National Program on Energy Saving and Renewable Energy of Republic of Armenia

Yerevan 2007

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1. INTRODUCTION

The Republic of Armenia has adopted a policy of sustainable economic development, which assumes harmonized growth for each branch of the economy. Under these conditions, the energy sector is the most important sector for growth of the society as its qualitative and quantitative development determines the degree of Armenia's level of development and well-being of its citizens.

The current rates of industrial development resulted in low economic efficiencies throughout the world due to intense utilization of natural resources. The main goal of the current human civilization should be to ensure sustainable development by harmonizing and balancing environmental problems.

In a world with finite quantities of energy resources, energy efficiently is imperative in order to ensure continuous societal growth and development. In addition, augmenting the use of renewable energy sources should be a high priority. There is an absence of industrial quantities of fossil fuels in Armenia. Energy availability, therefore, must be solved by increasing the energy efficiency of the economy and through the development of local renewable energy sources.

During the end of the 20th century, developed countries experienced an energy crisis and thus were forced to develop and utilize domestic renewable energy and energy efficiency resources. Energy use was evaluated in the technological processes of all economic sectors which revealed significant potential for energy saving.

Countries that incorporated energy saving policies and measures into economic development strategies have significantly increased energy efficiency of the GDP. Energy efficiency is in large part responsible for the increases in production rates in developed economies.

The international experience in advanced energy saving during the last century has shown that the energy saving potential of existing technologies is approximately 30-40% and that fuel saving measures are 2-3 times cheaper than the production and delivery of fuel to consumers.

This new source of energy – the energy saving is more beneficial than the other sources. According to data provided by the International Energy Agency, each dollar invested into energy saving measures (e.g. organizational-technical measures, adoption of new technologies, modernization and optimization of existing technologies) results in more "clean" energy than a dollar invested in production of any other energy source. It is worth mentioning that most of the saved energy is sourced from the consumer sector and that it is environmentally friendly, since there are no emissions during the process of energy saving, moreover, energy saving reduces the emissions. In some cases, energy saving is targeted to reduce the environmental pollution, for example, utilization of secondary thermal resources significantly reduces the pollution

Many countries have extensive experience in the development of renewable energy. The European Union has a goal of sourcing 12% of the total energy generation from renewable energy resources by the year 2010.

Armenia can meet only 35% of the total demand for energy with its domestic resources, thus it is highly dependant on imported energy resources. In addition, energy efficiency within the Armenian economy is much lower than that of developed countries in the region. Therefore, in order to secure the sustainable development of Armenia, priority must be given to the development of domestic energy resources and widespread implementation of energy efficiency throughout the economy. If Armenian is to achieved sustained economic growth, it must increase efficiency in all energy consuming sectors and develop renewable energy resources.

Hence, the sustainable development of Armenian economy and energy sector and its independence must be based on increasing energy efficiency in all energy consuming sectors and on the strategy and program of development of the renewable energy based on national interests and targeted towards mitigation and overcoming the problem of low energy efficiency of the national GDP and the scarcity of domestic fuel-energy resources.

2. FUNDAMENTALS OF THE NATIONAL PROGRAM ON ENERGY SAVING AND RENEWABLE ENERGY

The main purpose of the National Program on Energy Saving and Renewable Energy is to set targets for the energy saving and renewable energy development in Armenia and to determine the means for their realization.

Inclusion of energy efficient technologies and renewable energy in the fuel-energy mix will play a key role in increase the energy supply level of economy through the use of domestic fuel-energy resources and will ensuring an increased level of energy independence. It will alleviate the dependence of the country on foreign fuel sources and will establish a basis for transition from extensive quantitative economic development to more productive development and for making a policy based on national interest, through increasing energy independence of the country.

Additionally, heavier reliance on energy efficiency and the utilization of renewable energy resources will result in emissions reduction and will contribute to solving environmental complications associated with the burning of fossil fuels.

The adoption of energy saving and renewable energy is accompanied by implementation of new production and management technologies. This experience will assist in sustainable development of Armenia into a knowledge-based economy. It is of national interest to Armenia in order to avoid being a source of raw materials and labor for developed countries.

The development of energy saving and renewable energy, which contribute to energy independence of the country, also supports the process of integrating Armenia into the regional energy system.

The development of energy sector using only conventional fuel resources (natural gas, oil, etc.) is short-sighted. Traditional fossil fuels are finite in quantity and the exhaustion and/or the drastic price growth can be expected in the near future. In this regard, efficient consumption and use of renewable resources (solar, wind, etc.) is the only option for a developing economy.

An increase in energy efficiency throughout all sectors of the economy leads to lower production costs, thus increasing the competitiveness of a product.

There is a tendency to believe that increasing production and expanding economic growth directly leads to increased energy consumption. This National Program should outline clear methods for overcoming this belief. The policy priorities of the Armenian government are interrelated and include increased employment, economic growth, development of all sectors

of economy, environmental protection, healthcare improvement, increased energy efficiency of GDP, etc.

Using sustainable development conditions, there is no contradiction between the economic growth and environmental protection. When government policy has a systematic character, with coordinated and harmonized standards, it will not hinder the adoption of energy efficient technologies in all levels of government.

The following National Program was developed based on the 21st principle of Global Program of Sustainable Development of 1992 United Nations General Assembly Declaration on Environment and Development (Rio Convention or Earth Summit), ten years from that – the fundamentals for sustainable development proposed at Johannesburg Summit, other environmental conventions ratified by Armenia with the resulting responsibilities, the RA Government Poverty Reduction Strategy, the Energy Sector Development Strategy within the program of Economic Development of Armenia, as well as the state policy in the field of energy saving and renewable energy set by the Law on Energy and the Law on Energy Saving and Renewable Energy of Armenia. The National Program is directed to achieving the following goals:

1. Support for the sustainable development of the Armenian economy.
2. Through development of energy saving and renewable energy systems, decrease the dependence on foreign energy suppliers and avoid interruptions in the Armenian fuel supply.
3. Alleviate the inefficient growth of the energy sector by securing intensive implementation of energy efficiency measures.
4. Efficient consumption of fuel-energy resources and maximal employment of renewable energy resources, through application of targeted economic and legal mechanisms.
5. Develop practical measures for achieving the targets set by this program. This includes the development and application of modern technologies and management practices.
6. Maximal utilization of local/domestic advantages (renewable energy resources, professional human resources, the practice of “oversized” energy system operation, current conditions of a region with scarce energy resources, etc).

The main principles of energy efficiency, as outlined in this program, are:

1. Determination, throughout all sectors of the economy, of economically justified energy saving potential and its implementation.
2. Increase the efficiency of fuel-energy resource consumption in all sectors of economy.
3. Adoption of advanced technologies and work schedules for consumers of fuel-energy resources.
4. Provide of affordable consulting for fuel-energy consumers in efficient use of resources and products, as well as in decision making process.

The National Program on energy saving and renewable energy is directed at solving the following problems:

1. Plan the development of energy resources of the country parallel to the advancement of energy saving and renewable energy, taking into account that increased energy efficiency usually has a low-cost nature.
2. Synchronize the state policy on development of fuel-energy resources with the growth of the economy as a whole. This guarantees country-wide sustainable development through the introduction of regulatory reforms and an increase in public participation throughout the process.
3. Direct the finance and credit policy of the country to energy saving and renewable energy development, providing equal conditions for capital investment.
4. Establish and maintain an active market structure through introduction and explanation of energy efficiency benefits, providing an effective choice mechanism for market participants.
5. Organize, promote and provide equal accessibility to modern technologies for all members of society, consumer and corporate alike.

