thermal power plants can burn either natural gas, mazut or with extensive refitting and alteration of their boilers coal While natural gas prices have increased rapidly the increase in mazut prices has been even steeper making mazut more expensive per kilocalorie of energy Coal is even more expensive than either gas or mazut (see comparative energy price chart, Chapter 2)

on imported materials and equipment In addition, most of Turkmenistan's major gas clients (Armenia, Ukraine, Georgia) are unable to pay in cash for all the gas that they consume Barter allows Turkmenistan to collect something for its gas sales to these countries instead of accumulating compounding debts and hard currency payment arrears

In 1995 the Russian gas monopoly, Gazprom, entered into an agreement with the Turkmenistan government to handle all foreign marketing and sales of Turkmenistan's natural gas To carry out its responsibilities under the agreement, Gazprom has sought out private commodity trading firms to act as intermediaries in gas supply agreements in foreign markets such as Armenia, Ukraine and other NIS countries These trading companies contract with Gazprom to sell a specified amount of natural gas to foreign government agencies or directly to industrial and other customers The commercial trading firm is then responsible for all gas deliveries to the foreign country and payments back to Gazprom and/or its partners, such as the government of Turkmenistan The commercial trading company, Itera, was chosen to be the intermediary for gas sales to Armenia

Following independence, all gas purchasing from Armgasprom for the thermal power plants was conducted by the Armcontract Trade Agency (part of the Ministry of Material Resources) In 1995, as the thermal power plants established themselves as the single largest gas consumers in the economy, the Ministry of Energy received authority to negotiate barter agreements for natural gas, a task formerly under Armcontract A branch of Armcontract was transferred to the Ministry of Energy This branch became Armturtrade, the Ministry of Energy's trading arm

Currently the Armenian gas industry is involved in the joint venture with Russian Gazprom and Itera Itera, under the agreement, delivers gas to Armenia for $53 per 1000 cm Armenergo distributes the gas to the thermal power plants according to production targets established by the Ministry of Energy

3.5 NATURAL GAS TRANSMISSION

The Armenian gas transmission system is comprised of several pipeline loops radiating primarily from Yerevan, Kirovakan, and Sevan The Transgas state enterprise, part of Armgasprom, has authority over the gas transmission system Gas can be imported into Armenia from four main import pipelines Three of these pipelines emanate from Azerbaijan and are no longer active due to the Azeri blockade

- Kazak- Yerevan (two pipeline strings 700-1000 mm in diameter)
- Krasni Most - Alaverdi - Kirovakan (500 mm)
- Evlakh - Goris - Nakhichevan - Yerevan (700 mm)

The fourth, and newest, import pipeline bypasses Azerbaijan and connects to the Georgian gas pipeline network Currently all natural gas imported into Armenia flows through the Krasni Most - Berd pipeline (1000 mm)

Many of Armenia's major towns and cities are linked to this pipeline system Within each community a vast network of distribution lines transports gas to individual consumers The overall gas transmission/distribution system is designed to operate at three pressure levels high pressure (3 and up ATMs), medium pressure (0 5-3 ATMs), and low pressure (0 05-0 5 ATMs) The high pressure lines are designed mainly for transmission purposes The low and medium pressure pipelines make up the gas distribution network Some large industrial customers (such as the thermal power plants) draw gas directly from the medium pressure pipelines, while the bulk of Armenia's residential and other gas consumers are supplied by the low pressure network

The deterioration of gas supplies, and the gas sector in general, have left the low pressure distribution network in a state of serious disrepair Most of the low pressure distribution network linking residential consumers to the pipeline grid was disconnected in 1994 [5] The condition of the distribution system is so poor that major safety issues must be addressed in many areas before the gas flow to residential consumers can be restored [6] The failure of the distribution system has forced many residential consumers to turn to bottled gas for heating and cooking [7] The high and medium pressure pipelines continue to operate, but are also in need of major renovation

The rapid decline in gas supplies in Armenia has greatly reduced the average utilization of pipeline capacity in the high and medium pressure transmission lines to only 25% However, capacity utilization is highly concentrated in the Georgia-Armenia line and those supplying the thermal power plants The virtual closure of the entire low pressure distribution network has resulted in a capacity utilization factor of just over 8% for the low pressure network

Because of the deteriorated state of capital assets in the system (pipelines, compressor stations, etc) maximum pressure in each pipeline segment is estimated to be only 30-80% of design pressure, depending on location This condition limits the amount of additional gas that can be handled by the transmission system, even if greater supplies could be secured from abroad The reduced carrying capacity of the pipeline system may be a limiting factor on the growth of the Armenian economy in the future

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[5] Recently the gas supply to residential sector has been renewed for 64 000 residential consumers Hagler Bailly has started to install 2 074 meters for residential areas as a pilot project

[6] This problem has been solved for pilot project consumers

[7] Bottled gas sales are managed by a separate branch of Armgasprom

The joint venture with RAO Gazprom and Itera seeks to utilize the unused capacity in the existing gas pipelines as well as Armenia's proximity to energy hungry Turkey to develop a natural gas (or electricity) export market Initial plans for this joint venture call for the construction of a natural gas pipeline (or an electricity transmission line) between Armenia and Turkey A pipeline would most likely be constructed near the Armenian city of Gumri in the northeastern region of the country The joint venture is expected to eventually import roughly 9 bcm of natural gas into Armenia, with 7 bcm exported to Turkey and 2 bcm sold in Armenia to power plants and other customers This would nearly double the amount of gas currently available within Armenia as well as provide substantial revenues from gas transit operations The future of this project is far from certain and will require considerable political backing from the Russian, Armenia, Turkish, and Georgian governments

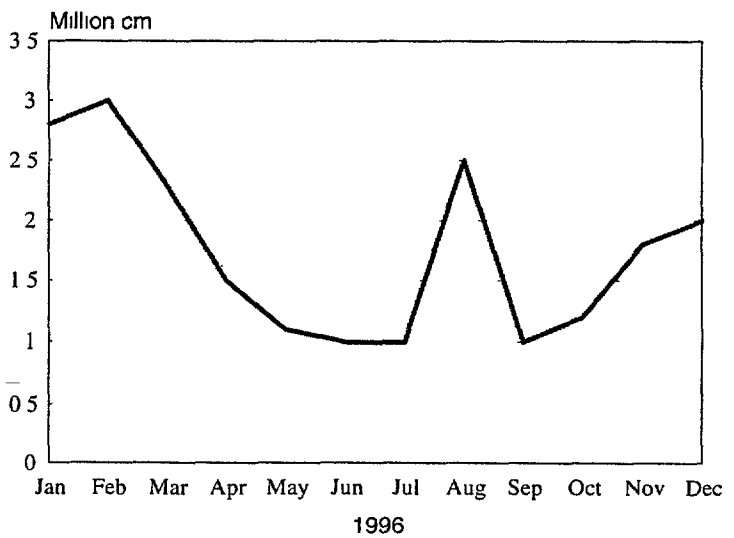
In addition, the Armenian and Iranian governments are considering the construction of a natural gas pipeline linking the southern region of Armenia with the Iranian gas pipeline system A pipeline to Iran would provide Armenia with up to 1 bcm of natural gas per year as well as an alternative gas supply source, reducing Armenian dependence on Russia and Georgia for gas transit This project is also in the early stages of development

3.6 NATURAL GAS AND THE POWER SECTOR

Natural gas is of particular importance to the Armenian power sector, as it is the primary fuel for the country's three thermal power plants These plants also provide district heating and steam for the communities and industries surrounding them in addition to electricity During the peak consumption year of 1989 the power sector used 2 11 bcm of natural gas Following the closure of the ANPP in 1989, Armenia's dependence on natural gas for power production increased even as total electricity demand declined During 1996 the thermal power plants consumed

Exhibit 3-4

Hrazdan Gas Consumption



Source Hrazdan TPP

42

almost 500 million cubic meters of natural gas, accounting for 95% of all the fuel consumed by the power sector

Natural gas consumption within the thermal power industry fluctuates during the year in response to seasonal changes in power demand As Exhibit 3-4 indicates, gas consumption is generally higher during the winter heating season Gas consumption also spikes in August, when in accordance to the traditional procedure in the former Soviet Union, nuclear power plants are shut down for refueling and maintenance to prepare them for increased demands during the coming winter

Natural gas quality has been fairly consistent among the three thermal plants However, some plant officials report that the pressure in the gas trunklines occasionally drops below standard levels, reducing the volume of gas delivered to the plants The thermal power plants do not have their own gas meters to accurately detect the volume of gas entering the plant, as the gas lines are metered by Armgasprom Judging from readings of fuel supply to the individual boilers within the plant, plant officials state that gas delivery volumes can be anywhere from 2 5 - 10% less than the contracted amount These figures fall well outside the permissible variance of 0 5 - 5% In addition, the gas is sometimes contaminated with foreign matter above acceptable levels

