American University of Armenia

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Research

Energy Sector Issues in Armenia

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CONTENTS

ABSTRACT

In any country Energy Sector is the core branch of national economy. Adequate supplies of energy at competitive prices are essential to maintaining and improving Armenian economy and enhancing the standard of living.

Nowadays Energy Sector is one of the most developed branches of the Republic's economy. But during several years from 1992 to 1995 the Energy System of Armenia was plunged into a deep energy crisis. That crisis was caused by several factors including:

- decommissioning the Armenian Nuclear Power Plant in 1989 after the severe 1988 earthquake in the Republic;
- the liberalization of fossil fuel prices in the supplier countries;
- the transportation problems;
- the infringement of the former power connections.

During the years of the energy crisis and afterwards Energy Sector has always been of a primary concern of Armenian Government. Presently, the energy crisis in Armenia has been completely overcome.

The objective of this research was to study issues that Energy Sector of Armenia still faces. It was revealed that geopolitical situation of Armenia requires power independence insurance of the country.

It is well known that Armenia and Azerbaijan are still technically in war and Turkey blockades Armenia in sympathy. Therefore, old natural gas and fossil fuel supply systems do not function today. The route of the gas pipe that is currently exploited lies on the territory of Georgia. That gas pipe had been damaged many times in the passed years. As a consequence, gas supply of Armenia has been frequently interrupted and the whole Republic was paralyzed.

For these reasons Armenian Government adheres to the power security increase politics. Currently, approximately 80% of electricity is produced from imported resources. In order to increase power independence it is necessary to develop Energy sector on the base of own resources. The only indigenous source for power generation in Armenia is hydroenergy.. Putting into operation new Hydro Power Plants will decrease dependence from imported resources up to 60%.

Construction of the second gas pipe (Iran-Armenia) also will contribute to the power security increase of the country.

Other issues that still remains in the Power Sector of Armenia are the aging of equipment and constructions of the Power Plants, and absence of thorough repair due to inadequate funding. It was revealed that all main equipment of existing Hydro and Thermo Plants needs radical renewal. Absence of thorough repair is a dangerous fact, because it will hinder the safe operation of equipment and constructions in Energy Sector.

Implementation of new tariff structure that was proposed in this research will contribute to the costs of electricity decrease, will increase profitability of Energy Sector enterprises , and will release funds for renewal and repair of the equipment and constructions.

1. INTRODUCTION

Throughout the history of mankind, from the moment our earliest ancestors first kindled fire to the rise of the great industrial societies, energy has formed the conerstone of civilization and development.

Energy is really now the key to growth and development, both economic and social. Electrification of the world in the 21-st century is an economic imperative. Electricity is fundamental to the quality of modern life. It is uniquely valuable, versatile, and controllable form of energy, which can perform many tasks efficiently. Lighting, refrigerating, electric motors, medical technologies, computers, robotics, and mass communications are but a few of the improvements it provides to an expanding share of the world's growing population.

An estimate of the rate of annual increase of electricity production in the world is derived from UN/World Bank Estimates.

Table 1.1

	To year 2005	To year 2010
North America, Pacific, Europe (East & West) (industrialized regions)	2.0%	1.75%
All other regions (developing regions)	6.0%	5.25%

Source: World Energy Council.(1994).

Mankind has used the energy of falling water for many centuries, at first in mechanical form and since the late 19th century by further conversion to electrical energy. Historically, hydropower was developed on a small scale to serve localities in vicinity of the plains. With the expansion and increasing load transfer capability of transmission networks, power generation was concentrate in increasingly larger units and to benefit from the economies resulting from development on a larger scale.

Sites selected for development tended to be the most economically attractive; in this regard, higher heads and proximity to load centers were significant factors. For this reason, development was not restricted to large sites, and hydro stations today range from ——— 7

In 1990, hydro plants accounted for some 22.9% of the world's total installed electric generating capacity, but the combined output was only 18.4% of the world electricity supply total.

Most hydro plant designs include considerably higher generating capacity than that which would be needed to handle average water flows. An appreciable proportion of plants connected to transmission grids are designed for peaking service, and in all cases extra generation capacity is necessary to accommodate river flow variations and reduce spillage. This has the effect of reducing the average annual hydro generation plant factor or capacity factor to 39.3%, compared with an average of 51.6% for conventional power plant.

Statistics for regional hydro capacity and production in 1991, published in "Water Power and Dam construction" (August 1992), are shown in the table 1.2:

Table 1.2

Region	Capacity (GW)	Production (TWh)
North America	133.7	579.8
Latin America	94.0	390.0
Western Europe	136.7	405.3
E Europe and CIS	82.3	260.2
Mid East and N Africa	13.1	40.2
Sub-Saharan Africa	16.5	45.1
Pacific	12.1	38.7
China	37.9	124.8
Asia	100.7	397.4
Total	627.0	2,281.2

Source: World Energy Council.(1994).

Approximately 75% of electricity in the world is produced by Thermal Power Plants (TPPs), that use organic fuel (solid, liquid or gas). Thermal Power Plants started their development in the 20's of the current century.

World organic fuel resources are shown in the below table:

Table 1.3

Type of organic fuel	Extracting reserves, billion T of conventional fuel	Additional reserves	Total
Oil	250.5	930.5	1081
Natural Gas	108	222	330
Condensates	9	17	26
Coal	720	10,500	11.220
Total (rounded)	1,100	11,600	12,700

Source: Rizhkin V. (1987)

Nuclear power is an indigenous, cost effective energy resource. It provides vital electricity in lower electric rates and without contributing to atmospheric emissions such as nitrogen oxides, sulfur dioxide and carbon dioxide. Nuclear power plant substitute widely for fossil fuel-fired capacity. This electrical substitution dramatically lessens dependence on unpredictable foreign oil supplies. Nuclear energy has a 5% share in total energy use in 30 years of commercial development.

Nuclear Power Plants (NPPs) development is shown in the table:

Table 1.4

Region	Installed Capacity of NPPs, GW		% of Installed Capacities of NPPs in the whole volume of power generation	
	1985	1990	1985	1990
North America	130.0	150.0	15	14
Europe	105.0	150.0	18	20
Japan	25.0	50.0	10	.15
Asia	10.0	20.0	4	5
Latin America	3.0	10.0	2	6
Africa and Mid East	2.0	3	3	3

Source: Rizhkin V. (1987)

The share of NPPs in total energy use is expanding. The role of TPPs and NPPs in the structure of production is shown in the below table.

Table 1.5

Regions	1990		1992	
	TTPs	NPPs	TPPs	NPPs
Euro Union	58.4	33.2	56.2	34.4
USA	72.2	19.3	71.2	20.1
USSR	73.4	12.2	73.5	11.9
Japan	65.7	23.8	65.6	25.2
Turkey	52.8	-	60.5	-
France	11.5	74.5	11.1	73.2
East Europe	77.2	13.0	N/A	13.0

Source: Rizhkin V. (1987)

The conventional energy resources, fossil fuels with electricity contributions from nuclear fission and large-scale hydroelectric energy, dominate the global near term energy supply picture. Other energy resources have not yet developed to any grate degree. Among these others are those referred to as the new and renewable energy resources. As a group, they are difficult to compare to the conventional energy resources, since they are widely distributed and relatively diffuse. They are now only partially developed to commercial status, and ask somewhat different compromises from the end- user.

The new renewable resources are divided in separate areas for investigation:

- solar;
- wind;
- geothermal;
- biomass (modern);
- ocean;
- small hydro. .

It should be noted that the current use of all renewable energy resources is dominated by biomass, which is a major energy supply in the developing countries of Asia and Africa, with some additional contribution in North and Latin America. When large-scale hydro use is included, the renewable resources contribute 1559 MToe (million tons of oil equivalent) or about 18% to mankind's total energy use today. Without traditional biomass and large hydro, the current contribution of all other renewables is expanding. However, extensive penetration of renewables into the energy market is not likely to happen quickly.

1.1. Total Capital Available for Investments

There is already significant concern over the ability of many countries to find the capital resources to finance their total development needs in the coming decades. This problem is especially acute in the developing countries, where the projections for capital requirements to finance. Electric power development identifies a need for US$100billion per year for at least the next 10 years. Electric power represents approximately 70% of the world's total capital investment, and half of the requirement for the electric power sector is for transmission and distribution facilities.

The developing countries already spend about 25% of their public sector budgets on power development, and their ability to expand this percentage is limited. The World Bank, other multinational agencies are estimated to be able to provide only 20% of this need for power development. The private sector must play a much larger role in financing energy development, and the indigenously private capital resources must be developed to the maximum extent possible.

The total world GNP was about US$ 18×10^{12} in 1990 and about US$ 42×10^{12} in 2020. The estimated investment in total energy development for year 2000 is equivalent to be about 5% of the total GNP.

1.2. Conventional Electricity Prices

Higher energy costs increase total production expenses costs while decreasing use – and generally have an adverse effect on an economy.