3. MACROECONOMIC AND ENERGY CHARACTERISTICS OF THE ARMENIAN ECONOMY

The GDP of Armenia in 2005 was 2,228 billion AMD, which made a 1,197 million growth from the year 2000 – around 86% growth (Table 1). During the period of 2000-2004 the annual growth of GDP was 12.86%. According to its GDP growth, Armenia was one of the leaders among the 170 countries. Between 2000 and 2005, this GDP index is close to the one of Moldova - 13.35%, Latvia - 11.83%, and Bulgaria - 13.64%. The GDP growth index is high in Russia - 15.43% and Hungary - 16.53%. In developed countries the GDP growth index is 3-8% (Table 2).

The information provided in the text of the National Program refers to the period of 2000-2005. When coming across different values for the baseline numbers, it was decided to consider the ones with the highest credibility source, and sometimes the data for certain years were absent. Hence, some data are provided for a short period of time (1-2 years).

The choice of countries was made in order to allow comparison of different indices for the same group of countries.

Table 1. Macroeconomic and energy-economic description of Republic of Armenia

N	Criterion	Measurement unit	Year				
			2001	2002	2003	2004	2005
1	GDP	billion AMD	1,175.9	1,362.5	1,624.6	1,896.4	2,228.0
2	Population	mln. people	3,2129	3,2103	3,2122	3,2158	3,2185
3	Primary fuel-energy resources	thousand toe	2,032.0	2,001.0	2,080.1	2,305.1	2,617.7
4	Electricity production	mln. kWh	5,744.8	5,518.8	5,500.9	6,030.0	6,316.5
5	Import of natural gas*)	mln. m^3	1,408.5	1,070.3	1,200.9	1,332.6	1,685.0
6	Import of oil products	thousand toe	367.6	378.5	431.6	411.8	402.2
7	Commercial export of electricity	mln. kWh	700.9	659.9	583.1	1,012.3	813.5
8	Final consumption of electricity	mln. kWh	3,872.0	3,400.0	3,655.0	3,991.6	4,374.4
9	Final consumption of natural gas*)	mln. m^3	1,299.7	901.4	977.2	1,155.9	1,443.5
10	Supply of domestic fuel-energy resources	%	30.33%	38.32%	33.87%	35.56%	33.51%
11	Final consumption of fuel-energy resources	thousand toe	1,610.3	1,301.8	1,430.0	1,564.1	1,788.8
12	Energy intensity of GDP	kg oe/1,000 AMD	1.728	1.469	1.280	1.216	1.175
13	Electric intensity of GDP	kWh/1,000 AMD	4.885	4.050	3.386	3.180	2.835
14	Energy efficiency of GDP	1,000 AMD /kg oe	0.579	0.681	0.781	0.823	0.851

*) The 2001data for natural gas imports and its final consumption is based on the evaluation of experts.

Source: National statistical service of Republic of Armenia and Ministry of Energy

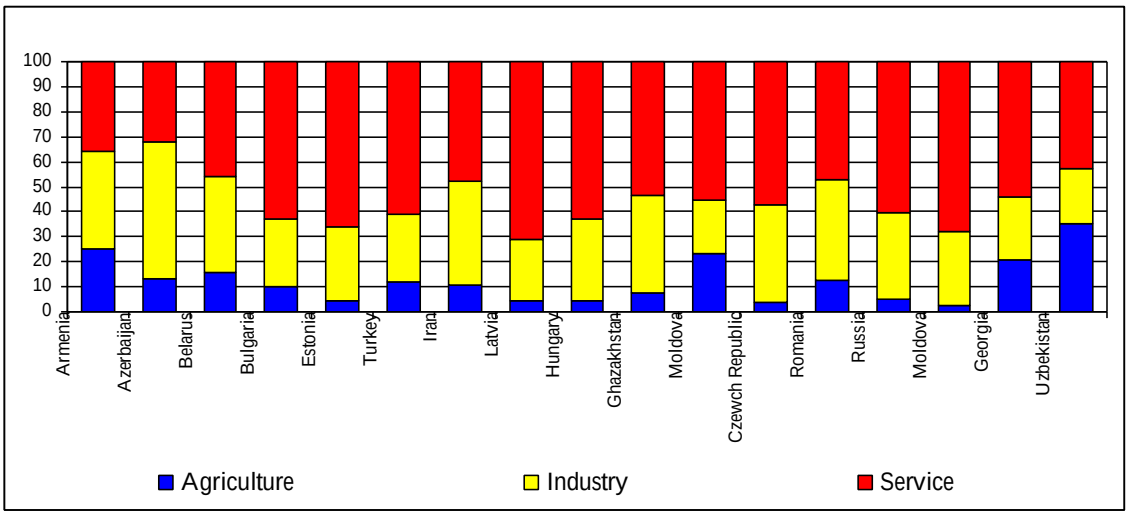
Table 2. Percentage of average annual growth for a number of countries based on GDP structure for 2000-2004.

N	Country	GDP,%	GP agriculture, %	GP industry, %	GP service, %
1	Armenia	12.86	13.68	16.58	11.23
2	Azerbaijan	10.48	3.18	12.69	3.67
3	USA	3.30	2.83	2.83	2.83
4	Belarus	14.41	17.92	14.33	14.56
5	Bulgaria	13.64	5.09	12.02	18.09
6	Germany	6.44	4.02	5.08	6.85
7	Estonia	15.13	9.46	19.71	16.89
8	Turkey	7.06	-0.96	7.24	6.07
9	Iran	10.99	2.63	16.02	7.02
10	Latvia	11.83	10.65	12.24	13.47
11	Hungary	16.53	16.24	16.24	16.24
12	Kazakhstan	16.49	11.67	15.88	18.09
13	Japan	1.20	0.95	0.95	0.95
14	Moldova	13.35	8.06	13.62	17.35
15	Czech Republic	13.98	7.30	13.20	15.55
16	Romania	13.57	14.90	17.09	11.85
17	Russia	15.43	10.13	13.05	18.57
18	Slovakia	14.32	1.40	13.36	15.44
19	Georgia	9.67	8.38	13.30	8.87
20	Uzbekistan	-5.78	-6.28	-8.33	-6.61

Source: http:/devdata.worldbank.org/external/CPProfile.asp

The structure of 2004 GDP in Armenia: 40% in industrial sector, 35% in service sector (including construction and transportation), and 25% in agriculture. The share of industry in the GDP of Armenia is close to the one in developed countries (30-40%). The share of service sector is 1.5-2 times lower than in developed countries (50-70%). The 25% share of agriculture in the GDP of Armenia makes it an agriculture oriented country. Thus, it is obvious, that the Armenian economy is agricultural-industrial, with developing service sector.