3 7 CONCLUSIONS

Natural gas has become the primary fuel source for the Armenian thermal power plants and is likely to remain the most reliable and economical fuel for the power system in the near future The current monopolistic structure of the natural gas system in Armenia places the thermal power plants in a position of dependence on ArmRosGazprom in terms of gas supplies, delivery terms, and quality The formation and actual operations of ArmRosGazprom are in the early stages It is not yet clear how ArmRosGazprom will handle issues such as permitting third party access to the natural gas transmission and distribution network This factor will undoubtedly complicate reform and privatization of the thermal stations At present, there is considerable uncertainty as to whether an investor will have access to a competitive fuel market for natural gas

CHAPTER 4
MAZUT AND REFINED PRODUCTS MARKET

4 1 MAZUT CHARACTERISTICS

The physical and chemical characteristics of mazut closely resemble those of Number 6 (residual) fuel oil There are two types of mazut used in Soviet-designed power plants, M40 and M100 Both are fairly similar in their physical characteristics The average heat content is between 9,500-9,700 kcal/kg Sulfur levels vary depending on the origin of the crude oil, with mazut split into low-sulfur (0 5%), medium-sulfur (2%) and high-sulfur content (3%) The major difference between M40 and M100 is viscosity M100 is a thicker, more viscous fuel oil, which makes it more difficult to handle, particularly in the winter when low temperatures increase the viscosity and impede the off-loading of mazut shipments at the power plants

When power plants are unable to buy mazut, they occasionally purchase component fuel Component fuel is an even lower-quality fuel than M40 or M100 It is even more viscous than M100 and has a lower heat content, usually in the range of 8,500 - 8,600 kcal/kg Component fuel also tends to have a high sulfur content (3 5%) Armenian power plants usually buy only M40 or M100 None of the plants visited for this report purchases component fuel

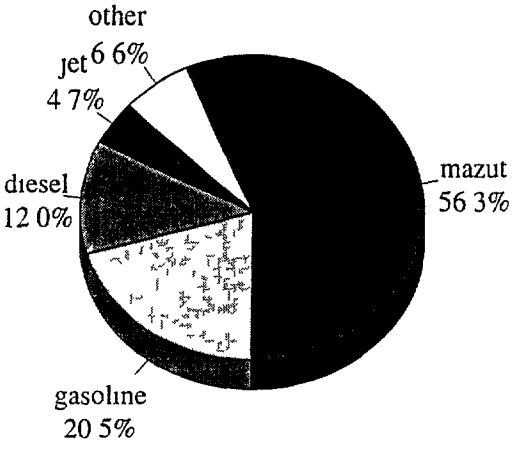
4.2 HISTORY

Mazut was the primary fuel source for industrial steam boilers throughout the former Soviet Union, due in part to the structure and technology used in the Soviet refining industry The most difficult fuels to extract from raw crude oil are light products such as gasoline, kerosene, and jet fuel Advanced technology and refining systems are needed to increase the yield of these fuels, making their production relatively more expensive In the West, higher prices for gasoline and kerosene encourage refineries to maximize their production of light products

In the Soviet refining industry however, petroleum prices were set by the government, rather than the market Regulated prices tended to be artificially low, failed to reflect the relative value of petroleum products, and typically remained fixed for long periods of time The Soviet refining industry was driven not by the principle of profit maximization, but by government plans to produce fuel as cheaply as possible to satisfy manufacturing and industrial needs In order to accomplish this goal, the refining industry focused on relatively low-tech refining practices to produce large amounts of mazut (see Exhibit 4-1) Prior to independence, the Armenian economy consumed approximately 4 million tonnes of oil equivalent (toe) of petroleum products Mazut

Exhibit 4-1

Petroleum Product Consumption
1985-1991



Source World Bank

consumption accounted for almost 60% of all oil products consumed

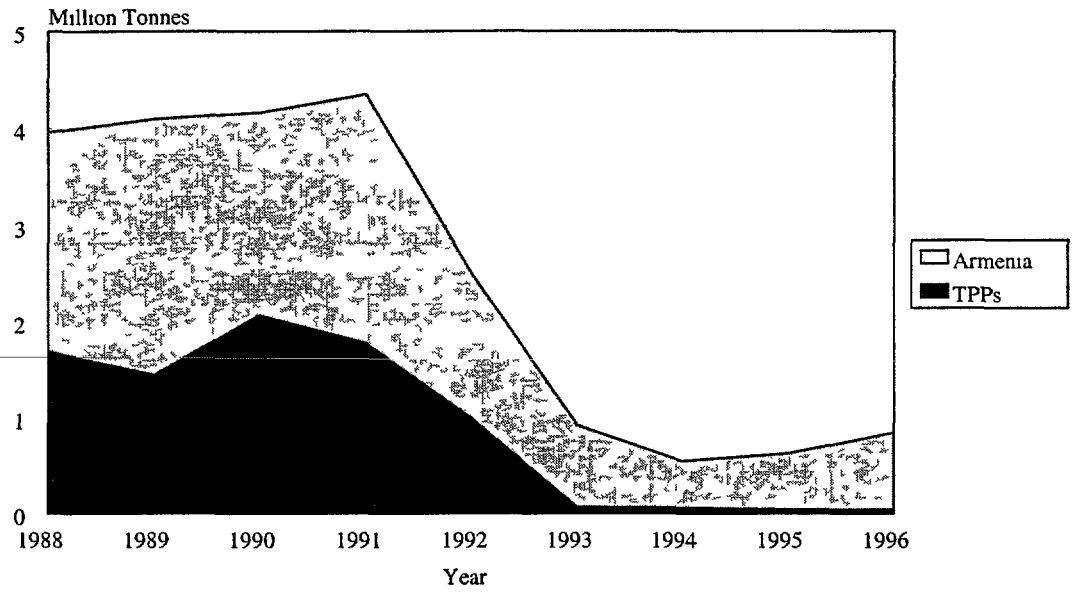
The technology and refining infrastructure in the former Soviet Union has changed little since the collapse of the USSR Refineries in the former Soviet republics continue to produce a large percentage of mazut Consumption patterns, in contrast, have changed dramatically While recent figures are not available, it appears that mazut consumption has fallen, and that gasoline and diesel fuel currently account for most of the petroleum product consumption in Armenia The rapid decline of the industrial sector, coupled with substitution by the thermal power plants of natural gas for mazut, have reduced total mazut demand At the same time, growth of the transportation sector has increased the demand for gasoline and diesel fuel

Armenia has no significant domestic petroleum reserves and lacks a petroleum producing industry [1] As in the case of natural gas, Armenia is completely dependent on imports to meet all of its petroleum product needs However, unlike natural gas, there are no oil pipelines in Armenia Almost all the petroleum products imported into Armenia are transported by rail, in addition a small amount of gasoline and diesel fuel are transported by tanker truck There are two main rail lines running through Armenia One line enters Armenia from Georgia and passes through the city of Gumri before turning south and running along the border with Turkey A rail link with Turkey exists just south of Gumri, but the rail gauge is different between the two countries, making it necessary to switch cargo from one train to another As the railway continues along the Turkish border it passes through the Azeri enclave of Nakhichevan, then briefly crosses the southern tip of Armenia before continuing into Azerbaijan The second railway originates in Azerbaijan near the Armenian town of Idjevan and continues to Razdan, where it forks One spur runs along the northeast side of Lake Sevan, while the second continues on to Yerevan and connects to the other railway as it runs along the Turkish border

[1] A 1993 US Geological Survey study found a few small oil deposits but these finds were determined to be uneconomic in terms of commercial development See "The Coal Resources of Armenia USGS Reston VA and Denver CO, 1994

Historically, Armenia has received most of its petroleum products from refineries in Baku, Azerbaijan and Grozny, Russia (Chechnya) These refineries are located near considerable oil deposits and production facilities and, during the Soviet period, supplied most of the fuel needs of the Caucasus region However, in the period since Armenia declared independence, the situation has drastically changed The Azeri embargo in 1991 effectively ended all oil imports from the Baku refinery, and petroleum and mazut supplies fell sharply from 1991 to 1993 (see Exhibit 4-2) Since the imposition of the Azeri embargo, all petroleum products have been imported along the rail line from Georgia These shipments have been vulnerable to sabotage and theft due to the civil unrest in Georgia, though the lull in hostilities during the past few years has reduced some of these risks