The analysis of conventional electricity prices combines the installed capital costs of plant equipment, converted to an annualized basis (with a 10% fixed charge rate), along with the operating and maintenance cost, the fuel cost and any other relevant annual costs such as waste disposal. For this analysis, the market fuel prices contained in recent World Energy Council projections were used to project future fuel prices. The capital and O&M costs of the facilities were taken from the recent US Interlaboratory Paper on Renewable Energy Potential, which is a compilation of data from other well-known sources[1].

The analysis was done for grid-connected electric power applications, since there is a considerable amount of information available for this en-use sector. Figure 1 presents the projected costs for peaking, intermediate load, and base load conventional systems. The first two are assumed to be natural gas or oil-fired, with base load using coal with flue gas desulfurization.

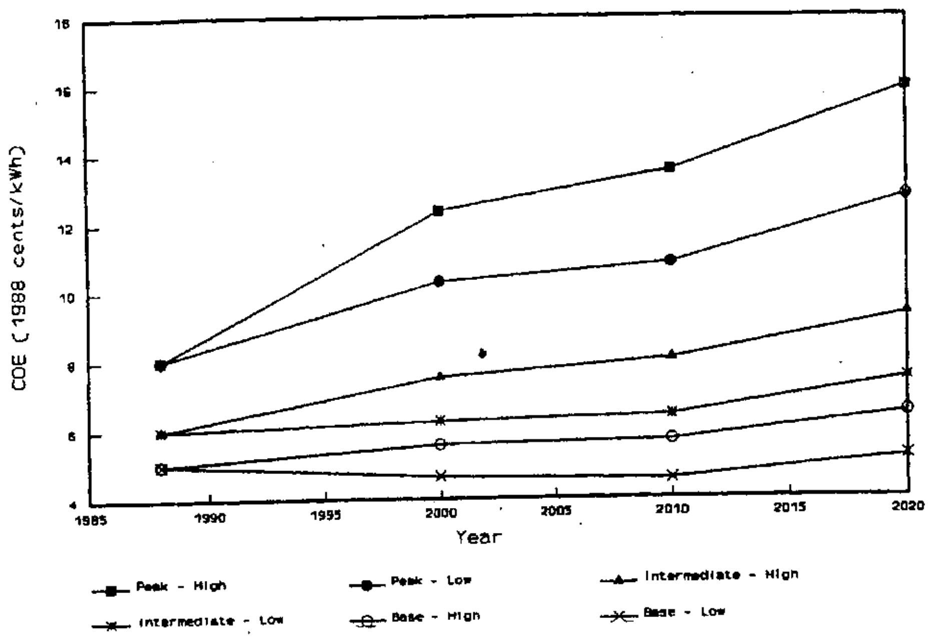


Figure 1. Conventional electricity prices.
Source: World Energy Council.(1994).

The high-low range shown for each type of plant is caused by the range in the fuel prices, combined with typical capital and operating costs as shown in Table 1.6.

[1] World Energy Council.(1994). New Renewable Energy Resources. A Guide to the Future. London.UK: Kogan Page

Assumptions for fossil-fuel generation plants (US$,1988) Table 1.6

Type	Capacity factor	Capital cost	O&M cost	Heat rate (kJ/kWh)
Peakload	10%	$340/kW	1.2%/yr	10,995
Intermediate	35%	$625/kW	2.0%/yr	8,270
Base load	65%	$1,525/kW	2.5%/yr	9,335

Source: World Energy Council.(1994).

The cost of electricity (COE) increases with time due to fuel cost increase greater than general inflation. The assumption is made that capital and operation/maintenance (O&M) costs keep pace with general inflation, and therefore do not change in constant dollars.

2. GEOPOLITICAL SUTUATION OF ARMENIA

Armenia is an independent country situated in the Caucasus with land area 29,743 km^2, which main allies are Russia (guns), America (money), Iran (trade). There is more than 3,000 km (1,000 miles) of international borders in the Caucasus. Only the smallest, the 9 km stretch between Azerbaijan's Nakhichevan province and Turkey, is truly friendly. The countries of the Caucasus have suffered a miserable decade of war, bad government, isolation and impoverishment. The Caucasus is – or should be – a splendid transit route between east and west, north and south, for goods, money, and ideas.

For energy firms the Caucasus is a way out for the oil and gas around the Caspian Sea. Proven reserves are estimated at 18 billion-35 billion barrels- about as much as America and the North Sea combined.

Geography should make the Caucasus rich and happy. History and politics make it poor and miserable. Most borders in the Caucasus divide rather than unite. Armenia and Azerbaijan are still technically in war. Turkey blockades Armenia in sympathy. Russia keeps a tight grip on its southern borders. Iran is chilly to Azerbaijan, Georgia to Armenia. Even when political ties are cordial, as with Georgia and Azerbaijian, physical ones are not.

3. ENERGY RESOURCES OF ARMENIA

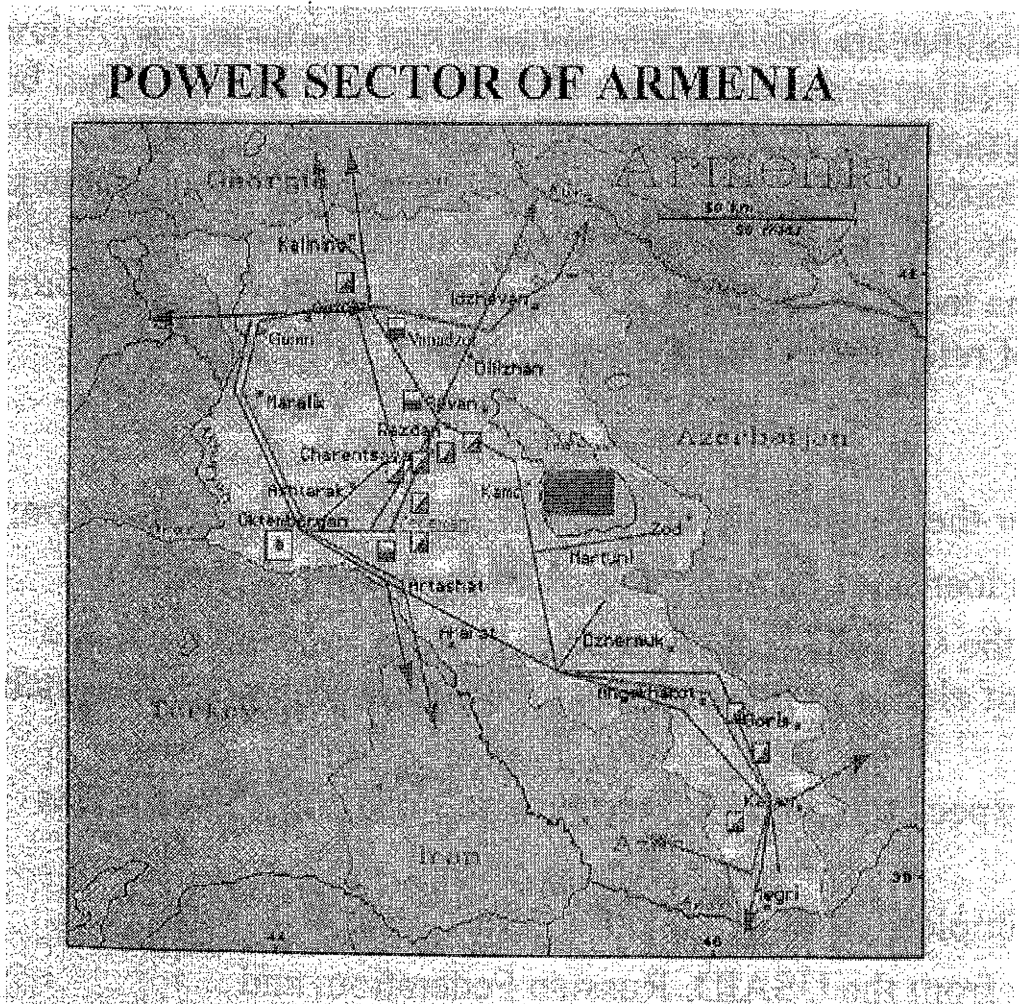
Adequate supplies of energy at competitive price are essential to maintaining and improving Armenian economy and enhancing the standard of living.

Energy is one of the most developed branches of the Republic's economy.

The main energy resources traditionally used in Armenia are oil products, natural gas, nuclear energy, hydropower and coal. During 1985-1988, the consumption of those resources fluctuated at 8.5-9.0 million-ton oil equivalent per year.

In the total fuel-energy balance 96% was imported energy. During the period of the crisis in 1992-1995 the consumption of the energy resources was reduced to 2.0 million tons oil equivalent per year.