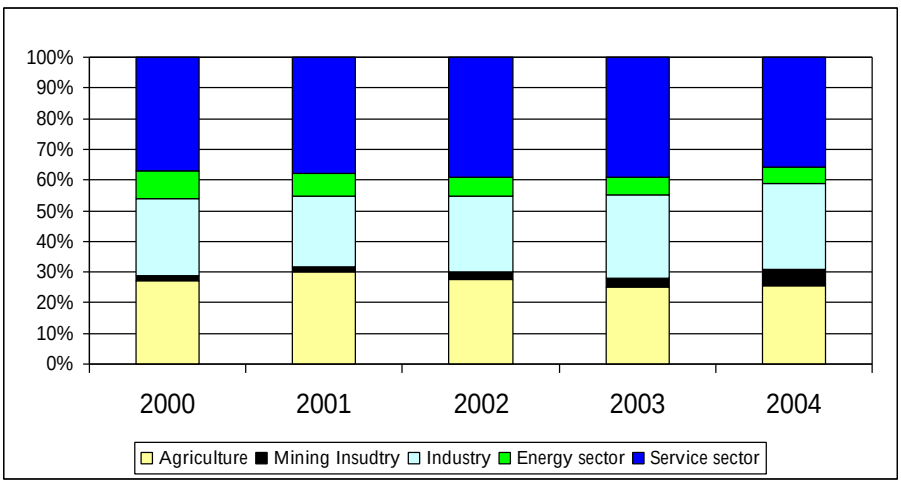
Figure 1. GDP structure for a number of countries in 2005, %



Source: http:/devdata.worldbank.org/external/CPProfile.asp

The dynamics of structural changes in the GDP of Armenia did not go through any changes during the period of 2000-2004 (Figure 2).

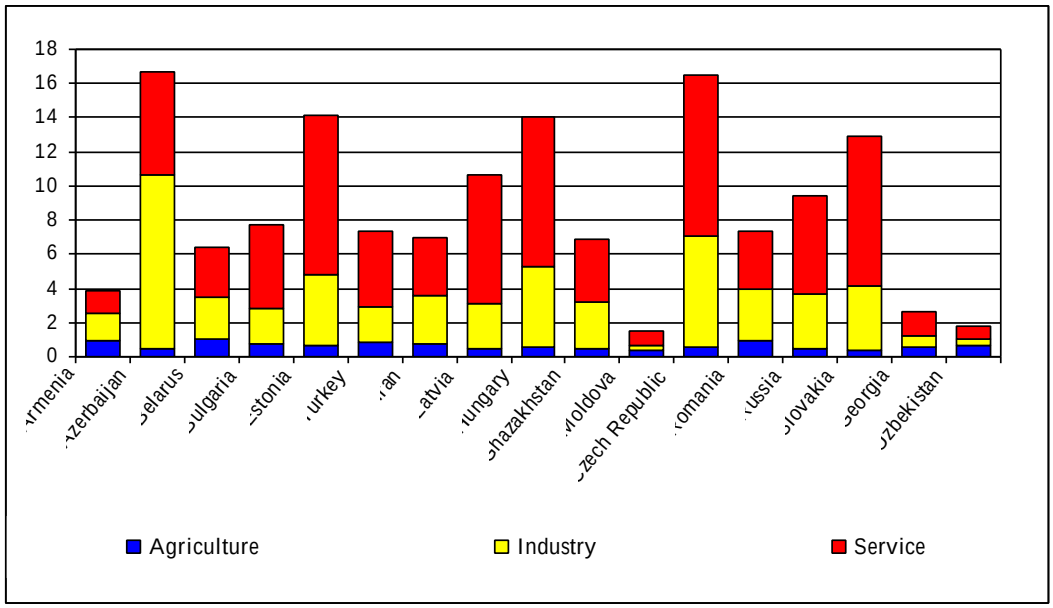
Figure 2. GDP dynamics in Armenia



Source: http:/devdata.worldbank.org/external/CPProfile.asp

According to the index of the gross agricultural product in 2004, Armenia had a high rate among other countries - 0.99 thousand USD per capita. According to the similar indices in industrial and service sectors (USD/capita) Armenia is behind the developed countries, although the annual percentage growth in all of these sectors is significant (Figure 3).

Figure 3. GDP structure of a number of countries in 2004 according to purchasing power, USD/capita



Source: http:/devdata.worldbank.org/external/CPProfile.asp

During the period of 2001-2005 GDP growth (from 1,175.9 billion AMD to 2,228 billion AMD) was accompanied by a decrease in energy intensity of the GDP from 1.73 kg oe/1,000AMD to 1.18 kg oe/1,000AMD, and electricity intensity from 4.89 kWh/1,000 AMD to 2.84 kWh/1,000 AMD. The dynamics of energy characteristics shows that the efficiency of fuel-energy resource consumption in the economy has a positive growth (Table 1).

The energy efficiency and electricity efficiency of GDP have grown for 46% and 71% correspondingly during 2001-2005.

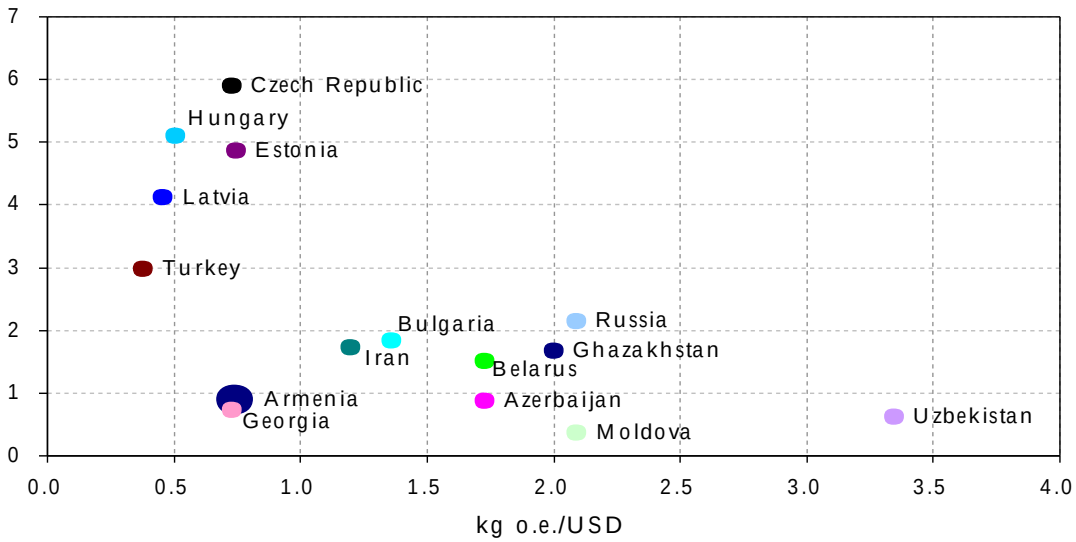
The 32% decrease in energy intensity of GDP is primarily a result of the application of non-energy intensive and advanced technologies (food industry, service sector, etc.) and the immediate utilization of natural gas by consumers. These changes were accompanied by an annual 8-14% physical growth of GDP**.**

The energy intensity of the Armenian GDP in 2003 was 0.74 kg oe/USD and was close to that of Estonia (0.75 kg oe/USD) and the Czech Republic (0.73 kg oe/USD), but differed from Uzbekistan (3.35 kg oe/USD) and Russia (2.09 kg oe/USD). Better characteristics can be

found in Latvia (0.46 kg oe/USD), Hungary (0.51 kg oe/USD), and Turkey (0.38 kg oe/USD) (Figure 4).

The energy intensity of the Armenian GDP and the structure of energy consumption according to the sectors of economy are determine on one hand by the level of economic development of the country (low energy intensity) and on the other hand by the presence of energy intensive technologies (high energy intensity). The GDP energy intensity of Armenia is on an average level and is close to the one in developing countries such as Estonia, the Czech Republic and Hungary.