Exhibit 4-2
Petroleum and Mazut Supply



Source Armenergo Ministry of Energy Yerevan TPP Razdan TPP

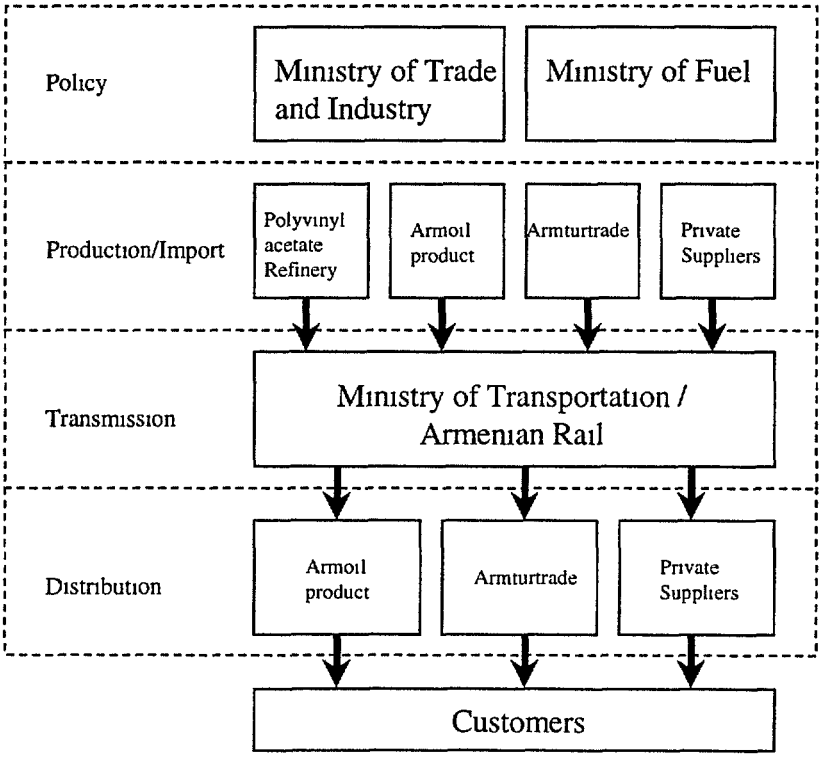
Not long after the Azeri blockade was put in place, hostilities in Chechnya suspended the supply of petroleum products from the Grozny refinery Currently, Armenia receives most of its petroleum products from oil ports along the Black Sea Oil tankers transport refined products from Novorossisk and other export terminals to ports along the Georgian coast where the fuel is loaded onto railcars and hauled to Armenia Rail shipments are brought to storage facilities located throughout the country and stored for later use by industrial enterprises or power plants The total oil storage capacity in Armenia is 1 2 million tonnes Roughly 350,000 tonnes of mazut storage are located at the three major thermal power plants Only a small fraction of this storage capacity is currently being used

4 3 PETROLEUM INDUSTRY STRUCTURE

The petroleum industry in Armenia falls under the joint jurisdiction of the Ministry of Energy and the Ministry of Trade and Industry (see Exhibit 4-3) Armoilproduct, a branch of the Ministry of Trade and Industry, deals with the Armenian petroleum industry and is largely responsible for petroleum imports, storage, and distribution Armoilproduct has 18 major storage facilities throughout the country, which are able to store over 800,000 tonnes of crude oil and refined products Armoilproduct sells these products to consumers through contract arrangements However, Armoilproduct does not have a monopoly over the domestic petroleum markets and therefore must compete against private importers Among Armoilproduct's competitors in the mazut market is Armturtrade, the fuel importing arm of the Ministry of Energy As with the natural gas supplies, once mazut is purchased it is distributed to the power plants according to the production plans of the Ministry of Energy

Exhibit 4-3

Armenian Mazut and Petroleum Industry



The existence of multiple mazut importers, both governmental and private, imparts a higher degree of competition in the mazut market than in the market for natural gas However, this competition is skewed by the fact that only governmental importers have mazut storage facilities Having storage facilities greatly increases the profitability of importing mazut since the importer can sell his products when the demand, and market price, are highest Importers who lack storage facilities must sell the mazut from the rails, sending the mazut shipments directly to buyers according to prearranged contracts This type of trading can be profitable, but it involves more risk due to price volatility Armoilproduct does not allow independent importers to lease their storage facilities

In addition to importing refined products directly from Russia, Armenian importers also contract to purchase crude oil from Russian suppliers This crude oil is transported by tanker to the Georgian refinery in Batumi, and refined into mazut and other products which are shipped by rail to Armenia This trade route was developed in response to the Azeri embargo and the loss of access to other refineries in the region The antiquated Batumi facility was built in 1918 as part of the first oil boom in the Caspian Sea basin It has been modernized over the years, but remains very inefficient The refinery had been closed for several years until it was reopened in 1991 to meet the unserved demand in Armenia resulting from the Azeri blockade The Armenian government offered to finance improvements of the facilities and technology at the Batumi refinery, but an agreement with Georgia was never reached The refinery is currently operating at only 10% of its capacity One reason for this low level of utilization is the fact that the plant can reportedly take over a month to process a batch of crude Because of the inefficiencies and other problems at the Batumi facility, Armenian importers are increasingly shipping processed mazut directly from Russian refineries through Georgia

Several governmental sources report that Armenia is also importing crude from Azerbaijan, even though the embargo is still officially in place According to these sources, the high price of mazut in Armenia encourages Azeri producers to ship mazut to Armenia through Georgia To get around the blockade, the final destination of the shipments is listed as Georgia, but once in Georgia shipments are rerouted to Armenia

At the onset of the Azeri embargo, the Armenian government considered building a refinery in Yerevan The refinery would be supplied with crude oil flown into Yerevan by cargo plane It was calculated that this method could be cheaper than importing mazut through Georgia At the time many petroleum shipments were being lost before they ever reached the Armenian-Georgian boarder due to civil war in Georgia An experimental refinery was established in Armenia at the Polyvinyl acetate chemical plant This plant is still refining small batches of crude imported by rail from Georgia The refinery is reportedly producing high quality mazut, benzene, and diesel fuel However, the primitive refining technology at the Polyvinyl acetate plant does not allow for the production of a wide variety of products

4 4 MAZUT AND THE POWER INDUSTRY

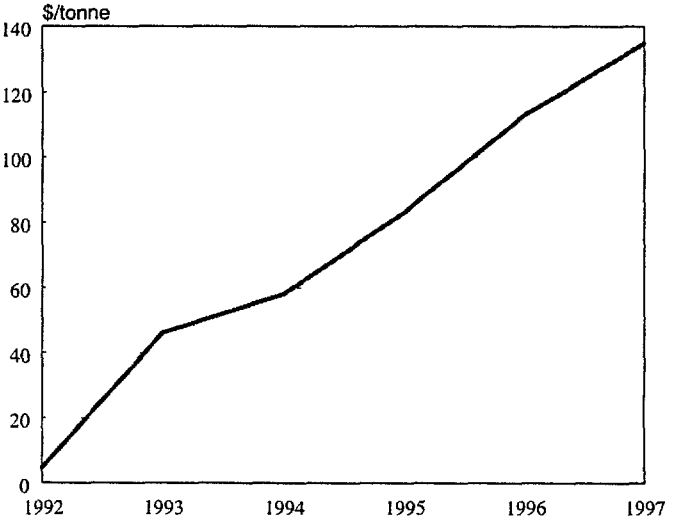
The thermal power industry in Armenian has increasingly substituted natural gas for mazut as the primary fuel source for the country's thermal power plants over the past several years Mazut currently accounts for only 5% of the fuel consumption in the power sector Even though mazut consumption has fallen sharply, it still plays an important role in the power sector as a reserve fuel for times when the natural gas supply is insufficient to meet demand, or is interrupted Because the thermal power plants have no gas storage facilities of their own, they consume gas in real-time, burning it as soon as it arrives at the plants Thus, any fluctuation in gas supply results immediately in a fluctuation in power supply unless adequate reserves of mazut are available

4 5 MAZUT PRICING

Mazut prices in Armenia are largely set by the market However, Armoilproduct and Armturtrade have considerable influence over the market, and hence pricing, due to their relative size advantage over competing private importers

In 1997, mazut prices in Armenia had risen over 2,800% above the mazut price in 1992 Mazut prices were kept artificially low during the Soviet period by the government to subsidize industry and other consumers This practice was continued when Armenia initially gained its independence, but the policy was not sustainable in the context of the Azeri embargo and rising prices from Russian suppliers