Figure 2. Power Sector of Armenia



3.1. Hydro-Energy Resources

The hydro-energy potential of Armenia is estimated at 21.8 billion kWh/year, 18.6 billion of which is from large and medium rivers and 3.1 billion kWh is the potential of small rivers. By the different estimations technically available potential fluctuates at 7-8 billion kWh[2]. The hydroelectric potential of the two large rivers Hrazdan and Vorotan is well-developed. The potential of the third bigger system Pambak-Dzoraget-Debet is relatively underdeveloped (with exemption of Dzora HPP-26MW). There are 17 Hydroelectric Power Plants operating on small rivers with annual generation of 120-130 GWh.

The projected electricity generation of the 2 cascade power plants and the small HPP constitutes about 20% of the technically available potential (1500GWh).

Economically available hydroelectric potential (EAP) of Armenia is estimated at the 6,000GWh, i.e. the residual available potential constitutes 4,500GWh.

The EAP of medium and small rivers of Armenia allows using the 35-40% of the technically available potential at the price of less than 10 cent per kWh.

3.2. Fossil Fuel Resources

Fossil Fuel geological exploration is being done. The coal deposits, oil shale, peat, bitumen, bituminous sands, gas emergence were discovered. Currently, the geological investigative work for oil and gas is in process.

The reserves of the coal and oil shale can be qualified as the industrial reserves.

3.3. New and Renewable Energy Resources

The territory of Armenia possesses the significant potential of the solar energy. The average annual insolation is 1720 kWh/m^2 (note that the average amount in Europe is 1000 kWh/m^2). The Sevan basin is the highest insolation. The part of the direct annual radiation constitutes 65-70%, which is very attractive for implementation of focused collectors.

[2] Ministry of Energy of RA (1998). Energy Sector of Armenia

Meteorological information prepared by Armenian resources gives an appropriate estimation of wind energy potential. The installation of the wind energy equipment is attractive for the Pushkin and Sisian passes and Aragats Mountain. The duration of the wind steam comes to 5200 h/yr and the wind minimal speed is 5-6 m/sec in these regions.

The amounts of 15-20 MW and 40-50 GWh/yr characterize the economically feasible potential of the network equipment based on the investigations of the Lahmeyer International.

4. POWER SECTOR MANAGEMENT STRUCTURE

The Republic's energy sector includes Thermal Power Plants (TTPs), Hydro Power Plants (HPPs), Nuclear Power Plant (NPP), Gas and Fuel supply systems with their transmission and distribution networks, also projecting, scientific, construction, installation, repairing service and other subdivisions.

As a result of decommissioning of the Armenian Nuclear Plant in 1989, liberalization the prices of fossil fuel prices in the supplier-countries, the transportation problems, the infringement of the former power connections the Energy System of Armenia was plunged into a deep energy crises during 1991-1995.

For the purpose of organizing more efficient management of the Energy System during the crisis and post-crises periods, the Government of Armenia made a decision to restructure Armenia's Energy Sector in December 1995.

Energy Sector Management Structure of Armenia

POLICY STRATEGY	GOVERNMENT MINISTRY OF ENERGY				TARIFFS AND LICENSES
GENERATORS	ANPP	TPP		HPP	
DISPATCHING IMPORT/EXPORT	ARMENERGO				
TRANSMISSION	HV NETWORK COMPANY				ENERGY COMMISSION OF RA
DISTRIBUTION	1	2	3	4	
CONSUMPTION	CONSUMERS				

According to the new energy policy all electricity distribution and retail sale functions were transferred to regional distribution networks, all generation functions to the independent generation enterprises/

The "High Voltage Networks" company executes the functions of the power transmission.

The National Dispatch Center "Armenergo" executes the dispatching and the management of the capacity and energy whole sale market.

The Energy Commission is responsible for antimonopoly regulation. The Commission is an independent body with 5 members appointed by the President of the RA. The key functions of the Energy Commission are antimonopoly regulation, tariff regulation and licensing of entities in the Energy Sector.

Practically ensured is demand for electricity in the domestic market, and also a portion is exported to the neighboring countries.

5. ENERGY SECTOR

5.1. Thermal Power Plants.

The installed capacity of the TPPs is 1754MW. Thermal Power Plants are in Yerevan, Hrazdan, and Vanadzor, and are operating on gas and mazut.

The capacities of cogeneration units (under 100MW) ensure the combined generation of the electric and thermal power.

Table 5.1.

Title	Units,MW	Starting year	Generation, million kWh	
			1996	1997
Hrazdan HPP	**1110**		**1561**	**2273.3**
Section 1	2X50	1966-1967		
	2X100	1969		
Section 2	3X200	1971-1974		
	1X210	•		
Yerevan TTP	**550**		**754**	**758.4**
Section 1	5X50	1963-1965		
Section 2	2X150	1966-1968		
Vanadzor TPP	**94**	1964-1976	**1.9**	**0**

Source: Ministry of Energy of RA (1998).

5.2. Nuclear Power Plant

The capacity of the Armenian NPP is 815MW (2 units). The operation of the ANPP was terminated in March of 1989 after the severe 1988 earthquake in the Republic.

The energy crisis followed by the earthquake and collapse of the Soviet Union was the reason for the Government decision in 1992 to rehabilitation and additional measures for improving the seismic safety; unit #2 of NPP was restarted in November 1995. This has decisively contributed to the power supply stabilization in Armenia.

Table5.2

Title	Units, MW	Starting year	Generation, million kWh	
			1996	1997
Arm. NPP	815		2324	1617.6
Unit # 1	1X440	1976		
Unit # 2	1X440	1980/1995		

- Unit#1 and Unit#2 of NPP were conserved in March of 1989. Unit#2 was restarted in November 1995.

Source: Ministry of Energy of RA (1998).

5.3. Hydro Power Plants

The only indigenous source for power generation in Armenia is hydroenergy. The installed capacities make up 532MW on the Sevan-Hrazdan Cascade (7 plants),

400MW on the Vorotan Cascade (3 plants) and 60MW on the small HPPs. The hydro potential of the Sevan Lake was intensively used during the period of the crisis.

Currently the amount of outflow from the lake reduced to the level of irrigation needs of the Republic.

Table5.3

Title	HPP,MW	Starting year	Generation, million kWh	
			1996	1997
Sevan-Hrazdan Cascade HPP	**around 550**		**593**	**534.7**
Sevan	34	1949		
Hrazdan	81.6	1959		
Argel	224	1953		
Arzni	70.6	1956		
Kanaker	102	1936		
Yerevan 1	44	1961		
Yerevan 3	5	1956		
Vorotan Cascade HPP	**400**		**889**	**759.7**
	75	1984		
Spandaryan	168	1977		
Shamb	157	1970		
Tatev				
Small	**56**	1913-1954	**87**	**86.1**

Source: Ministry of Energy of RA (1998).

5.4. Transmission Network

The High Voltage transmission network composed from HVL-220kV with the 14 substations of 220kV and HVL-110kV with the 119 substation of 110kV.

The capacity of high voltage network is sufficient for the forecasted load.

- Intersystem Connection

Country	Connection type	Current situation
Azerbaijan	One line HVL-330kV(100km)	Not in use
Georgia	One line HVL-220kV(65km)	Operable
Turkey	One line HVL-220kV(65km)	Not in use
Iran	One line HVL-220kV(78.5)	Operable

- Transmission

Voltage level	220kV	110kV
Power transmission lines	1,323km	3,169km
Substation	14	119

Source: Ministry of Energy of RA (1998).

5.5. Distribution Network

Voltage levels of the distribution networks are 35, 10, 6, and 0,4kV.

Distribution companies serve about 850,000 consumers including 740,000 subscribers in the residential sector, 270,000 of whom in Yerevan.

Voltage Level		35kV
Power transmission lines		2,675km
Substations		278
Voltage Level	10kV	
Power transmission lines	Overhead 8,470 km	Cable 2,900 km
Voltage Level	6kV	
Power transmission lines	Overhead 1,270 km	Cable 2,055 km
Voltage Level	0.4kV	
Power transmission lines	Overhead 13,570 km	Cable 2,160 km
Substations 10(6)/0.4kV		8,598
Transformers 1000kVA		120
Number of consumers		850,000

Source: Ministry of Energy of RA (1998).

5.6. Installed Capacities

The installed capacity of the Armenian Power System constitutes about 3,200MW (without unit #1 of the NPP). The maximum demand was 1,260 in the year 1999, the forecasted maximum demand will be at least 1,350-1,400MW in 2000, and 2,100 MV in 2010.

Out of 3628 MKWh efficient electricity produced in Armenia in 1999, 1250 MKWh is consumed by the population. Consumption of efficient electricity was about 1200 KWh/yr (taking into consideration that official data on population in Armenia is 3 million, which is not equal to the real number). Total electricity produced in Armenia in 1999 was equal to 5700 MKWh. Consumption of produced electricity per capita of population was about 1800 KWh/yr.

After the year 1992 there was noticed decrease of energy consumption per capita of population in the Republics of the former USSR and countries of Eastern Europe. It was connected with the fact that countries with planned economy spent 4 times more energy on the [illegible] of their GDPs, than developed Western countries. It should be taken into consideration that per capita consumption of energy depends not only on level of technology development but also on climate conditions of the country.