Figure 4. GDP/capita and GDP energy intensity in a number of countries (2003)



Source: Key World Energy Statistics from IEA

It is evident that the comparison of GDP energy intensity of different countries can not provide adequate information unless it is combined with the GDP/capita index. Thus, the low GDP energy intensity in Armenia is solely a result of low installed power per capita (end-use consumption of electricity). The increase of the installed power per capita (towards the developed countries' index) will result in worsening the GDP energy intensity index.

The industry sector of Armenia has a low (good) energy intensity characteristic, 329.4 kg oe/$1,000 USD, compared to the one for Uzbekistan, 2616 kg oe/$1,000 USD, Estonia, 569 kg oe/$1,000 USD, Moldova, 1264 kg oe/$1,000 USD, and Georgia, 304 kg oe/$1,000 USD.

Figure 5. Structure of energy consumption by the economy sectors in 2003, thousand USD.

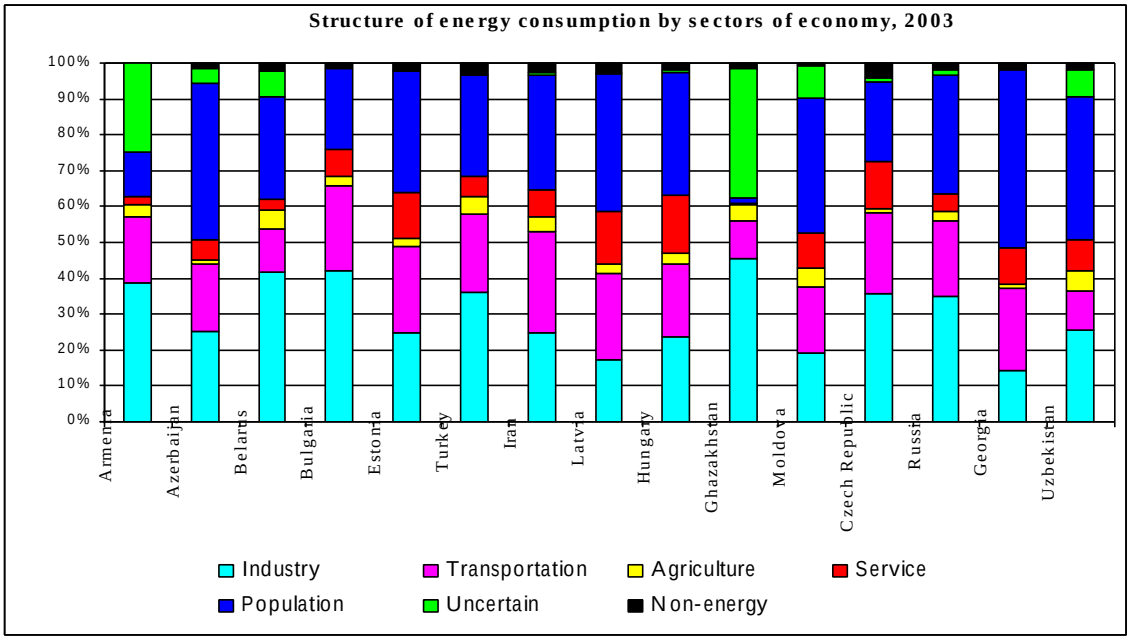
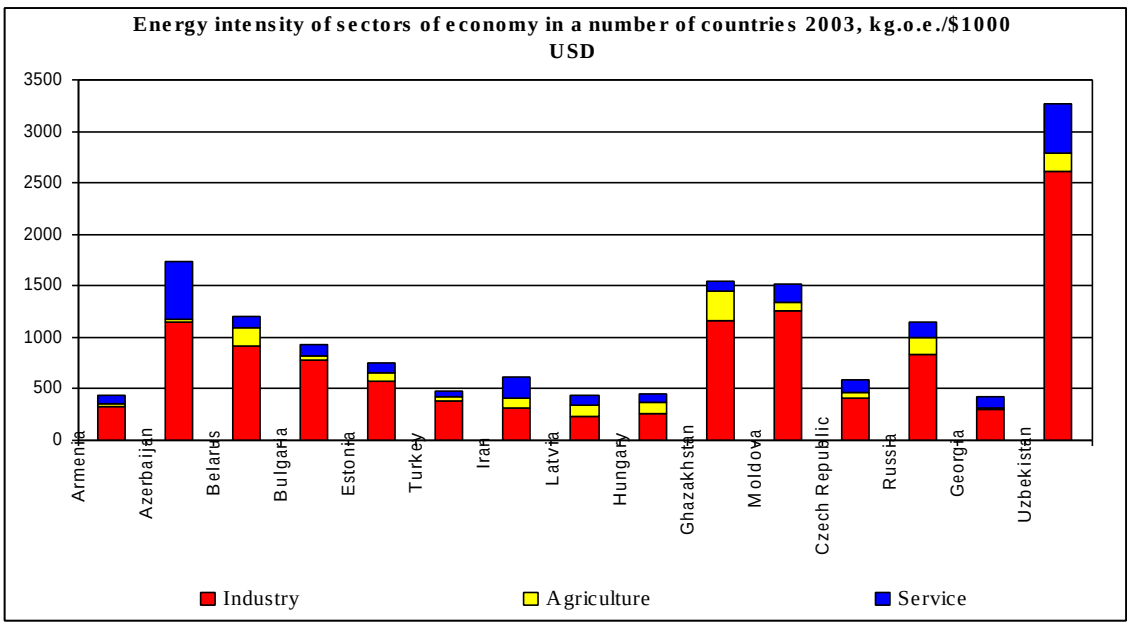


Figure 6. Energy intensity of economy in a number of countries in 2003, kg oe/thous.USD



Source: Key World Energy Statistics from IEA htpp:/www.iea.org/dbtw-wpd/Textbase/stats/nmcbalancetable.asp

This means that the load of the energy intensive production is very low ("Nairit" factory, "Polyvinylacetate" factory, etc.), and that the share of production using modern energy

efficient technologies is high (food production, non-energy intensive production). It is necessary to maintain the level of this characteristic and further decrease it in future.

The energy intensity of Armenian agriculture sector, 24 kg oe/$1,000 USD, is close to the one in Georgia, 8.2 kg oe/$1,000 USD, Azerbaijan, 20 kg oe/$1,000 USD, and Bulgaria, 42.6 kg oe/$1,000 USD. This shows a low level of mechanization in agriculture. The major energy consumption is in the irrigation systems using water pumps (Figure 5).