Exhibit 4-4
Mazut Price Increase



Source Ministry of Energy Yerevan TPP Razdan TPP

In 1993, mazut prices were essentially liberalized as the government scrambled to meet demand in the face of diminishing supplies As a result the price of mazut increased dramatically in a relatively short period of time (see Exhibit 4-4) The sharpest increase occurred in 1993 following the onset of the Azeri economic blockade, when mazut prices increased by 965%, from roughly $4 79 per tonne to $46 20 per tonne The price of mazut has subsequently increased by 20% - 45% per year, currently the price for mazut in Armenia is higher than the world price (See Exhibit 4-5)

Much of the mazut in Armenia comes from Russian refineries which ship the mazut from Novorossisk, a major oil exporting port on the Black Sea Some mazut also comes from crude oil shipped to the Georgian port of Batumi and transported by a short pipeline to the Batumi refinery two kilometers outside of the city There the crude is refined into mazut and other products, and transported by railroad tanker cars to Armenia [2]

Exhibit 4-5
Comparative Mazut Prices

Price	1992	1993	1994	1995	1996	1997
Armenia ($/tonne)	$4 79	$46 20	$58 00	$83 25	$113 10	$135 00
% increase		965%	26%	44%	36%	19%
World ($/tonne)	$92 54	$105 42	$99 12	$103 88	$108 76	$115 54
% increase		14%	-6%	5%	5%	6%

Source IEA DOE Ministry of Energy

Profit margins for importing mazut are very slim (see Exhibit 4-6) Mazut can be purchased in Novorossisk for $75/tonne The cost of transporting mazut to Yerevan, including extra costs for loading and unloading the mazut onto tankers and railcars, is close to $55/tonne, thus the delivered cost is close to $130/tonne Since the current price for fuel in Armenia is $135/tonne, the profit margin from such a transaction is very small, around $5 or 4% This small return is insufficient to compensate for the risks for private importers One day of unexpected demurrage on the tanker or rail cars could easily wipe out any profits Only government agencies are willing to operate given such small profit margins

Exhibit 4-6
Mazut Import Price

$75	mazut purchase price per tonne
$ 3	loading on the tanker ship
$18	shipping
$ 3	off loading
$30-35	transport to Yerevan
$129-134	delivered price per tonne

As already noted, there is speculation that oil is being imported from Azerbaijan through Georgia and then redirected to Armenia The transportation cost for sending mazut from Baku to Yerevan via Georgia is only $25/tonne plus the cost of off loading which as assumed by customers in Armenia

[2] The Georgian port city of Poti has a facility to load crude oil and liquid petroleum products on railcars but Poti lacks the necessary equipment for loading railcars with viscous refined products like mazut

There is disagreement regarding the quality of mazut received by Armenian power plants While some sources state that fuel quality is fairly consistent, other officials note that the humidity levels of the mazut received by the power plants range anywhere between 0 4% to 4%, more than twice the acceptable range

Issues Related to Transportation Within Armenia

All mazut is delivered to the Armenian power plants by railroad tankers Railroad transportation is unreliable and delays are common Delays in rail transportation result in demurrage charges for mazut importers which can significantly increase the cost of imported mazut

The Armenia railroad system remains a state owned monopoly, under the control of the Armenian State Department of Railroads, a division of the Ministry of Transportation, with little available funding or incentives to improve service and make capital improvements According to private importers, tariff rates are very low, at levels that barely cover operation and maintenance costs Thus, cash flows are inadequate for financing new investment and rehabilitation of existing railroad stock As a result the physical condition of the system is very poor In addition, the industry is riddled by bureaucratic procedures and forms that add to delays The rapid decline of economic activity, coupled with the deterioration of the rail industry, has resulted in a ten fold decline in rail transport in Armenia since the late 1980s

4 6 CONCLUSIONS

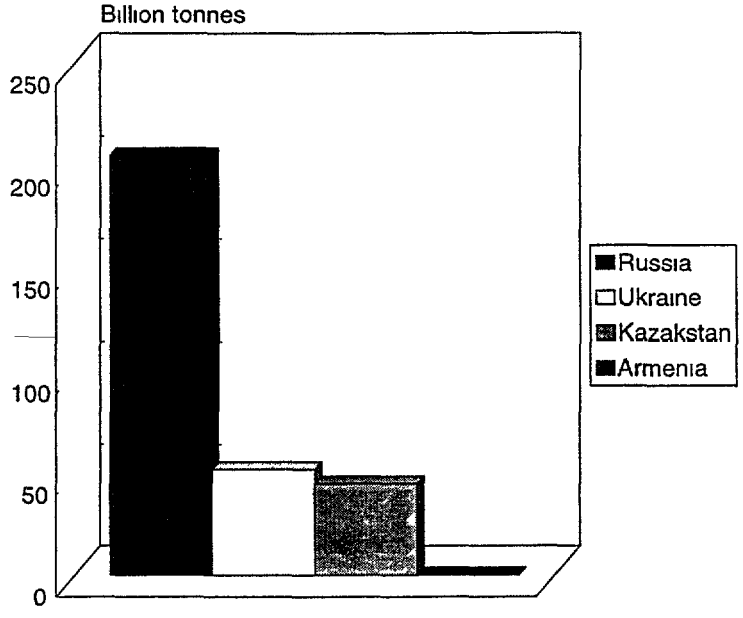
The market for mazut has become relatively more competitive as private importers enter the market, but the lack of open access to State storage and other facilities still skews the market in favor of State mazut suppliers Similar to natural gas, the domestic mazut market is entirely dependent on imported products transported through Georgia While mazut can be purchased from numerous foreign producers, the reliance on one transit point (Georgia) makes the mazut market extremely sensitive to any disruptions in the Georgian transportation link The Armenian rail system, the main transportation vehicle for mazut locally, is also in need of substantial reform

CHAPTER 5
COAL MARKET

5 1 HISTORY

Armenia has an embryonic coal industry that is only now beginning to develop the relatively scant coal reserves that exist in the country During the Soviet period, Armenia's relatively insignificant coal resources were largely ignored by Soviet energy officials While Armenia's proven coal reserves are over five million tonnes and total reserves are estimated to be as much as 100 million tonnes,[1] they are dwarfed by the size of the coal deposits in Russia, Ukraine, and Kazakstan Reserves in these former Soviet republics are measured in tens, or even hundreds, of billions of tonnes, and are often found in large concentrated deposits with thick, easily mined coal seams (see Exhibit 5-1) By contrast, Armenia's relatively meager coal reserves are spread among a number of small deposits, and the seams tend to be thin, making industrial mining difficult and uneconomic

Exhibit 5-1
Selected NIS Coal Resources



Source World Bank Hagler Bailly

Since Soviet energy officials channeled all funding for coal exploration and development towards the more favorable areas of Russia Ukraine, and Kazakstan, Armenia's coal reserves are relatively unexplored and untapped However, in 1992, the energy shortages resulting from embargoes by Azerbaijan and Turkey led Armenia to resume coal exploration In 1993, under USAID's Energy Efficiency and Market Development project, the U S Geological Survey provided assistance to the Armenian government in conducting a preliminary assessment of the coal and solid fuel resources of Armenia Similar assistance was provided by the European Union

[1] Report on Subsector Solid Fuel EU-TACIS June 1995

in 1995 Based on these and other assessments, the Armenian government has initiated small-scale coal mining in Armenia

5 2 COAL CLASSIFICATION

The term "coal" refers to a wide range of solid hydrocarbon fuels categorized primarily according to their fixed carbon content The percentage of fixed carbon found in the various grades of coal directly corresponds to the fuel's heat content, coals with a high percentage of fixed carbon also have high heat content values [2] In addition to fixed carbon and heat content, several other factors are important in determining the quality of various grades of coal including volatile matter, moisture, ash, and sulfur content

Volatile matter refers to those gasses, exclusive of water vapor (moisture), given off during combustion The percentage of volatile matter is inversely proportional to the fixed carbon content of the coal Within a certain range, volatile matter assists in the combustion process, and the lack of volatile matter in coals with high fixed carbon content will actually reduce the combustibility of the coal Thus, coals with high carbon content and low volatile matter are more difficult to ignite, but produce a relatively large degree of heat On the other hand, coals with lower fixed carbon and higher percentage of volatile matter are easier to ignite but produce less heat

Moisture is another factor that affects coal quality Coal with a high moisture content is more difficult to burn In addition, high moisture content can lead to problems with coal freezing in the winter during transportation or storage

Two other quality measurements that have environmental as well as performance implications are ash and sulfur content The ash content measures the percentage of incombustible (mineral) matter contained in the coal Coal with a high ash content is difficult to burn and can cause problems with the build up of slag (waste) in the boiler and downstream combustion systems High ash content levels also result in higher levels of air, water, and soil pollution The material remaining from the combustion of coal is either released into the atmosphere as particulates, or it settles to the bottom of the boiler as slag which must be removed and disposed of in special ash storage facilities