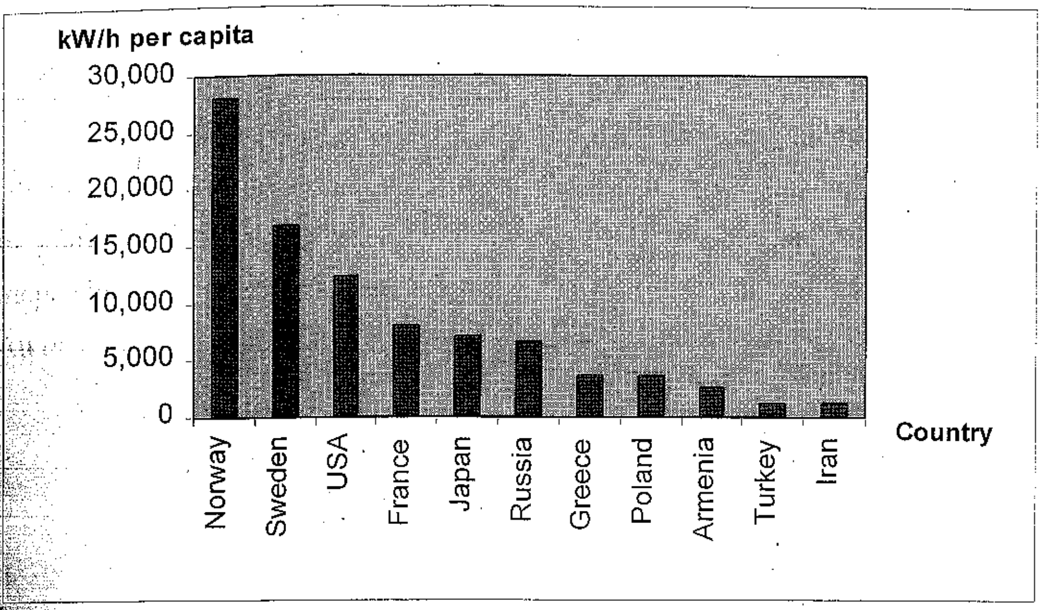


Figure 3. Consumption of Electricity per Capita of Population in 1992.
Source: Ministry of Energy (1998).

It should be mentioned that in 1990-1992 average increase in consumption of electricity per capita of population in EuroUnion was about 1.4%. In the Republics of the Former USSR there were noticed an average 5% decrease in per capita electricity consumption (in Georgia – 14%, Armenia and Azerbaijan about 7%, and in Russia – 3.8%). The same trend was noticed in all countries of East Europe (except Yugoslavia).

Electricity consumption trend in Armenia from 1988 to 1999 is shown on the figure:

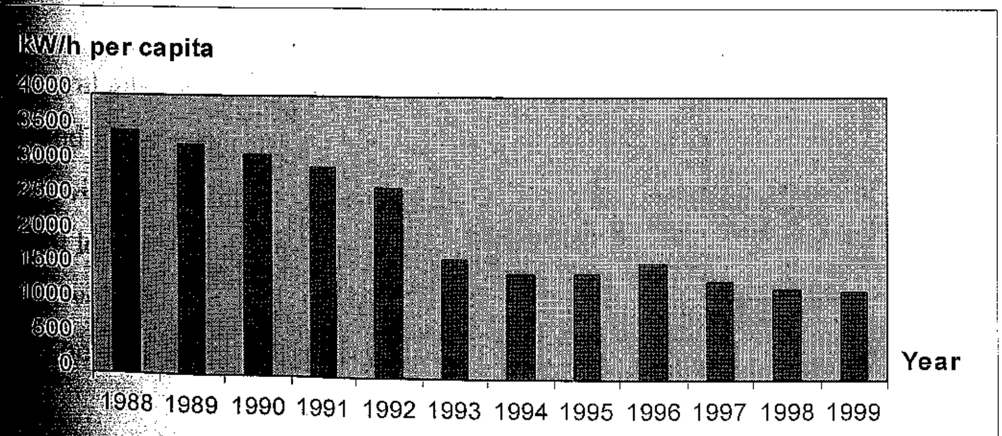


Figure 4. Consumption of Electricity per Capita of Population.
Source: Ministry of Energy of RA (1998)

Currently, Armenia is exporting electricity to Georgia. In 1999 Armenia exported to Georgia 250MKWh electricity with tariff equal to 2.5 cents per KWh (exported production is not subject to VAT). It is planned to export to Georgia from 500 to 600 MkWh of electricity. To smooth peak hours load and have higher utilization Armenia exports energy to Iran (0-tariff) in summer time (Iran has developed air-conditioning system and because of that fact increasing demand during summer), and imports during the winter.

An example of daily load profile is shown in the figure below[3].

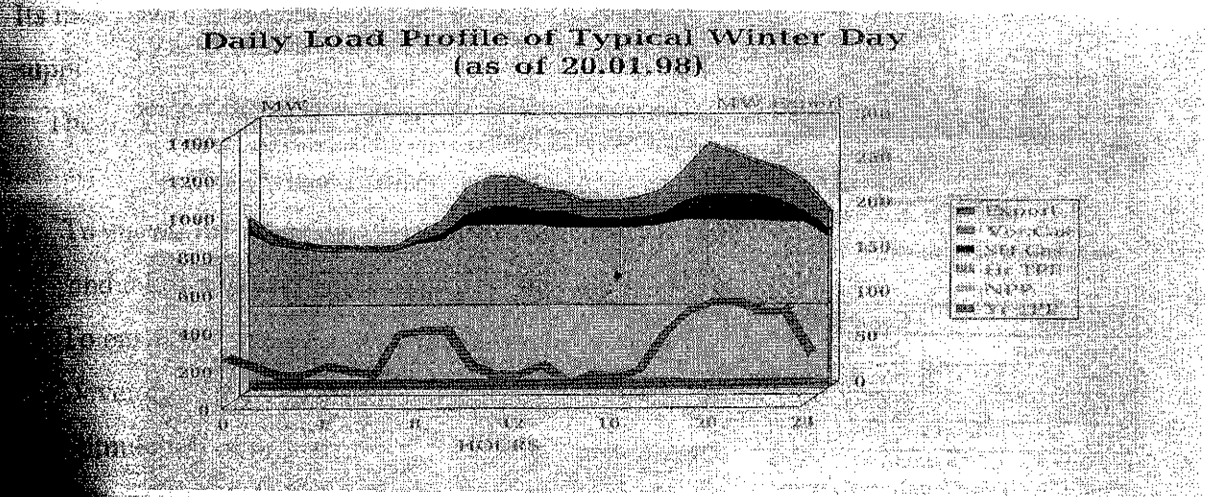


Figure 5. Example of Load Distribution

5.7. Gas and Fuel Supply

...ral gas supply system consists of the main ring-shaped distribution networks and an ...ground gas storage system with the capacity of 1.7million m^3. The useful volume of the ... will be 180 million m^3 under the maximum pressure of 12.5 MPa.

... length of the main and gas distribution networks is 2.0 thousand and 9.3 thousand- ...ctively. The pipelines can receive and deliver to consumers about 450-million m^3 gas ... The percentage of dwellings connected to the natural gas system is approximately

... year in gas supply was the year 1989 with the natural gas consumption of 5,76- ... gas per day.

... Energy of RA (1998). Energy Sector of Armenia

The other problem- based energy resource is mazut, the use of which for power generation is not economically feasible due to the high cost of transportation.

There is storage capacity of oil products of 358 thousand tons.

6. INSTITUTIONAL BASIS AND REGULATION

From the July1, 1997 The Energy Law of the RA was enacted to regulate relations in sector. Its main effect is to give the right to consumers to receive electricity, thermal energy and gas supply on a contractual base.

The basic principles of the energy policy that is conducted by the Ministry of Energy are:

a) To ensure the reliable and efficient generation, transmission, and distribution of the electric and thermal power, and also the delivery, transportation and distribution of the natural gas,
b) To ensure the improvement of safety,
c) Development of a competitive environment by creation of necessary conditions,
d) Stimulation of privatization of state owned companies.

The problems that should be regulated at the governmental level include also the stipulation of the local energy resource development, the energy saving, protection of the environment, the scientific technical progress and professional development.

The Energy Commission (ERC) is responsible for the antimonopoly regulation. The key [illegible] of the antimonopoly regulation are tariff regulation and licensing of entities in the [illegible] Sector. The responsibilities of the Energy Commission for the tariff regulation are set [illegible] the main principles of the Energy Law, which should be considered in tariff setting. [illegible] principles include tariff-covering maintenance and operating costs, amortization costs, repair, debt service, and equity income. Besides that the Law regulates also [illegible]ntal subsidies, exception of the cross subsidies and possibilities for the multilevel [illegible]entiated tariffs.