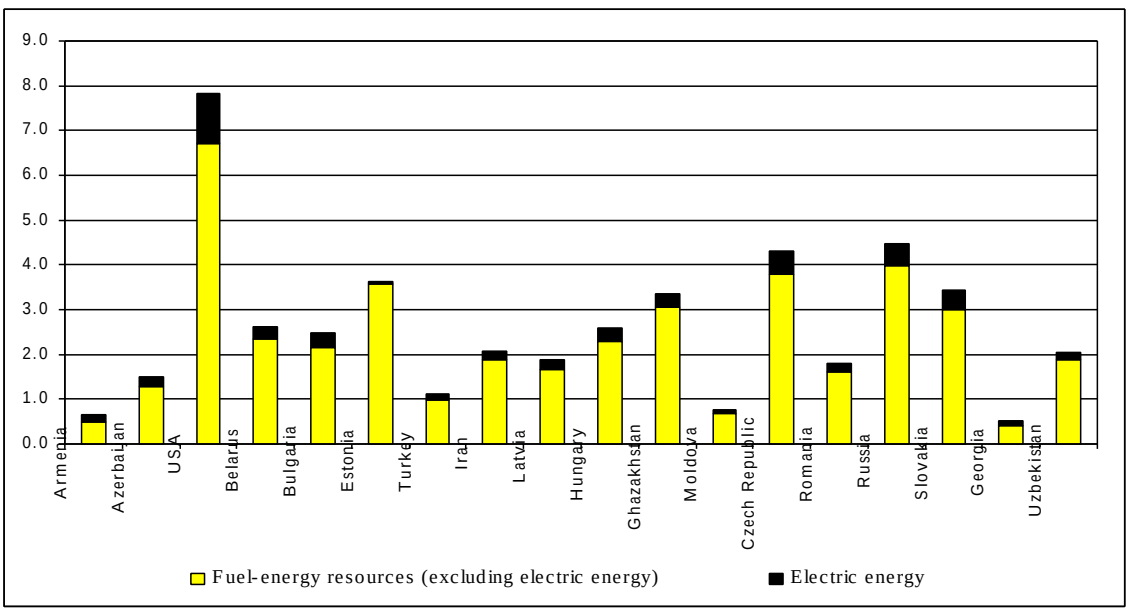
The energy intensity index in the service sector of Armenia, 90.4 kg oe/$1,000 USD is close to that of many developed and developing countries: Estonia, 91 kg oe/$1,000 USD, Latvia, 99.7 kg oe/$1,000 USD, Czech Republic, 114.8 kg oe/$1,000 USD (Figure 6). The developing service sector in Armenia is experiencing the same issues of energy efficiency as in developed countries and do not represent a high energy saving potential.

Therefore, according to the consumption of fuel-energy resources per capita and the volume of GDP, Armenia is on the same level with Georgia and Moldova and is drastically lower – almost 6 times – than the Czech Republic and Estonia. The latter is explained by the low installed power per capita and low energy efficiency (Figure 7).

When comparing to developed countries, it is necessary to mention that Armenian economic development requires an increase of relative consumption of fuel-energy resources per capita, which will lead to corresponding growth of GDP per capita.

The GDP per capita in Armenia does not differ much between its agricultural, service and industrial constituents. However, it is necessary to achieve this difference as it is significant in a number of developed countries, which shows low efficiency within the Armenian industry and service sectors. There is a significant potential for increasing the efficiency in the aforementioned sectors, which is evident from the experience in developed countries.

Figure 7. Primary fuel-energy source per capita in a number of countries, 2003



4. DESCRIPTION OF FUEL-ENERGY COMPLEX AND FUEL-ENERGY CONSUMPTION IN ARMENIA

The domestic fuel-energy resources of Armenia are the following: hydro, nuclear[1], wind, wood, coal, solar, geothermal, and other fossils (although these represent a very small share of the fuel-energy complex).

The major part of fuel-energy resources consumed in Armenia is imported. Of the energy consumed in 2005 (3,739.5 thousand tcf), 6.7% (251.4 thousand tcf) was sourced from domestically produced hydropower and 26.8% (1,000.9 thousand tcf) from nuclear power. Thus, hydropower and nuclear power together added up to 33.5% of the total energy consumed in Armenia during the year 2005. Therefore, all remaining energy resources -, 66.5% of total demand during the year 2005, was imported (Table 3).

An analysis of the energy system of Armenia during the period of 2001-2005 shows that there was an 11% increase of generation during 2001-2005 periods with about 4,778.3 million kWh electricity supplied to the network. The technical losses in 0.38-220 kV networks were reduced to 10%, whereas in 2004 the measured accounted losses were 18.23%. In 2001 the losses accounted for around 25.6%, including the transformation losses (Table 4 and 5).

The relative index of fuel-energy consumption in thermal power plants (TPP) shows that there is a significant physical and moral deterioration of the plant energy stations. TPPs consume around 360-390 gr. c.f. for generation of 1 kWh of electricity, whereas the modern technology index for this fuel-energy consumption is 1.5 times lower (Table 6).

[1] The nuclear fuel for the Armenian NPP is imported from Russia, but according to the International Energy Charter, the energy produced in an NPP is counted as a domestic fuel-energy resource

Table 3. Structure of fuel resources consumption based on the sector of economy and fuel type, thousand tcf

Type of Fuel / Sector	2001	2002	2003	2004	2005
Petroleum	**280.1**	**270.5**	**277.1**	**321.2**	**275.2**
Transportation and communication	224.1	216.4	235.5	273	234
Agriculture	56	54.1	41.6	48.2	41.2
Diesel fuel	**126.6**	**129.9**	**149.9**	**156**	**163.1**
Transportation and communication	31.6	32.5	37.5	31.2	32.6
Agriculture	95	97.4	112.4	124.8	130.5
Mazut (residual fuel)	**2.73**	**1.01**	**1.93**	**1.65**	**1**
Energy sector	2.73	1.01	1.93	1.65	1
Kerosene and aviation kerosene	**70.54**	**76.22**	**38.7**	**57.5**	**66.77**
Population and services	11.3	1.2	10.2	0	0
Transportation and communication	59.24	75.02	28.5	57.5	66.77
Fossil oil	**12**	**16.5**	**34.5**	**16.2**	**12.2**
Industry	12	16.5	34.5	16.2	12.2
Oil	**5.22**	**0**	**45.19**	**0.07**	**0**
Industry	5.22	0	45.19	0.07	0
Liquid gas	**30.5**	**38.1**	**36.6**	**36.9**	**30.5**
Population and services	25.3	32.4	31.1	31.3	25.9
Transportation and communication	5.2	5.7	5.5	5.6	4.6
Natural gas	**1,494.6**	**1,036.6**	**1,123.77**	**1,329.28**	**1,660.07**
Industry	192.6	222.33	237.21	317.12	398.76
Population and services	165.5	116.53	176.04	253.52	357.1
Energy sector	1032.2	596.41	569.31	617.67	711.88
Transportation and communication	104.3	101.33	141.21	140.97	192.33
Coal and wood	**20.4**	**38.4**	**13.54**	**20.65**	**15.21**
Population and services	20.4	38.4	13.54	20.65	15.21
Total					
Industry	209.8	238.8	316.9	333.4	411.0
Population and services	222.5	188.5	230.9	305.5	398.2
Energy sector	1034.9	597.4	571.2	619.3	712.9
Transportation and communication	424.4	431.0	448.2	508.3	530.3
Agriculture	151.0	151.5	154.0	173.0	171.7
Total energy resources. thousand tcf (thousand toe)	**2,042.7 (1,429.9)**	**1,607.2 (1,125.1)**	**1,721.2 (1,204.9)**	**1,939.5 (1,357.6)**	**2,224.1 (1,556.8)**
Renewable sources. thousand tcf	**128.0**	**216.1**	**257.0**	**264.9**	**236.9**
Nuclear energy. thousand tcf	**732.1**	**841.0**	**736.1**	**885.4**	**1,000.9**
Total fuel-energy resources. thousand tcf (thousand toe)	**2,902.8 (2,032.0)**	**2,858.6 (2,001.0)**	**2,971.6 (2,080.1)**	**3,293.0 (2,305.1)**	**3,739.5 (2,617.7)**

Source: Damare CJSC (Energy design institute)

According to the structure or installed capacity and electricity generation in 2004 the share of HPPs, TPPs and the NPP in the total mix of generated electricity was 33.4%, 26.7% and 39.9% correspondingly; in 2005 it was 28.29%, and 43.00%. The annual import of electricity is around 260-350 million kWh, and the export is around 600-1,100 million kWh.