Sulfur also impedes combustion and can lead to slagging in the boiler Moreover, burning high sulfur coal produces significant air pollution problems The sulfur dioxide emitted during coal combustion combines with atmospheric water vapor to form sulfuric acid, which precipitates as acid rain

[2] In coals with fixed carbon greater than 86% the heat value begins to decline

The various coal quality factors are used to categorize coal into different classifications However, comparing coal classifications between countries is often difficult since category names and specifications often vary This can be seen in the differences between coal classifications in North America and the former Soviet Union (see Appendix 2) Nonetheless, most international classification systems recognize a basic distinction between hard coal (anthracite, bituminous) and brown coal (sub-bituminous, lignite)

These different coal types are used for two fundamental purposes the production of *coke* and the production of *steam* Coke is a processed coal byproduct used as a fuel source in ferrous metallurgy The production of high-quality iron and steel requires the use of a fuel with minimal impurities In the coking process, coal is heated to reduce volatile matter and other impurities Coal used in the production of coke is generally low in volatile matter and other impurities with a high percentage of fixed carbon and certain other specific qualities Due to their characteristics, anthracite and high grades of bituminous coal are most often used as coking coal (see Exhibit 5-2)

Exhibit 5-2
Typical Characteristics of Coking and Steam Coal

	Steam Coal	Coking Coal
Heat content (kcal/kg)	6 000	8 500
Volatile matter	>23%	0-22%
Moisture	8%	5-6%
Ash content	9 5%	7 6%
Sulphur cont	1 2%	1 2%

Source DOE

Steam coal is consumed in boilers to produce steam for industrial and other uses Most coal-fired boilers in thermal power plants are designed to burn high volatile bituminous (and sub-bituminous) coal Since these coals are high in volatile matter they tend to be easier to ignite Moreover, high volatile coal does not need additional assistance to burn once the combustion process in the boiler is started However, some power plants are equipped with boilers designed to burn anthracite or, at the other end of the quality spectrum, lignite These coals require co-firing with oil or gas to maintain the combustion process

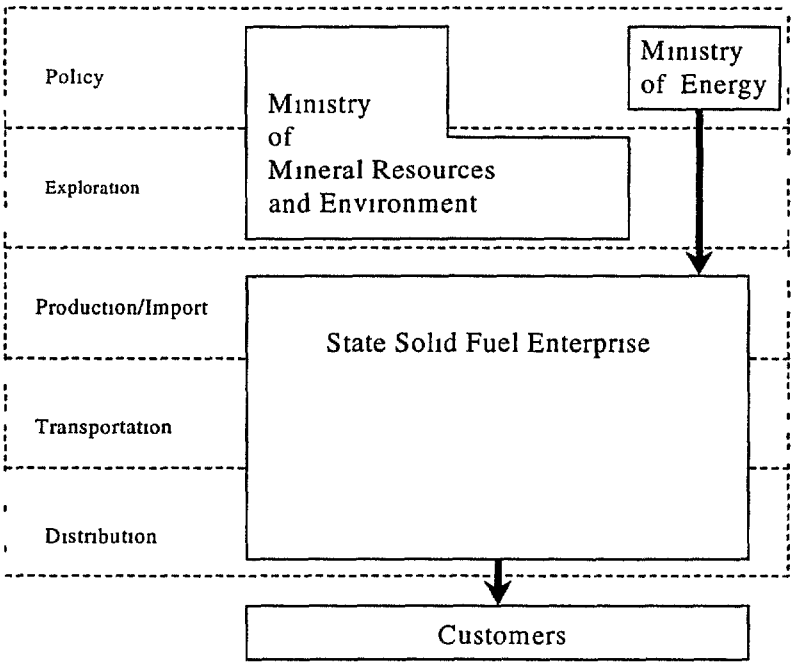
5 3 INDUSTRY STRUCTURE

In Armenia, authority over the coal industry is divided between two governmental agencies the Ministry of Mineral Resources and Environment and the Ministry of Energy (see Exhibit 5-3) The Ministry of Mineral Resources and Environment is responsible for all coal exploration as well as the initial preparation phases of coal mine preparation and development If further development of the mine is determined to be feasible, development is turned over to the Ministry of Energy's State Solid Fuel Enterprise The State Solid Fuel Enterprise then oversees the expansion of coal production at the site under the guidance and direction of the Ministry of

Energy At the present time, this transfer of responsibilities has yet to take place at any Armenian mine While the State Solid Fuels Enterprise is not currently involved in domestic coal mining, it is responsible for all coal imports into the country The import function of the State Solid Fuels Enterprise will be discussed further in the section concerning coal production and supply

Exhibit 5-3

Armenian Coal Industry



The State Solid Fuels Enterprise was scheduled to be privatized in July 1997 However, to date no purchaser has been found The general director of the enterprise has stated that he does not see much future in the coal business in Armenia As a result, the director has already begun to diversify the company by moving into the production and marketing of building materials

5 4 COAL AND THE POWER INDUSTRY

Coal is not used by any of the thermal power plants in Armenia for the production of heat or electricity All of the Armenian thermal power plants were constructed with boilers designed to burn either mazut or natural gas While Soviet boilers can be converted to burn coal, this is a

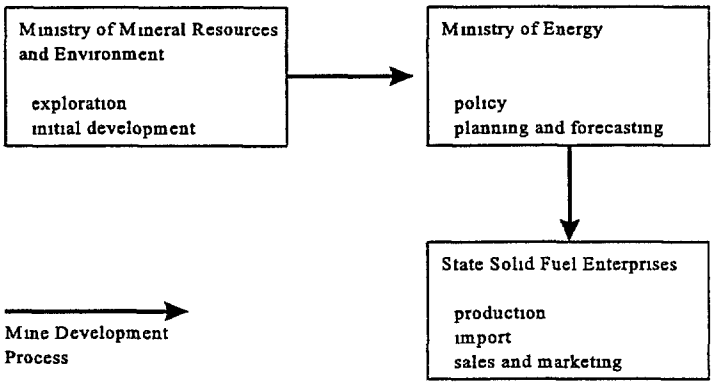
long and expensive process, justified only if there is an economic advantage in consuming coal over mazut and gas In Armenia coal has no such advantage over other fossil fuels, supplies of the proper coal qualities are limited and the price per kilocalorie (kcal) of heat content is higher than that for gas and mazut It is unlikely that coal will become an economically feasible fuel choice for the Armenian electric power industry, barring the discovery of a major domestic steam coal deposit However, Burns and Roe is presently investigating the feasibility of a coal-fired fluidized bed unit Further determination as to the role of coal in the Armenian generation sector will need to await the outcome of the Burns and Roe Study

5.5 COAL PRODUCTION AND SUPPLY

While several coal mines have been identified in Armenia and some small scale production is conducted at each, none of the coal mines have been relinquished by the Ministry of Mineral Resources and Environment to the Ministry of Energy for commercial production (see Exhibit 5-4)

Exhibit 5-4

Coal Mine Production Cycle
and Division of Authority



There are three coal mines currently in production in Armenia Idjevan, Djadjur, and Nor Arevik In addition, there are a number of coal test sites at Ghermanis, Antaramut, and Shamut Total proven coal reserves currently amount to between 3-5 million tonnes [3] Potential reserves of more than 80-100 million tonnes are estimated to exist at greater depths than have currently been tested