[illegible] Energy Commission should implement licensing of activities only for the persons of [illegible]

[illegible] part of antimonopoly regulation, the Law stipulates that any stockholder that owns [illegible] more of the stock of one of the distribution, transmission, or generating companies have no right to own the stock of any other energy company without the permission of the Energy Commission.

Implementation of the Ministry's energy policy has ensured the participation of Armenia as reliable and equal partner in such well-known international organizations as the European Energy Charter, the Black Sea Economic Cooperation, and the Power Council of CIS. According to the International Monetary Fund, Armenia is one of the leading CIS countries for implementing energy sector reforms.

7. THE POLICY OF ARMENIAN GOVERNMENT IN ENERGY SECTOR

During the interview with Robert Kharazyan[4] we revealed that Armenian Government adheres to the power security increase politics, which includes the following:

A) Currently, approximately 80% of electricity is produced basically from imported resources (gas, oil, uranium). In order to increase power independence it is necessary to develop energy sector on the base of own resources. From the point of view of economic availability Hydroenergy development is the most important. That is why it is planned not only to replace existing equipment of HPPs but also to put into operation new HPPs. Nowadays, it is possible to build approximately 240 MW of installed capacities that will have competitive energy charge (tariffs) for produced electricity (less than 6 cents for 1 KWh). That will give energy production opportunity from 900 to1000 million KWh annually and will decrease dependence from imported resources up to 60%.

B) Diversification of Energy Sector resources supply:

- Construction of the second gas pipe.[5]
- Using of approximately 50MW wind energy potential. Feasibility study of that project is made by Dutch and Danish companies in accordance with PSO program of Government and company "Solar EN".[6]

4 Robert Kharazyan (September 2000). Member of Energy Commission of RA.

C) IN accordance with the agreement with Euro Community Armenia must put out of exploitation Unit #1 of ANPP in the year 2004. Armenian Government announced that in the case of putting into exploitation compensating power it will adhere to the previous agreement. It is evident that compensating power should be of such character which will ensure the principle of diversification i.e. either nuclear power or conventional power.

According to TACIS program and with the finance of USAID 2 research groups are elaborating the plan of energy sector further development up to the years 2015-2020. That plan takes into consideration possible putting out from exploitation the ANPP on planned time...

In spite of the fact that deep energy crisis of the years 1992-1995 has been overcome and nowadays energy sector is an export industry, Energy System faces numerous problems which solutions are difficult and costly. They are the following:

- The age of 40% of power of HPPs is more than 30 years.(*Useful life of a HPP is considered to be about 30 years).*
- Majority of turbins has already approached the limit resource, which comprises about ...0,000 hours.
- ... age of 70% of HPPs is more than 45 years, and the age of 50% of HPPs is more than ... years...
- ... years 1992-1995 the frequency in the Energy System fluctuated from 43 to 45 Herz. ... of rotations of the turbins' rotors per hour was:

  $N = V/V_0 * n_{nom} = 44H/50H*3000rot/h=2640rot/h$,

  ... to critical frequence of turbins rotation and brings to tiredness of the metal, and ...racs forming, etc.

...

... of gas pipe that will lie on the territory of Armenia is completed. Project design of the part of the ... Iran side is responsible is not conducted.

... ARMNEDWIND has completed monitoring in the 5 sites of Armenia. Derived information is ... and the feasibility study will be completed by the end of the year 2000.

... ARMNEDSUN has installed solar collectors on the roofs of different buildings throughout ... they are conducting marketing research with regard to water heating. They intend to install water ... line in Armenia.

3. During the same period from 1992 to 1995 turbins of TPPs worked in conditions of frequent stops and starts, also they worked in regimes that were very close to minimum permissible ones.

So, we have to conclude that whole main equipment of Power Plants needs radical renewal.

7.1. Further Development Obstacles

Main obstacles that hinder power-engineering development have socio-economic character. Low payment capacity of population and from 10% to 15% of producing enterprises not only hinders the realization of development but also covering the costs of energy production of the sector's enterprises. High level of energy losses during transportation, distribution, and utilization lead to the increase of the cost of efficient energy and hardens energy accessibility for perceptible part of consumers.

Another obstacle that causes the increase in the cost of imported energy resources is the fact that Armenia continues to be in the blockade.

During certain period (1991-1997) the absence of law regarding the regulations in energy sector also hindered further development of power engineering. Fortunately, from the July 1997 The Energy Law of the RA was enacted to regulate relations in the sector. Its main ... is to give the right to consumers to receive electricity, thermal energy and gas supply on contractual base.

... that the Law regulates also governmental subsidies, exemption of the cross ... and possibilities for multilevel and differentiated tariffs. As it was mentioned ... due to insufficient level of own resources, Armenian energy industry should be ... even in the far future.

... obstacles that hinder further development of power engineering are accrued financial ... reached the level of 110-115 million US$ in the year 1998.

... sector is the core branch of national economy. The profitability and problems of the ... always connected with particular political events in society. For Armenia the year was full of political events that sometimes had tragic coloring. The tariffs for electricity that were not suitable for poorly socially secured layers of population were used by some politicians during election campaign. They promised to lower tariff ill groundedly and appealed to the population not to pay their debts on energy. All these facts had influence on financial-economic indicators of the energy sector. As a result payment level of population achieved in the first half of the year 1999 was only 73.8% compared to 85.9% of payments in the previous year. In the second half of the 1999 there occurred increase in percentage of payments (up to 89.1%) due to certain measures that had been taken in time. But still annual indicators of payments had sufficient increase comparing with the 80.9%.

In a whole the level of payments for electricity was near 88.5%, that was assessed sufficient in the current situation in Armenia even by international organizations. In conditions of similar consumption of useful electricity in the current year it was observed a decrease in electricity generation by 475 million kWh (7.6% less) than in the year 1998. Most important factors that caused the decrease were following:

- Unprecedented struggle against useless and illegal usage of electricity;
- Improvement of control system through application of higher quality energy meters and increase in their quality;
- Decrease of energy losses in distribution networks;
- Decrease in pure imported volumes from 360 to 240 million kWh.

[illegible] of reduction in generation, energy sent to the end user distribution network [illegible] by 32 million kWh, that was caused by bold decrease in losses of energy. In [illegible] networks the level of losses were 1090.8 million kWh (or 18.85), overnormative [illegible] 9.99% that was sufficient level according to SAC-3 program conditions (9%).

[illegible] gas supply was near 1226.5 million m^3 (in the current year that was by 19% less [illegible] previous year). Basic consumer of Natural Gas is energy sector. Politics of [illegible] of the load distribution process has made possible to decrease the level of energy [illegible] Thermal Power Plants. Gradual increase in quantity of Natural Gas consumers [illegible] must also be taken into consideration as one of the factors that makes possible [illegible] of load distribution.

The indicators of financial-economic activities of energy sector in 1999 were really hopeful. In the fiscal year it turned out well that energy sector's debts on credits were decreased up to the 20 milliard AMD . All budget obligations were also fulfilled.

Planning and executing of work regimes were mainly done by optimization of fossil fuel outlay through process of minimization of the fuel expenditure. In the core of the optimization process were best possible use of Armenian Nuclear power Plant's capacities and energy production diminishing of Thermal Power Plant. High safety and reliability of system, work was insured by parallel work with Iran's energy system and anti-emergency automatics.

8. INVESTMENT POLITICS

According to *Lahmeyer Intrnational -96* program[7] (LI-96) necessary investments in Energy Sector that are done with minimum expenses are shown in the following table:

Investments volume in Energy Sector, million US$ Table 8.1

Name	Total 1997-2010	Including 1997-2001
1. Nuclear type development	2111,0	911,7
Non-nuclear type development	1445,0	334,8

...of Energy of RA (1998).

...vestments are evaluated in 1996 US$ without taking into consideration 1.5-2.0% ... per year. They also do not include investments for construction of the unit #5 of ...P, Gyumush HPP, Kanaker HPP repairing, and other smaller PPs construction

... of investments are directed for maintenance and efficiency increase of existing ... and are supposed to be used to prepare Energy Sector construction program ...). From 0.6 to 1.5% of investments will be used specially for energy saving

...istry og Energy of RA, an investigation on the "Least-cost Power Investment Program of ... out by the German Lahmeyer International Company.

Investments in maintenance, safety, efficiency sphere will be done in two stages:

- emergency program for the years 1997-2001 that includes near 169.1 million US$ investments;
- program that is supposed to increase "useful life" of appliances and includes about 81.9 million US$ investments.

In Natural Gas sphere about 85% of investments (110.2 million US$) are connected with Iran-Armenia gas pipe construction.

Investments in Energy Sector are characterized by long period of self-compensation (in the former USSR it was equal to T=8 years)[8]. Investment efficiency characterizing value is some service (for example, transportation by High Voltage Lines) or electricity cost. According to [illegible] 96 program minimum expenditures investments efficiency is function of coefficient of load (level of usage).

[illegible]

[8] [illegible] of RA (1998). "Program of development of the Energy Sector of Armenia till 2010."