All of the natural gas consumed in energy and other sectors of economy is imported from Russia (transit through Georgia). During the period of 2001-2005 the import of natural gas has increased by 19.6% and reached 1,685 million m^3 in 2005 (Table 7).

Table 4. Electricity balance in 2001-2005, million kWh.

			2001	2002	2003	2004	2005
Total production of electricity			5,745	5,517	5,501	6,032	6,316
Including	**ANPP**		1,987	2,282	1,998	2,403	2,716
	TPP		2,791	1,572	1,522	1,613	1,827
	HPP		967	1,662	1,981	2,015	1,773
	including	**large HPP**	892	1,559	1,869	1,867	1,618
		small HPP and wind power plants	75	104	112	149	155
Total own demand			392	335	313	341	374
Including:	**ANPP**		172	204	179	202	207
	Hrazdan TPP		174	91	95	103	108
	Yerevan TPP		37	30	26	26	48
	Large HPP's		8.20	8.62	10.18	8.02	7.66
	Small HPP' and Lori-1 wind power station		1.43	1.71	2.24	2.54	2.62
Electricity supply from power plants			5,352	5,182	5,188	5,681	5,911
Including:	**ANPP**		1,814	2,078	1,818	2,201	2,504
	Hrazdan TPP		2,336	1,214	1,211	1,283	1,316
	Balancing electricity		-	-	-	-	60
	of which:	**import**	-	-	209	328	671
	Yerevan TPP		244	237	190	199	338
	Large HPP's		884	1,550	1,862	1,858	1,600
	Small HPP' and Lori-1 wind power station		74	102	108	141	153
Total electricity received by "HVEN" CJSC			5,678	5,484	5,495	5,906	6,027
Including:	**from power plants**		5,352	5,182	5,188	5,681	5,689
	inflow of electricity		326	302	307	260	338
Total energy supplied by "HVEN" CJSC			5,339	5,226	5,266	5,773.80	5,929.40
Including:	**"AEN" CJSC**		-	-	-	1,273	4,778
	including:	**from power plants**	-	-	-	512	2,267
		from "HVEN" CJSC	-	-	-	761	2,519
Total outflow of electricity			699	658	583	1,004	1,151

Source: Scientific Research Institute of Energy

Table 5. Electricity losses in 0.38-220 kV networks in 2001-2005 (excluding transformation losses in power plants), million kWh

N	Name of characteristics	2001	2002	2003	2004	2005
1	**Electricity supplied by "HVEN" CJSC**	5,678	5,484	5,495	5,906	6,027
2	**Inflow**	326	302	307	260	338
3	**Outflow**	699	658	583	1,004	1,151
4	**Technical losses in 0.38-220 kV networks**	708	669	663	638	605
4.1	**Including: Distribution losses**	347	329	345	324	302
4.2	**Losses in transformers**	344	323	303	301	290
4.3	**Other**	17	18	15	13	12
5	**Measured losses**	-	-	-	1,077	932

Source: Scientific Research Institute of Energy

Table 6. Production of Armenian thermal power plants and relative expenses *of fuel-energy sources*

N	Production type	Measurement Unit	Yerevan TPP				Hrazdan TPP			
			2001	2002	2003	2004	2001	2002	2003	2004
1	Thermal Energy	Thousand GCal	342	216	193	230	83	94	106	97
2	Electrical energy	Million KWh	281	267	215	225	2509	1312	1302	1388
3	Relative expenses of fuel-energy resources for production of thermal energy	kg c.f./GCal	181	175	178	178	178	150	150	150
4	Relative expenses of fuel-energy resources for production of electrical energy	g c.f./kWh	373	391	386	360	372	371	374	383

Source: Ministry of Energy of Republic of Armenia

Table 7. 2002-2005 natural gas balance of Republic of Armenia thousand m^3

	Name	Year			
		2002	2003	2004	2005
1	***Gas remnant at the beginning of the month***	21,758.0	26,008.0	76,425.1	60,911.0
	- In the system	5,977.0	6,224.0	5,223.1	3,680.0

	- In the underground gas station	15,781.0	19,784.0	71,202.0	57,231.0
2	***Total received from***	1,140,428.0	1,272,893.9	1,403,440.1	1,744,124.0
	- From "Karmir Kamurj" measurement unit	1,070,292.0	1,200,945.0	1,332,570.0	1,685,031.0
	- System	6,746.0	7,707.9	7,162.1	4,880.0
	- Underground gas station, total	63,390.0	64,241.0	63,708.0	54,213.0
	Pumped into the underground gas storage station	69,511.0	116,684.0	52,257.0	83,944.0
	Left in the gas-transportation system	6,993.0	6,707.0	5,619.0	9,811.0
3	***In the "Transgas" LTD system***				
	- Technological loses	45,819.3	51,733.2	61,699.0	69,140.7
	- Construction needs	25.4	67.0	370.1	134.6
	- Emergency leakage	679.2	452.1	1,046.1	945.5
	- Loses of underground gas storing station	215.0	980.0	2,473.0	1,996.0
	- Emergency leakage of underground gas storing station	1,854.0			
4	***Total distributed***	1,017,425.5	1,097,317.6	1,282,819.0	1,580,282.8
	- Gas distribution system	959,675.9	1,031,926.3	1,211,352.8	1,499,557.3
	- To pressurized gas filling station	41,279.4	45,203.7	50,754.1	54,734.7
	Technological needs of "Transgas" LTD	7,047.5	8,364.9	5,840.8	8,183.1
	- Technological needs of underground gas storing station	49.0	45.0	47.0	46.0
	- For "Artsakhgas"	9,397.4	11,755.7	14,501.2	17,627.1
5	***Gas remnant at the end of the month***	26,008.0	76,425.1	60,911.0	93,531.0
	- In the system	6,224.0	5,223.1	3,680.0	8,611.0
	- In the underground gas station	19,784.0	71,202.0	57,231.0	84,920.0
6	***Utilized through gas distribution system***	901,389.1	977,187.8	1,155,893.5	1,443,539.1
	In the gas distribution system				
	- Technological losses	53,888.5	53,028.7	53,616.9	54,051.7
	- Technological needs	3,976.0	1,253.6	1,534.8	1,334.3
	- Emergency leakage	422.2	456.2	307.7	632.2
7	***Total in the system***				
	- Technological losses	99,707.9	105,741.9	117,788.8	125,188.4
	- Technological needs	11,023.5	9,618.5	7,375.6	9,517.4
	- Emergency leakage	1,117.4	908.3	1,353.8	1,577.7

Source: ArmRusGasprom CJSC

*) 2001 results are not given, based on inconsistent data

Table 8. Consumption of natural gas and its structure based branches of economy for 2002-2005, thousand m^3

	Name	Year			
		2002	2003	2004	2005
Gas distribution system		901,389	977,192	1,155,894	1,443,540
1	Energy sector	518,622	495,050	537,100	619,033
	Yerevan TPP	105,098	84,757	86,466	153,334
	Hrazdan TPP	411,135	407,277	448,764	464,672
	ANPP	2,389	3,016	1,869	1,028
2	Pressurized gas filling station	23,392	42,423	59,764	93,771
3	Industry type	193,331	206,275	275,765	346,748
	Including : “Nairit” factory	28,897	17,124	38,091	72,794
	Mika Cement	30,387	19,639	38,255	53,151
	Ararat Cement	31,890	54,854	77,770	89,807
	Metallurgy	25,585	27,332	32,250	35,749
	Glass	10,759	12,707	16,694	17,019
	Bread	5,810	6,754	8,240	9,917
	Canned goods	4,006	7,544	2,982	4,114
	Beverages	17,600	19,439	22,072	22,883
	Other consumers	38,398	40,883	39,412	41,314
4	State budget funding	15,633	19,423	22,782	28,922
	Hospitals	3,289	3,773	4,884	6,539
	Other consumers	12,344	15,649	17,898	22,383
5	Various consumers	20,250	28,697	33,659	44,054
6	Heat supply	28,826	32,244	6,371	497
7	Population	101,335	153,080	220,452	310,515

Source: ArmRusGasprom CJSC

Main consumption of electricity is in the service, residential and industrial sectors (Table 10).