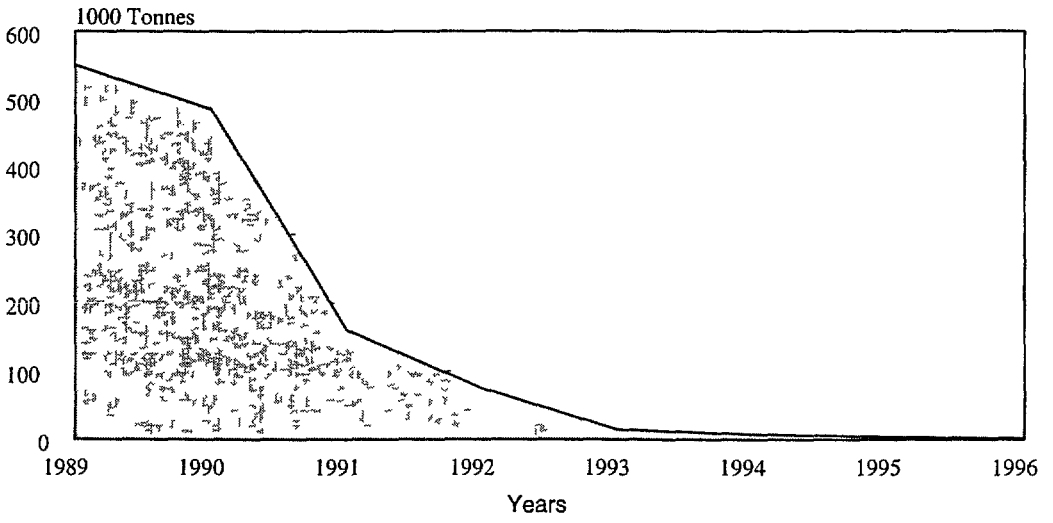
The largest Armenian coal mine is near the city of Idjevan Idjevan was the focal point for the limited coal exploration conducted in the region during the Soviet period It is also the site where test mining was first resumed in 1992 Current estimates place the proven reserves at Idjevan between 500,000 and 750,000 tonnes Deeper below the surface (>600 meters) there are possibly between 40 and 70 million tonnes of coal at this site However, these deep reserves are unproven and will require substantial testing to verify the actual size and quality of the deposit The relatively narrow and sharply dipping coal seam near the surface of the Idjevan site is mined using an open pit method with minimal heavy equipment (a shovel excavator and two heavy

[3] Report on Subsector Solid Fuel EU-TACIS June 1995

trucks) The maximum production at Idjevan with this equipment is estimated at less than 150 tonnes per day [4]

The Djadjur field near Gumri in the northern region of the country and the Nor Arevik field near Megri in the south also produce small quantities of coal The Djadjur field is reported to contain close to 500,000 tonnes of proven reserves and several times more in potential, or unproven, reserves Figures for the proven reserves of the Nor Arevik field are not available, but estimates of the potential size of the deposit are around 3,000,000 tonnes [5] Current production from these fields is minimal, and the coal is used primarily for residential heating in the communities surrounding the mines Of the remaining coal test sites, none appear to be of the necessary size to support a commercial mining operation

Exhibit 5-5
Coal Consumption



Source State Solid Fuel Enterprise

In the past, coal accounted for less than one percent of Armenia's overall energy needs, primarily to meet seasonal demand for residential heating Currently, coal demand has plummeted to nearly imperceptible levels In the mid 1980s, Armenia imported between 300,000 and 400,000 tonnes of coal each year, mainly from the Donbas Basin in Russia and Ukraine The peak year of coal imports was 1988-1989 when Armenia imported nearly 550,000 tonnes of coal Since its peak in 1988-1989, Armenia's coal consumption has fallen to less than 5,000 tonnes per year

[4] Ibid

[5] Ibid

Exhibit 5-5 illustrates the dramatic decline in coal consumption over the past seven years Due to the Azeri economic blockade, Armenia lost over 200,000 tonnes of coal in transit through Azerbaijan in 1991 alone Coal supplies and consumption have never recovered

As coal became scarce and prices increased in the early 1990s, residential consumers turned to other fuels for heating during the winter months The favored substitute became wood cut from local forests During the period from 1992-1994, the consumption of wood greatly increased while coal consumption dropped to a fraction of its former level In addition to its slight price advantage over coal, wood became popular as vendors began selling wood door-to-door In contrast, coal must still be purchased by the consumer from one of the 12 remaining coal warehouses in the country, and the consumer must pay for transportation and loading/unloading [6]

Even during peak coal use in 1989, the volume of coal consumed is hardly enough to fuel even a medium-sized power generating unit Based on data for Soviet designed anthracite-fired coal units, a 100 MW unit loaded at 70% would use over 500,000 tonnes of coal per year

5.6 COAL QUALITY AND PRICE

By Western standards, much of the coal that Armenia receives is very high in ash and moisture levels and below the standard for heat content The exception is the coals purchased from Rostovugol in 1992 and 1993, which were of markedly higher quality than the rest, and come close to meeting the international norms for anthracite In general, Soviet-built coal-fired thermal power units are designed to consume coal with heat content levels between 5,600-6,500 kcal/kg for anthracite, and 4,100-5,800 kcal/kg for bituminous coal Most of the coal available in Armenia falls within this range, but the high ash content can result in high ash disposal costs and impede boiler combustion The Georgian brown coal and Armenian peat from Idjevan are far too low in heat value to be used for power generation The Idjevan site is capable of producing higher quality coal, but it would require substantial cleaning and drying to reduce the high moisture content (see Exhibit 5-6) The Djadjur coal, while promising, is from too small of a deposit to support an Armenian market It may not be feasible to use any of the domestically produced coals as a primary fuel for thermal power production

Although a coal testing lab exists, there are currently no cleaning facilities in Armenia Without coal cleaning facilities, Armenian coal must be consumed without the benefit of processing to remove sulfur and reduce the ash and moisture content Coal cleaning could greatly improve the quality of much of the coal mined in Armenia, but the small volume of coal produced does not justify investment in coal cleaning facilities

[6] There are 22 coal warehouses in Armenia but due to the low level of coal supply only 12 are functioning

Exhibit 5-6
Characteristics of Armenian Coal Imports and Domestic Production

Year	Coal Source	Quantity (tonnes)	Moisture (%)	Ash Content (%)	Calorific Value (Kcal/Kg)	Cost/tonne ($)
1992	Rostovugol, Russia	44,902	3 6	10 0	8,300	
		28,308	4 02	12 6	7,500	
	Tkibuli, Georgia	879	16 0	37 0	3,600	
1993	Tkibuli, Georgia	1,360	16 0	37 0	3 600	43 55
	Idjevan, Armenia	8 500	16 6	36 8	5 900	91 94
	Djadjur, Armenia	5 450	23 5	24 0	3 880	
1994	Rostovugol Russia	2,625	3 6	10 0	8 300	72 9-110 5
	Kemerov, Russia	3,152	2 9	40 3	6,100	41 96
	Tkibuli, Georgia	740	8 0	30 5	4 900	37 50
		1,032	16 0	37 0	3,600	
	Idjevan Armenia	110	12 5	15 6	6 300	
		130	8 3	44 0	2 700	37 90
1995	Kemerov Russia	1,935	2 18	35 0	4 500	42 00
	Tkibuli, Georgia	740	8 0	30 5	4 900	74 10
	Rostovugol Russia	617	0 6	36 8	5 000	111 12
	Djadjur Armenia	30	2 71	14 63	5 100	
	Idjevan, Armenia	60	8 3	44 0	2,700	
1996	Tkibuli Georgia	2,000	8 0	30 5	4 900	72 64
	Idjevan Armenia	100	8 3	44 0	2 700	

Source State Solid Fuel Enterprise

Compared with those in other NIS countries, coal prices in Armenia are extremely high The government, through the State Solid Fuel Enterprise, sets the price of coal for all consumers There are no independent coal importers or producers operating in the Armenian coal market

The high cost of coal is the result of two major factors the general increase in energy prices in the former Soviet republics, and the increased cost of shipping goods to Armenia due to political

unrest and the deterioration of the transportation infrastructure in the Caucasus Coal cannot compete in energy markets where there are viable substitutes Exhibit 5-7 illustrates the cost added by transportation of anthracite and bituminous coal into Armenia

Even domestically-produced coal is relatively expensive, although transportation costs are lower than those for imported coal, the production costs are higher Armenian coal pits are not able to take advantage of economies of scale that allow larger foreign coal producers to lower their marginal costs by investing in more efficient production machinery

Exhibit 5-7
Cost of Coal Transport

	Anthracite ($/tonne)	**Bituminous ($/tonne)**
Cost at mine (Rostov)	70-75	30-40
Transportation to Yerevan	70-75	70-75
Final cost	140-150	100-115

Source State Solid Fuel Enterprise

5.7 CONCLUSIONS

At present, there is not enough coal currently on the Armenian market to support power generation Increasing domestic coal production will require significant capital investments and will not show returns for several years while infrastructure and mine shafts are constructed Since Armenia does not currently have adequate supplies of domestic steam coal, large volumes of coal would have to be imported from abroad, exposing coal supplies to all the political and economic risk that affects natural gas and mazut imports Moreover, the transportation sector is not equipped to handle the large volumes of coal needed to supply even a small power plant Finally, Armenian power plants currently have no coal-fired units and would require significant funds for the conversion of their boilers to consume coal as their primary fuel In sum, the price of coal for power generation is high, making natural gas or mazut appear decidedly more economical Nonetheless, final conclusions regarding the role of coal in the power sector should await completion of the Burns and Roe circulating fluidized bed feasibility study