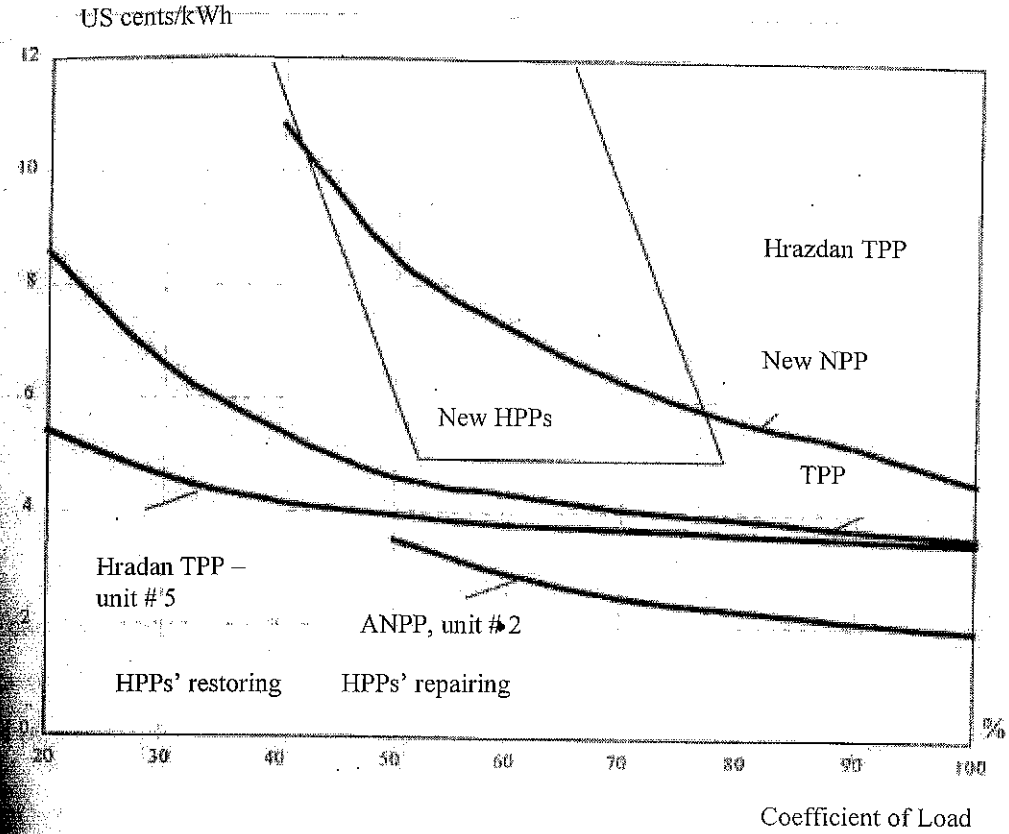


Figure 6. Efficiency of Energy Producing Units
Source: Ministry of Energy (1998)

ture makes evident HPPs reconstruction and rearmament, and ANPP's Unit#2 its starting absolute advantage.

uction of the old gas supply system and construction of new gas supply systems out electricity from the heat demand market. That will economize in Republic near illion m^3 Natural Gas daily. Iran-Armenia gas pipe investments' self compensation posed to be near 7.7 years, other project's – 3 years.

al Indicators of Electricity Production, Transmission, and Distribution

ioned before indicators of power entrance into the distribution networks in the less than in 1998 and we caused not by decrease in consumption but by ase

There were created special subdivisions in all discrete points of distribution network that were supposed to have contractual bases for inspectors' work and financial responsibility of managers.

For the period from November of 1998 to December of 1999 payments' % for electricity were near 88.5%, including:

Population	80.9%
Industry	128.3%
Budget organizations	74.2%
Other	91.5%.

As it can be concluded from these indicators, they could be better in case of higher ...icators of budget organizations that were near 5.7 million AMD. In the table below are ...sented payments indicators for the years 1998 and 1999 (%):

Table 8.2

	Population	Industry	Budget organizations	Other consumers	Total
...rst half ... year ...99)	73.8	104.3	59.9	86.5	77.3
...cond ... the ...99)	89.1	151.0	86.5	97.9	100.2
[illegible]	80.9	128.3	74.2	91.5	88.5
[illegible]	85.9	93.0	49.9	84.7	77.0

...stry of Energy of RA (2000).

... for the year 1999 could be better if in the first half of the year 1999 level of ... not low. It was already mentioned about obstacles that caused that law payment ... factor vas electricity tariff increase (it is known that any tariff increase causes ...ease in level of payments). Higher level of payments in the year 1998 was caused by governmental donations to some part of population that composed 1500.0 mil. AMD. Payments picture is shown below in the table.

Table 8.3

	Entered into distribution network, million KWH	Standardized losses, million KWH	Sold in the case of overlosses absence, million KWH	Average tariff, AMD/KWH	Total payments million AMD Actually paid, million AMD	Actually paid, million AMD	Payment level, %
1999	4,719.0	513.8	4,205.2	21.86	91,939.6	69,403.1	75.5
1998	5,038.2	551.1	4,487.1	20.27	90,932.2	56,106.0	61.7

Source: Ministry of Energy of RA (2000).

It can be seen from the table that payments level in 1999 increased by 14% compared to 1998, which is high enough indicator.

8.2. The Analysis of Expenditures, Costs, and Debts on Credits.

In the year 1999 Energy Sector's associations continued financial stabilization politics through working out expenditure stabilization programs. In the fiscal year energy production cost comprised 30.4 milliard AMD or 45.4% of total energy costs. It was 2.7% higher than in the year 1998. Absolute indicators of ingredient parts of energy production costs are shown in the below table.

Table 8.4

	1998		1999	
	Mil. AMD	%	Mil. AMD	%
Resources and raw materials	4.6	17.8	4.2	13.8
Capital expenditures	1.9	7.3	1.2	4.0
Wages	8.9	34.2	10.3	33.9
Social insurance payments	1.9	7.4	2.58	8.2
Amortization allocations	2.0	7.8	3.1	10.2
Interest rates on credits	0.8	3.0	1.1	3.6
Other	5.8	22.4	8.0	26.3
Totals	26.0	100	30.4	100

Source: Ministry of Energy of RA (2000).

It is evident (table) that although total payment level increased from 1998 to 1999, but capital expenditures and usage of resources and raw materials decreased. In the case of resources and raw materials expenditures' decrease it is a good sign of working in the economizing regimes. But in the case of capital expenditures' decrease it is bad sign because absence of thorough repair of equipment and constructions during certain period of time will hinder their safety in future.

It should be mentioned that it was paid more to banks for credits (300 million AMD) in the year 1999 than in 1998[9]. Other expenditures in Energy Sector also increased (such as transportation, communications, service orders, rent, office expenditures, business trips, etc.)

[9] Ministry of Energy of RA (2000). "Annual Report of the Ministry of Energy of RA Activities in the year 1999".

absolutely by 2.2 billion AMD. It was worked out an economizing program in all mentioned spheres.

It can be seen from the table above that expenditures on wages increased absolutely by 1.4 million AMD. It was done in accordance with the agreement with Energy Commission.

According to the Ministry of Finance debts on credits composed 101.0 billion AMD in June of 1999 and in the end of the year they were 82.9 milliard AMD[10]. So, due to measures insured by the Ministry of Energy of RA during 1999, the debts on credits were decreased by approximately 20 billion AMD.

9. TARIFF POLICY AND TARIFF FORMATION

Independent of the organizational and econŏmic models of Energy Sector, regulation of tariffs comprises a complex and multi-aspect technical and economic problem.

Untill1996, tariff formation in Armenia was performed according to the accounted-costs-based methodological approach. To design the long term project of the sector development, German *Lahmeyer Intrnational* Company has carried out, by request of the Ministry of Energy of RA, an investigation on the "Least Cost Power Investment Program of Armenia". For the first time in Armenia, Integrated Resource Planning approach that takes into account the basic principles of marginal cost methods was implemented

Commencing from 1996, the Ministry of Energy of RA, and later the Energy Commission of RA undertook the application of economic-cost-based methodological approach which includes such expenditure items as the full covering of the operating costs, the amortization of fixed assets, debt service, the environmental protection expenses, the changes in the demand structure and volume of consumers, the long-term seasonal and daily changes in demand indices.

[10] Ministry of Energy of RA (2000) "Annual Report of the Ministry of Energy of RA Activities in the year 1999".