During the period of 2001-2005 the fuel-energy resource consumption grew in all sectors: industrial sector doubled, residential and service sectors by 2.7 times, transportation sector by 1.5 times, in agriculture by 1.14 times. In the energy production sector, however, it decreased by 1.5 times, mainly due to reduction of losses in electric networks (Table 11).

Table 9. Structure of natural gas consumption in Armenia, million m^3

N	Name	Year				
		2001	*2002*	*2003*	*2004*	*2005*
1	**Industry, including**	**258,0**	**193,3**	**206,3**	**275,8**	**346,7**
	steel and cast iron	33,4	25,6	27,3	32,2	35,7
	non metal ore	117,4	73,0	87,2	132,7	160,0
	other	107,2	94,7	91,7	110,8	151,0
2	**Transportation, including**	**19,9**	**24,8**	**44,0**	**61,6**	**96,0**
	air transportation	1,4	1,4	1.6	1.9	2,3
	auto transportation	18,6	23,4	42,4	59,8	93,8
3	**Other sectors, including**	**157,0**	**164,6**	**231,9**	**281,4**	**381,7**
	construction	2,3	2,1	2,3	2,8	3,4
	agriculture	0,4	0,4	0,4	0,4	0,6
	trade and service	14,3	13,0	21,6	27,9	37,8
	residential	87,9	101,3	153,1	220,5	310,5
	other	51,3	47,7	54,5	29,8	29,3
4	**Electrical energy**	**920,6**	**518,6**	**495,0**	**537,1**	**619,0**
5	**Total consumption**	**1356,4**	**901,4**	**977,2**	**1155,9**	**1443,5**

Source: ArmRusGasprom CJSC

Table 10. Structure of electrical energy consumption in Armenia, million kWh

Sector of economy	2001	2002	2003	2004	2005
Industry	850	720	800	920	1,020
Population and services	1,710	1,790	1,900	1,970	1,890
Transportation and communication	120	120	120	120	110
Agriculture	290	300	750	320	290
Other	480	470	90	670	1,060
Total	**3,450**	**3,400**	**3,660**	**4,000**	**4,370**

Source: Ministry of Energy of Republic of Armenia

Table 11. Structure of fuel energy consumption, thousand tcf

Sector of economy	2001	2002	2003	2004	2005
Industry	227.2	262.7	355.6	368.8	457.9
Population and services	159.9	207.4	249.7	308.8	434.4
Energy sector	1180.5	702.6	705.5	676.0	776.1
Transportation	432.8	477.3	500.1	597.3	648.0
Agriculture	151.0	151.5	154.0	173.0	171.7
Total, thousand tcf	**2,151.4**	**1,801.5**	**1,964.9**	**2,123.9**	**2,488.1**
Total, thousand toe.	**1,510**	**1,260**	**1,380**	**1,490**	**1,740**

Source: Ministry of Energy of Republic of Armenia

The fuel-energy resource consumption per capita in Armenia has increased by 11%, from 501.2 kg oe to 555.8 kg oe during the period of 2001-2005. During the same period of time, the final consumption of electricity has increased by 12.8%, from 1,205.1 kWh/capita to 1,359.1 kWh/capita. Natural gas consumption increased by 10.9%, from 404.5 m^3/capita to 448.5 m^3/capita. The installed power per capita, or the end-use consumption of electricity per capita in Armenia in 2005 was 1,359.1 kWh, which is much lower than the one in Czech Republic (5,400 kWh) and Hungary (3,440 kWh). It is necessary to increase this index, taking into consideration the well known fact that the increase of installed power per capita in an economy by 1% leads to increases of work production by 1%. When compared to the fuel-energy consumption index, Armenia is inferior to many countries in the region, moreover the difference between Armenia and developed European countries is 5-8 times. For example, this index in France is equal to 4,410 kg oe/capita. During the period of 2002-2005 there was a 10-12% growth in average fuel-energy resource conversion (Figure 8, 9, 10).

Figure 8. Per capita primary fuel-energy resources and final consumption, 2001-2005