CHAPTER 6
RECOMMENDATIONS

Based on the analysis of the Armenian fuel markets presented in this report, there are a number of initiatives that the Government of Armenia can adopt to improve fuel supply, quality, and price in the domestic fuel markets The first group of recommendations consists of measures applicable to all sectors of the energy industry These measures are designed to enhance the fuel market reform process by improving energy coordination, competition, and transportation Additional sections present specific recommendations for each branch of the energy/fuel industry — thermal power, natural gas, mazut, and coal

6.1 GENERAL RECOMMENDATIONS

National Energy Policy The energy policy of the GoA was published in November 1996 and focuses primarily on production targets and investment needs, not on reform and restructuring The leadership at the Ministry of Energy appears to have a broader understanding of the necessity of structural reform in the energy sector But this view, or views, on the future of the energy industry should be synthesized into an actual policy statement It is important that the government formulate a policy that can be referenced and relied upon by other members of the Armenian energy industry as well as by foreign donors and investors

Government policy on restructuring and reforming the energy sector were articulated in a recent speech by Dr Galen Galustian, First Deputy Minister of Energy, delivered at the First International Energy Conference held July 27-31, 1998 in Yerevan

"Today, we are faced with the problem of reducing private investor risks as to the nature, scope and terms of privatization of energy complexes, rates and depth of incorporation, choice of reliable partners, the making of a competitive market and many others Obviously, these tasks, considering the political, social and economic infrastructure of the country, require acceptance of step by step coordinated decisions The Plan of privatization was developed by the active participation of experts from the World Bank, USAID and other international organizations The main goals of the Plan are the following

1 Energy complexes whose main power production is interconnected will be restructured, incorporated and privatized with strategic investors,
2 Non-strategic facilities are privatized by their direct transfer to the private sector,
3 New energy complexes will be established on the basis of the attraction to the private sector by projects such as BOT and BOOT schemes

In order to develop the private sector, the Ministry of Energy of Armenia is ready to discuss the realization of projects using BOOT and BOT schemes, making joint-ventures, concession agreements and others

Development of new principles of economic relations and firm steps of development of the economy, creation of new strategic priorities for the Armenian Energy Sector include

- *Reduction of energy dependency on imported fuel,*
- *Ensuring maximum energy stability on the basis of realizing sound principles of diversification including the efficient use of the domestic resources,*
- *Ensuring maximum safety of atomic energy,*
- *Restoration and development of interconnected electrical and gas supply system relations with neighboring countries,*
- *Development of legislation,*
- *Determination of market relations in the energy sector,*
- *Creation of an efficient investment infrastructure,*
- *Improvement of tariff policy and regulations,*
- *Development of the privatization process of the energy sector,*
- *Development of the standard-normative base to bring it to the world-level,*
- *Training and increasing the amount of personnel qualified to work under conditions of a market economy*

Development of the electricity sector is realized in accordance with the "Program of development of the energy sector of Armenia till 2010" and is oriented at the realization of a three-level energy diversification policy

- *On generation sources - HPP, TPP, NPP,*
- *On fuel - natural gas, oil, nuclear fuel,*
- *On fuel delivery - gas pipelines, delivery of oil product, exploiting domestic fuel resources*

Along with Armenian specialists, many experts from foreign companies within the framework of the technical assistance of TACIS, USAID, the World Bank, the German engineering-consulting company Lahmeyer International and others participated in the preparation of the "Development Plan "

The investment program stimulates

- *Hydro power*
  - rehabilitation of the existing hydro power plants,
  - development of 230-250 MW economically expedient new hydro potential,
  - construction of small and micro HPP's with private foreign and local investors,
  - establishment of pumped storage plants with comparatively low investment

- *Thermal power*
  - operation of existing facilities to completely exhaust their technical potential,
  - commissioning of a new 300 MW unit at the Hrazdan TPP in the central part of Armenia,
  - refurbishment of the Yerevan TPP on the basis of two modern Combined Cycle (CHP) units,
- *Development of geothermal resources,*
- *Development of nuclear energy on the basis of modern technologies,*
- *Development of renewable energy,*
- *Implementation of an aggressive DSM campaign*

During the realization of the Development Plan of the energy sector, the Ministry of Energy of Armenia emphasizes the integration of the fuel-energy complex of Armenia with the regional energy market on the basic principle of new and mutually beneficial economic relations At present, Armenia exports to Georgia 80-100 MW of electricity Negotiations for the organization of reverse power with Iran and Turkmenistan are in progress, as well as the transit of electricity from Iran to Georgia through Armenian transmission networks "

The GoA should develop and publish a comprehensive national energy policy clearly indicating the future direction of energy reforms in Armenia This national policy should focus on the process and scope of transforming state-owned energy enterprises into fully corporatized and privatized companies As part of this policy, the government should outline the steps that it intends to take concerning the development of the fuel markets within the country In addition to clarifying restructuring goals and implementation plans, the national energy policy should also include

- A re-evaluation of the current reform plans for the fuel sectors The efforts to reform the fuel sectors should be brought in line with the vision for the reform of the entire energy industry

- An emphasis on reducing the role of the State in energy production and management in favor of the private sector Privatization of state energy industries should be seen as a method for improving management, attracting investment and encouraging development of the energy industry

- A plan to restructure the State energy institutions to reflect a focus on policy formation and regulation rather than setting production targets and directing investment decisions

- A plan to improve policy coordination between the various energy sectors Grouping all state-owned energy enterprises (including Armoilproduct) under the Ministry of Energy before corporatizing and then privatizing them may be part of this process

- Creating a time line establishing milestones and dates for achieving the goals outlined in the policy A time line will help to visually organize the sequencing of reform activities and add to the coordination of the reforms between the various energy sectors

- Establish greater transparency in the reform process by publicizing forecasts and restructuring plans

Price Fuel by Heat Content, not Weight or Volume If the government continues to regulate fuel prices, it should price fuels based on heat content rather than weight or volume International fuel prices tend to reflect the heat content since fuel value is related to its ability to produce heat, adjusted for special qualities or diseconomies associated with each fuel (e g , ease of handling, associated pollutants, etc)

Corporatize and Regulate Rail Transportation The state railroad monopoly in Armenia should be separated from the Ministry of Transportation, corporatized and allowed to operate as an independent business entity Railroad operations need to be commercialized to transform the railroad from an ailing, loss-making enterprise into a financially viable and self-sustaining company Since the railroad will most likely remain a monopoly, it should be regulated by an independent commission in order to protect customers from monopoly abuses and ensure satisfactory service Rail tariffs should be based on the actual cost of service The tariffs should reflect all rail transportation costs, including capital costs to ensure that the railroad has funds available for future expansion and rehabilitation Regulations should place greater liability on shippers for the cargo that they transport between fuel suppliers and consumers

Increase Cooperation with Donors The government of Armenia should continue to expand its close relations with donor nations and international lending institutions to develop, finance and implement energy reform and development programs International donor agencies and lending institutions may be sources of financing and expertise for many of the initiatives highlighted in this section, including creating a national energy policy, corporatizing and privatizing state-owned fuel enterprises, conducting needs assessments and procuring equipment, improving legal documents and contracts, and enhancing general operating procedures In addition, assistance may be valuable in areas which are not mentioned in this section, such as

- Attracting private investment and preparing investment promotion materials for the energy sector,

- Providing small business seed money to private fuel marketers and developers

6 2 POWER GENERATION INDUSTRY RECOMMENDATIONS

There are a number of inter-related recommendations that the government should undertake to give the power plants more control over fuel procurement activities In addition, there are several recommendations which the power plants can implement themselves to take more control over the fuel procurement and delivery process

Allow Power Plants to Procure Their Own Fuel Individual power plants should be given the authority to procure their own fuel supplies As part of the restructuring process, the individual power plants are being given more decision-making freedom and operational independence from Armenergo The plants will be held increasingly accountable for lowering their costs and becoming financially viable enterprises However, the plants have not yet been given complete authority to make their own fuel procurement decisions and establishing direct contracts with fuel suppliers Since fuel procurement is the single largest cost of operating a thermal power plant, plant management must have control over fuel procurement in order to control operating costs It is strongly recommended that the government establish a time frame to quickly transferring fuel procurement authority to the individual power plants This transfer of authority must be legally binding and clear to all parties

Pay Power Plants for the Full Value of the Electricity Generated In order to enable the power plants to procure their own fuel supplies, Armenergo must pay the power plants for the full value of the electricity they generate Currently Armenergo only transfers payments to the power plants to cover operations, maintenance, and overhead costs, while retaining much of the proceeds from the supply of electric power for the procurement of fuels for the entire industry The funds for fuel procurement costs must be transferred to the power plants if they are to control their own fuel procurement