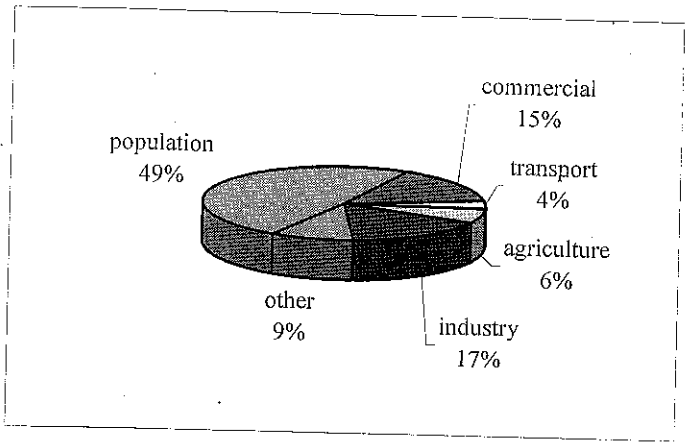


Figure 7. Structure of the Electricity Consumption in 1997
Source: Ministry of Energy of RA

The further development of the tariff policy will be based on a comprehensive analysis of the development indices in overall economy and the Energy System of the RA, i.e.:

- Demand analysis for energy and capacity (long-term, middle term and short term);
- Analyses of supply (heat supply, water resources, alternative energy sources, energy saving, power flow);
- Condition of fixed assets;
- Structure of cost;
- Investment projects and investment projects implementation methods;
- Privatization;
- Energy System operations;
- Improvement of tariff structure (dual-rate, time of use, etc.).

End-users tariffs on electricity are the following:

Low Voltage users - 0.4 kV	25AMD;
High Voltage users- 6-10-350 kV	20 AMD;
High Voltage users –110 kV	16 AMD;
Favorable diversified tariff	17-23 AMD.

Cost of electricity produced by different Power Plants:

HPPs	4 AMD;
NPP	10.5 AMD;
TPP	18AMD.

Weighted average cost of produced electricity that is being sold to Armenergo comprises 8 AMD.

It is interesting to mention that in the Western countries differentiated tariffs are applied to different groups of end-users. Changes in electricity tariffs for Japan, France, and Canada are shown on the figure:

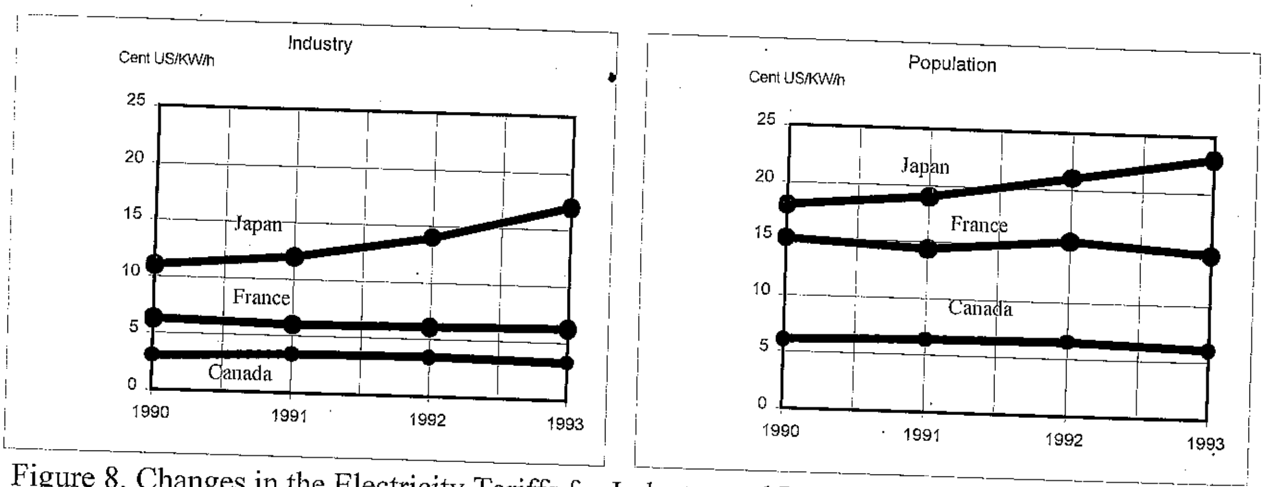


Figure 8. Changes in the Electricity Tariffs for Industry and Population.
Source: Ministry of Energy of RA (1998).

In the countries with relatively cheap energy (such as Norway, New Zealand, Poland and so on) tariffs for population are 35-70% higher than tariffs for industrial consumers. In the countries with relatively expensive energy (Germany, Portugal) electricity tariffs for population are 1.35-2.00 times higher than for industrial consumers. In France tariffs for population are 2.65 times higher than for industrial consumers.

Different types of tariffs on electricity that are used now in Armenia include:

1) Diversified tariff that was put into practice from the 1st of October of 1999. According to that tariff:

- Payment for 1 kWh of electricity is equal to 15 AMD for usage of energy from 6a.m. to 11p.m.;
- Payment for 1 kWh of electricity is equal to 25 AMD for usage of energy from 11 p.m. to 6a.m.

Now approximately 3500 subscribers use differentiated tariff. The same tariff was put into practice for commercial consumers from the January 1, 1999.

2) Seasonal diversified tariff (today not implemented).
3) Block tariffs that means diversification of tariffs in accordance with the needs of different population groups. This kind of tariff restructuring needs change in law base. Existing Law of Energy of RA (1997) is now in the process of reconsidering.

9.1. New Tariffs

As we have seen in previous part, Energy Commission proposed different new tariffs. Hagler Bailly[10] is currently working with ERC to help design new tariff structure that will be implemented on a contractual basis between Generating Companies (Gencos) and Armenergo. The following is an example of payment terms in a contract. It is not necessarily perfectly consistent with that proposed by ERS/Hagler Baily, but it sets the background for the its main principle. Payments are supposed to be done on contract base between Generating Companies and Armenergo.

The two components of payment in the contract will comprise:

- capacity, and
- energy.

The payment for capacity is designed to cover the fixed costs (capital costs including profit or opportunity cost of capital, staffing and fixed operating costs) which will be incurred

[10] Hagler Bailly is a well-known American consulting company , which is now an official subcontractor of EC and partly Ministry of Energy of RA with regard to economic and financial issues (including energy demand forecasting and development of generating power).

irrespective of whether the plant is called upon to generate. This element is also called the "availability" component of the contract - the generator is being paid for making the plant available.

The payment for energy is designed to cover the variable costs (fuel and variable operating costs) which result from generating electricity.

Other payments may also be made separately from capacity and energy charges such as start-up and shutdown costs and provision of ancillary services.

9.2. Capacity Purchase Price

A capacity payment is designed to cover the fixed costs of providing a power plant. The main components of fixed costs include a return on the investment (the opportunity cost of capital), staffing and fixed maintenance costs. The capacity payment might also include any take or pay agreements for natural gas, which are incurred irrespective of the KWh generated.

The Generating Company agrees to provide:

- X MW of capacity,
- over a given period (e.g. one year or two years), and
- with availability of Y hours during the above period.

For example, the annual fixed costs (staffing, capital and fixed O$M) for a 100MW plant might be estimated at $2 million per year or $20/kW per year.
The capacity payment is calculated annually but will probably be paid monthly.
Armenergo would then pay a monthly Capacity Payment (CP) of:

CP = [annual capacity price (in $/kW/year)] * [contracted capacity (in kW)] * [capacity price index (CPI)] / 12 =
= $166,667 per month.

Capacity (availability) payments are made whether or not a plant operates. The Generating Company declares the availability of its generating units to Armenergo. Capacity (availability) payment is made on the basis of actual availability of contracted capacity.

The "contacted" capacity need not be the installed capacity. For example, for Yerevan TPP only a fraction of the capacity might be contracted.

Where a unit is only required during the winter months, for example ANPP, it would be possible for Armenergo to contract for two units of ANPP during the winter months and only one unit during the summer. Nevertheless, the contract price would need to cover the fixed costs of both units of ANPP for the full year. The difference between contracting for a whole year rather than for half a year is:

-ANPP's cash flow: its payments during the winter would have to be sufficient to cover fixed costs during the summer.

- Rights to the spare capacity during the summer months. If both units are contracted to Armenergo then Armenergo would have the right to the production from both units. If ANPP does not contract for the full capacity for the entire year then ANPP would be free to sell the production to another consumer (e.g. export). That means that Generating Companies continue to receive revenues during the times when its plant is unavailable due to scheduled maintenance.

For each and every day declared, Armenergo pays a Capacity Payment calculated on the basis of the expected availability. Assuming an availability of 6,000 hours or 250 days and using the costs that were discussed earlier, this would imply;

= $5,479 per day for 100MW of capacity.

Payments would probably be made monthly (days declared available * $5,479) but during periods when the plant is undergoing scheduled maintenance, no capacity payment would be maid.

9.3. Capacity Price Index (CPI)

The Capacity Price Index (CPI) is designed to allow changes in fixed costs to be passed to Armenergo. The costs that are indexed in this way will typically be those ones over which the Generating company has no control (for example, staffing costs may be indexed to Armenia labor cost index). In Armenia, the CPI may be an inflation index so that revenues rise to match rises in wage biles and maintenance costs.

9.4. Energy Purchase Prise

[EP in $/kWh] = base price * [energy price index (EPI)].

[The energy price will vary and should reflect the short run marginal cost of production, which is dominated by the cost of fuel. The price will be calculated for a base fuel price level]

9.5. Energy Price Index (EPI)

[Indexation of the energy price is critical component. It must be designed to balance the need of the generator to recover un-controllable costs, while providing incentives to improve efficiency in respect of controllable costs. It is likely to be almost 100% fuel costs].

9.6. Treatment of Capacity Surpluses

Utilities aim to provide enough capacity so that there is a reasonable surplus of capacity over peak demand. The optimum size of that surplus depends on several factors including the size of the system, the size of the units and the possibilities for exchange with neighboring systems. In some circumstances, for reasons beyond the control of the utility, demand forecasts prove inaccurate and capacity surpluses arise. This occurred across the whole western world during the 1970s following the oil price increases in 1973 and 1979. It also occurred recently in many countries of Eastern Europe.

The Armenia electricity supply industry also faces an additional issue: how to deal with the existing surplus capacity? Should Armenergo (and indirectly the Distributing Companies and consumers) pay to keep this surplus capacity maintained so that it is available in future, or should the owners of the plant (ie the state) pay to keep them maintained, or should the plant be retired?

Currently, Armenergo acts as a single buyer. Therefore, Energy Commission needs to review and approve Armenergo's investment decisions in advance.

9.7. Example

Assume Armenergo forecasts demand for five years ahead as follows:

Year 1 1,200MW

Year 2 1,200MW

Year 3 1,400MW

Year 4 1,500MW

Year 5 1,600MW

To meet this demand, Armenergo estimates that it must contract for the capacity shown in the table bellow:

Estimate of Capacity Needed

Table 9.1

Year	Peak Demand	ANPP	Sevan-Hrazdan Cascade	Vorotan Cascade	Small Hydro	Hrazdan TPP	Yerevan TPP	Total	Reserve margin
	(MW)	(MW)	(MW)	(MW)	(MW)	(MW)	(MW)	(MW)	(MW)
1	1,200	600	550	400	56	250	50	1,906	58.8%
2	1,200	600	550	400	56	250	50	1,906	58.8%
3	1,400	600	550	400	56	500	50	2,156	54.0%
4	1,500	600	550	400	56	750	50	2,406	60.4%
5	1,600	600	550	400	56	750	50	2,406	50.4%

The required capacity is assumed to be identified using Loss of Load Probability (LOLP) reliability criterion. If Armenergo contracts for the bare minimum capacity necessary to satisfy LOLP reliability criterion -as shown in the above table - then decisions need to be made:

- to close the redundant units, or
- to mothball the units until such time that they are needed.

9.8. How Much Capacity Should Be Contracted?

Imagine Armenergo approaches Energy Commission to contract for capacity as shown in the table.

Proposed Contracting Strategy

Table 9.2

Year	Peak Demand	Capacity needed to meet demand							Additional capacity contracted	Mothballed capacity
		ANPP	Sevan-Hrazdan Cascade	Vorotan Cascade	Small Hydro	Hrazdan TPP	Yerevan TPP	Total	Hrazdan TPP	Hrazdzn TPP (unit#3)
	(MW)	(Mw)	(MW)	(MW)	(MW)	(MW)	(MW)	(MW)	(MW)	(MW)
1	1,200	600	550	400	56	250	50	1,906	250	250
2	1,200	600	550	400	56	250	50	1,906	250	250
3	1,400	600	550	400	56	500	50	2,156	0	250
4	1,500	600	550	400	56	750	50	2,406	0	0
5	1,600	600	550	400	56	750	50	2,406	0	0

In the year 1, Armenergo estimates that it needs 1,906MW of capacity to achieve satisfactory reliability. This includes 250MW at Hrazdan TPP. However, if Armenergo contracts for exactly 250MW then Hrazdan TPP would not have the financial resources to cover the fixed costs of maintenance and salaries and the remaining units would have to close. If would then not be available for the future.

Armenergo therefore argues that it is more cost effective to pay the fixed costs to maintain the plant and to keep the staff available for unit 2 that a third unit should be "mothballed" for three years and then brought back into service in year 4. This analysis is shown below.

In this example, in Scenario2, one “surplus” unit is kept fully available for two years until it is needed in year 3. Unit 3 however is mothballed from year 1 until year 4 when it is returned to

Analysis of Contracting Options

Year	Scenario 1		Hrazdan TPP #2-4 Decommissioned			
	HrazdanTPP (MW)	Fixed costs ($mn.)	Alternative TPP (MW)	Capital costs ($mn.)	Fixedcosts ($mn.)	Total costs ($mn.)
1	250	2.5	0			2.5
2	250	2.5	0			2.5
3	250	2.5	250	200	2.5	205
4	250	2.5	500	400	5	407.5
5	250	2.5	500		5	7.5
6	250	2.5	500		5	7.5
7	250	2.5	500		5	7.5
8	250	2.5	500		5	7.5
9	250	2.5	500		5	7.5
10	250	2.5	500		5	7.5
11	250	2.5	500		5	7.5
12	250	2.5	500		5	7.5
13	250	2.5	500		5	7.5
14	250	2.5	500		5	7.5
15	250	2.5	500		5	7.5
Present value costs ($mn)						**470.0**

Analysis of Contracting Options (continuation)

Year	Scenario 2 Hrazdan TPP #2-3 Contracted								
	Hrazdan TPP	Fixed costs	Alternative TTP	Capital costs	Fixed costs	Mothballed unit	Invest. costs	Fixed costs	Total costs
	(MW)	($mn.)	(MW)	($mn.)	($mn.)	(MW)	($mn.)	($mn.)	($mn.)
1	500	5	0			250	20	0.6	25.6
2	500	5	0			250		0.6	5.6
3	500	5	0			250		0.6	5.6
4	750	7.5	0			0			7.5
5	750	7.5	0			0			7.5
6	750	7.5	0			0			7.5
7	750	7.5	0			0			7.5
8	750	7.5	0			0			7.5
9	750	7.5	0			0			7.5
10	750	7.5	0			0			7.5
11	750	7.5	0			0			7.5
12	750	7.5	0			0			7.5
13	750	7.5	0			0			7.5
14	750	7.5	0			0			7.5
15	750	7.5	0			0			7.5
Present value costs($mn) 70.6									

operation. Units 1 and 2 would probably be used in rotation so that the operating hours of each would be the same, i.e. both relatively low. The mothballing of unit 3 would require some investment, as shown in figure#, following which it would be taken out of service for three years. On-going maintenance work would be required to ensure that it would be usable when called upon to operate in year 4.

Table 9.3 shows that it is cheaper to keep unit 2 in operation and to mothball unit 3 (Scenario 2) rather than to close the units and open new ones in year 3 and 4 (Scenario 1).

Note, implicit in this analysis is the assumption that other units, which are no longer required, would be retired.

10. CONCLUSION AND RECOMMENDATIONS

Today in Armenia all the elements for the international cooperation and development of the private sector are in place. Energy specialists of Armenia are ready to cooperate with the foreign partners in all aspects of the generation, transmission and distribution of the electric and thermal energy, gas and oil products. Government is committed to an Energy sector dominated by the private enterprises.

The main reforms are directed to private sector further development. Special attention is given to increase the efficiency of Energy Sector and to make it attractive to the international joint-venture partners. The focus of the Ministry of Energy of Armenia is the successful privatazation of Energy Sector according to the Privatization Master Plan.

The Ministry of Energy is resolving issues related to the reduction of the private investors' risks. At present, we have gone through the first experience of privatization with a pilot programs. In September 1997, 13 small HPPs were privatized. Experts from the foreign organizations participated in the tendering procedures. Two of the 13 HPPs were purchased by the French businessmen and the rest by the local ones.

Nowadays strategic investors are participating in the bidding process of privatization. Government is elaborating proceedings for the bids up to the end of year 2000. High level of unmeterred losses (up to the 9% -that shows hidden demand) creates debts for Distribution Companies (Discos). Privatization of those companies will help to decrease losses.

Ministry of Energy of Armenia emphasizes the integration of Armenia with the regional energy markets on the basis of mutually beneficial economic relations.

Presence of interconnections with the power systems of exporting and reexporting 700-800 MW due to the surplus of the installed capacities show that at present, the Armenian Power Sector has all the prerequisites for working in larger regional grids.

Implementation of the new tariff structure that was proposed in this research will contribute to the costs of electricity decrease, will increase profitability of Energy Sector enterprises, and will release some funds that are necessary for equipment and constructions repair and renewal. It should be recommended:

A) New tariff structure that would decrease costs of electricity produced by Power Plants that also includes:

1) implementation of seasonal diversified tariffs;
2) implementation of contractual agreements between Gencos and Armenergo (and indirectly Distributing companies) in the case of surplus capacities;

B) To elaborate and implement State Energy Conservation Program that would help to reduce energy losses and might include installation of meters on the end-users water supply systems that would charge higher prices for energy usage during peak hours.

11. References:

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