Shift Electricity and Fuel Forecasting Responsibilities to the Power Plants Responsibility for forecasting fuel requirements should be transferred to the thermal power plants from the Ministry of Energy Forecasting and planning should be based on actual market demand forecasts guided by the principle of profit maximization The power plants should base fuel consumption forecasts on the plant's estimates of anticipated generation as determined by the expected market demand In order to carry out such forecasts the power plants will have to enhance their forecasting capabilities and increase their market analysis tools The Ministry can conduct its own independent forecasting, but it should relinquish control over the distribution of fuel based upon its forecasts

Continue to Increase Cash Collections In order to take control over the fuel procurement process, the thermal power plants must have adequate cash reserves to conduct competitive fuel procurement Without cash, the power plants will be forced to engage in inefficient, non-monetary means for acquiring fuel Increasing cash reserves for fuel purchases at the thermal

power plants will require a major improvement in the overall collection rate by Armenergo and the transfer of a fair proportion of such revenues to the power plants

Adopt Competitive Procurement Procedures To ensure that they are receiving the highest quality fuel at the lowest price, the power plants should adopt international competitive procurement procedures to create competition among fuel suppliers to meet their fuel needs Western assistance can be leveraged in training power plant officials to conduct competitive tenders The government can encourage a transition to competitive procurement by promoting the development of competition in the fuel sectors

Improve Fuel Contracting Procedures Armenian power plants should draft their own fuel supply contracts By using their own fuel contracts, the power plants can dictate the fuel amounts, quality and other related terms to meet their own needs Among other issues, contracts should clearly state delivery dates, quality parameters, and ensure pricing based on heat content, not weight or volume The plants can also use penalties and/or premiums to their advantage to acquire the best quality fuel at a clearly stated price Contracts can be patterned after those used by Western power plants, tailored to adhere to the Armenian legal code Technical assistance can be integral in training and assisting Armenian power plant officials on international fuel contracting and negotiating procedures

Improve Fuel Testing Facilities In order to realize the benefits of improved contracting, the thermal power plants must have the ability to properly test and analyze the fuel that they receive from suppliers Each plant should ensure that its fuel testing equipment is sufficient to provide timely and accurate fuel quality information Donors may be employed in financing and supplying the technical expertise to conduct an assessment of the fuel testing equipment needs of the power plants

If modernizing the fuel testing labs at each power plant proves too costly, a single mobile testing facility could be created to handle all the testing needs of the power plants Because there are only three thermal power plants which are relatively centralized, only two of which are presently operating, one mobile laboratory could service all the plants This mobile laboratory could be owned and operated by the power plants collectively, or it could be run as an independent company

Increase Mazut Reserves Mazut levels at the Armenian thermal power plants are extremely low and provide little, if any, cushion in the event of a termination of gas supplies To ensure that the power plants are able to operate if their primary fuel supply (natural gas) is cut off, the thermal power plants should maintain adequate mazut reserves The exact size of the reserves is subject to further analysis, but an initial target of 30 days supply is recommended International lending institutions might provide financing for the purchase of fuel reserves The World Bank extended financing for this type of program in Ukraine in 1997

Lease Mazut Storage Capacity As independent market oriented enterprises, the thermal power plants should look for ways to leverage the assets that they possess to enhance or create new revenue streams One potential source of revenues that could be used to finance mazut purchases, is leasing unused mazut storage capacity to private mazut traders Private mazut traders lack access to storage capacity At the same time the cash-strapped power plants have considerable excess mazut storage capacity With the addition of equipment at the mazut storage facilities to allow for the loading of mazut onto railroad tanker cars, the power plants could lease their storage capacity to private mazut traders In return the plants could either take payment in cash or mazut The power plants could also include provisions giving them the right to utilize the mazut in storage, at a fair price, in the event of a fuel emergency This scheme would increase the plants' relative mazut reserves, but only require the plant to incur the cost of these reserves when they are needed

6.3 MAZUT AND PETROLEUM RECOMMENDATIONS

As part of the general economic reforms in Armenia, the government should reduce its role in the production, import, pricing and distribution of petroleum products in favor of private sector enterprises The following recommendations are aimed at increasing the role of the private sector in the mazut and petroleum industries

Corporatize/Privatize State Mazut Import Enterprises In order to reduce the role of the state in the mazut market, the state mazut import agencies should be corporatized and then privatized within a relatively short time frame Armturtrade and Armoilproduct should be separated from their respective Ministries and either disbanded or corporatized as independent business enterprises with the intent of privatizing them as quickly as possible Technical assistance may be valuable in this process to develop a sound policy and strategy for corporatization and privatization

Lease/Privatize Mazut Storage Facilities The government should allow private firms to have access to State mazut storage facilities State importers currently have a clear advantage over private importers due to their control over storage facilities This advantage distorts competition and limits the impact of the private sector in the mazut market To ensure fair competition, the government should allow all parties to have access to mazut storage facilities at a reasonable price The government should also consider privatizing its mazut storage facilities as part of the larger commercialization of the petroleum industry

Increase Mazut Sourcing and Transportation Options As a landlocked country, Armenia is dependent on its rail links with other countries for access to external mazut supplies The loss of many of these connections in the past years has severely reduced the supply options available to the power plants and to the country as a whole Armenia is vulnerable to disruptions in fuel deliveries along its primary supply route from Georgia The Armenian government should

undertake activities to increase the country's import options Re-establishing trade relations with Azerbaijan and Turkey would immediately increase Armenia's supply and transportation options, but reconciliation with Azerbaijan appears unlikely at the present time As a long-term strategy, Armenia may have to construct infrastructure links (rail lines and/or gas pipelines) to Iran International financing for projects establishing links in the south to Iran would be largely unavailable due to Iran's status in the international community However, the tremendous oil and natural gas reserves in Iran, as well as the existence of natural gas trunklines relatively close to the Armenian border make Iran a potentially valuable fuel supply source for Armenia

6.4 NATURAL GAS RECOMMENDATIONS

The following recommendations are intended to support creation of a competitive national gas market

Promote Gas Import Market Competition It is recommended that the authority to import gas be granted to any interested and qualified party The Russian-Armenian joint venture should not become the sole gas importer for Armenia Other Armenian companies should be allowed to make independent contracts for gas supply with other producers linked to the Russian pipeline network Moreover, the power plants themselves, as the country's largest gas consumers, should be allowed to directly contract with suppliers and negotiate their delivery, quality and price specifications

Establish an Independent System Operator for the Gas Transmission System The Haitransgas State Enterprise should become the independent system operator for the transmission system in Armenia Haitransgas should be corporatized and operated as an independent enterprise with its actions regulated by the Energy Regulatory Commission As the country's gas transit monopoly, Transgas should operate under an open access regime, allowing all gas suppliers access to the transmission system Transgas should also continue to manage the gas storage facilities since these assets are an integral part of the transmission system and necessary for maintaining pipeline pressure

Spin Off Ancillary Enterprises Separation of non-core enterprises and activities from the primary gas enterprises should take place Candidates for this process include Armgasprom's interests in gas equipment manufacturing, butane marketing, automotive gas, high pressure gas maintenance, and other non-core business activities (farms, schools, apartments)

6 5 COAL RECOMMENDATIONS

The coal markets are of little importance at present for the Armenian thermal power plants, nonetheless operations could still be improved within the coal industry Our recommendations support further privatization

Support the Privatization of the Coal Industry The Armenian government has taken appropriate steps to privatize the operations of the formerly state-owned coal import enterprise The government should also consider privatizing coal exploration activities within the country Currently, the Ministry of Environment and Underground Resources has authority over coal exploration However, with limited financial resources, there is little that the Ministry can do in terms of sophisticated exploration activities and mine development The government should consider selling exploration and production rights to private firms to explore for coal deposits

Coal's niche market will most likely remain in low-grade heating application, such as residential heating, where it must compete with wood The Armenian government may choose to promote the consumption of coal due to deforestation associated with the growing use of wood within the country

6 6 CONCLUSION

The Armenian energy sector is recovering from the extreme fuel crisis that persisted in the early 1990s The branches of the domestic fuel industry are transforming themselves to address future challenges to meet growing demand for energy The individual fuel sectors are only in the early stages of this restructuring process This is thus an important time for the Armenian government and the donor community to guide the industry toward a market-oriented direction Some of the major obstacles that must be addressed in this process have been highlighted in this report Further analysis is recommended, at the plant and enterprise level, to identify more detailed potential solutions to the issues set forth in this report, and to support development of Armenian fuel markets in a manner that promotes continued growth of the power sector and the economy as a whole