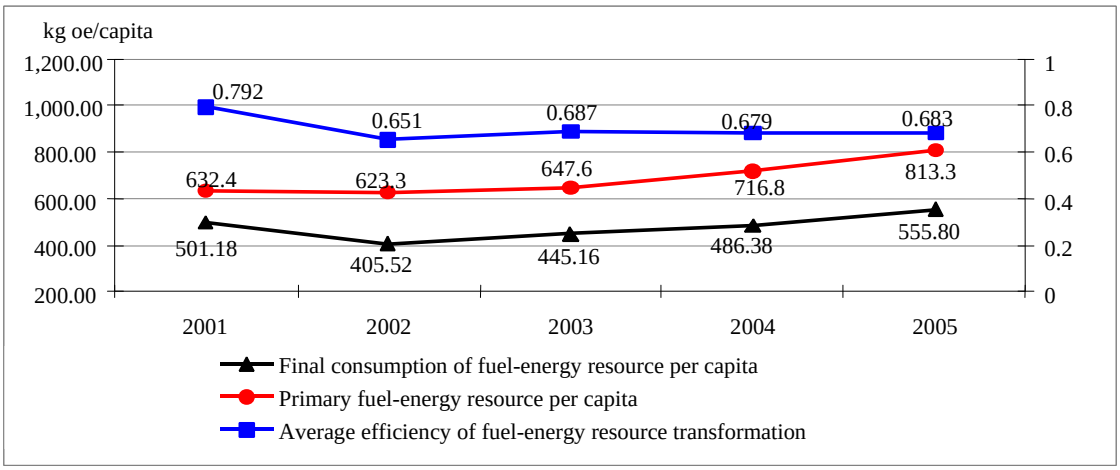


Figure 9. Per capita electricity production and final consumption, 2001-2005

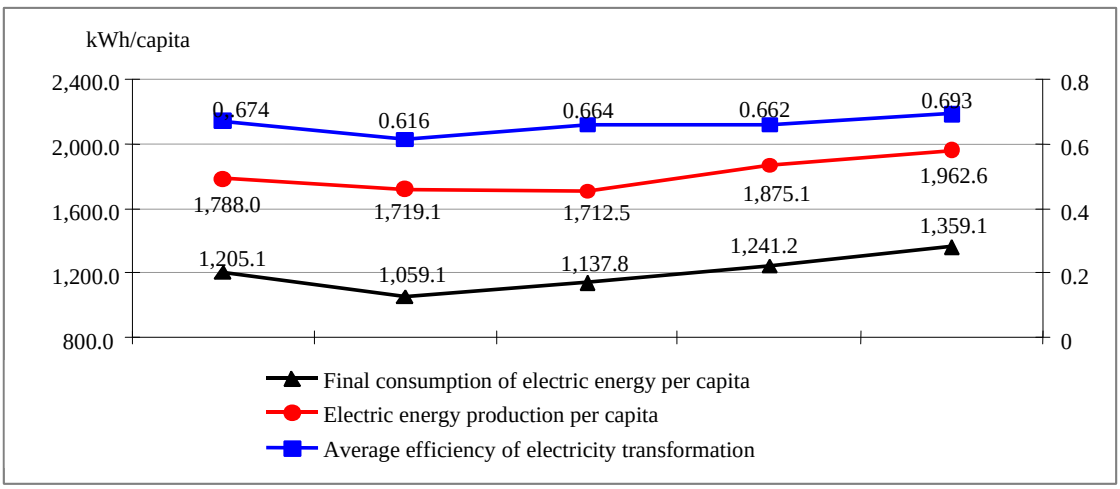
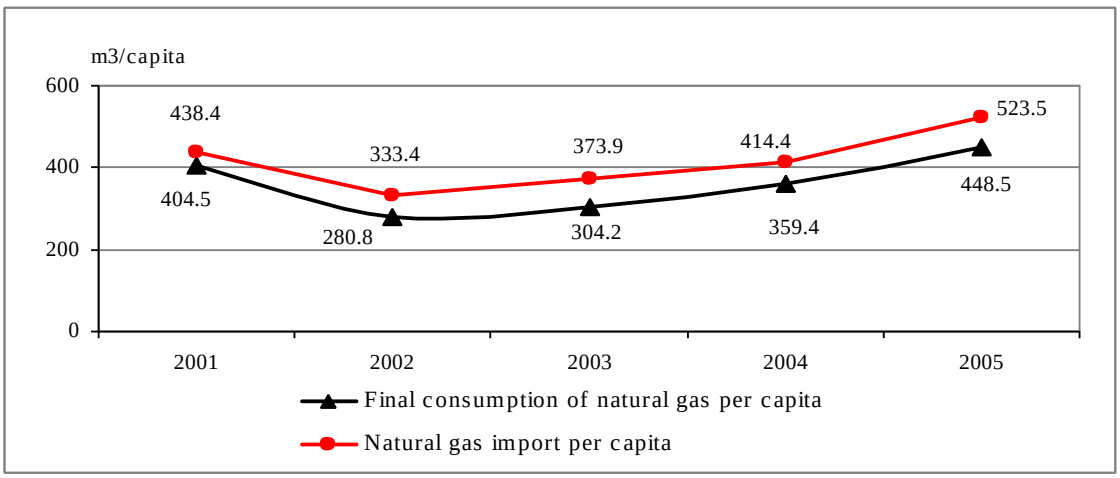


Figure 10. Per capita natural gas import and final consumption, 2001-2005



Source: State Statistical Service and Ministry of Energy

The analysis shows that the installed power per capita in Armenia should grow in parallel with the development of the economy. Furthermore, there is a projected growth of fuel-energy resource consumption.

Energy consumption in the residential sector in 2005-2006, sorted by resource type, has the following pattern:

1. In January 2006 the consumption of electricity per capita in residential sector varied from 78 kWh to 383 kWh. The national average for the country was within the range of 119 kWh to 223 kWh.
2. Natural gas consumption per capita in January 2006 varied from 134 m^3/capita to 313 m^3/capita. The national average was 217.9 m^3/capita.
3. The total electricity consumption by residential sector in January 2006 was 181.5 million kWh and varied from 109.1 million kWh/month to 188 million kWh/month during the winter.
4. The total natural gas consumption by residential sector in January, 2006 was 72 million m^3, and varied from 33.8 million m^3/month to 72 million m3/month during the winter.
5. In 2005, around 16,000 tcf was consumed for residential heating purposes. It is necessary to mention that the accuracy of this data is very low.
6. Manure was used as the major source of heating in the mountainous regions where there is a lack of wood. There is no accurate quantitative data on this energy source. The share of households using manure as a heating source, estimated using the expert approach, constitutes to 131,000 households - 60% of rural housing (228,507 households).

The pattern of fuel-energy resource consumption for heating purposes is the following:

1. The annual demand for thermal energy in residential sector equals to 11,149 thousand GCal, of which only 25.6% is supplied (2,859 thousand GCal).
2. The annual demand for thermal energy in municipal buildings is 1,369.1 thousand GCal. The heat supply of municipal buildings is on a higher level than in residential sector.
3. The administrative buildings in Yerevan and other cities, as well as the educational, healthcare and cultural facilities, have their own heat supply systems (boiler houses, or electric heaters).
4. In the industrial sector the administrative buildings are partially heated, in rare cases from their own boiler houses (“Nairit” factory, Yerevan TPP, etc.) and in other cases using electric heaters.

The growth of electricity (from NPP and HPPs) and natural gas final consumption in Armenia during 2001-2005 were 26.6 % (from 3,450 million kWh to 4,370 million kWh) and 11 % (from 1,494.6 thousand m^3 to 1,600 thousand m^3) accordingly. During that period,

consumption of fuel-energy resources has grown by 15.6 %, from 2,151.4 thousand tcf to 2,488.1 thousand tcf. For oil products the growth was 4.2 %, from 497.2 thousand tcf to 518.3 thousand tcf The average annual consumption of fuel-energy resources during the period of 2001-2005 was 521.9 thousands tcf

During the last five years the average annual growth of energy consumption was the following:

- Fuel-energy resources – 3.12 %
- Electricity – 5.32 %
- Natural gas – 2.2 %
- Oil products – 0.84 %

Because there is an absence of domestic hydrocarbon fuel resources, renewable energy is the only potential domestic energy source for Armenia. Therefore, there is no other alternative to the policy of increasing energy efficiency in the economy and the development of available renewable energy resources.

5. ENERGY SAVING PRIORITIES AND POTENTIAL IN ARMENIA

5.1. ENERGY SAVING PRIORITIES

1. According to the data on the fuel-energy resource consumption structure in 2005 (acquired through collection and analysis of energy passports from 62 large energy consumers from the Armenian Electric Networks CJSC, the ArmRusGasprom CJSC, and the National Statistical Service of Armenia) the priority sectors in which Armenia can save energy are the following:

- Production and distribution of electric and thermal energy
- Irrigation and drinking water supply
- Electric lighting
- Metal mining industry
- Non-metal mining industry
- Chemical production
- Communication
- Food production

2. The following table presents the major energy consumers by industry type.

Table 12. The major consumers, based on the sector of economic activity (annual data)

N	Name	Electrical energy mln. kWh	Natural gas, mln.m^3
1	Consumption of a household	1,440	310
2	Manufacturing industry, including: - chemical production - food industry - other	659.1 227 236 183.7	324.6 73.4 39.4 211.8
3	Electricity, natural gas, water production and distribution	428.6	620.1
4	Mining industry	371	26.7
5	Transportation and communication (except, auto transportation)	181.8	2.8
6	Autotransportation	-	93.7 (liquid gas- 2.05 thousand. ton,

			diesel fuel`-60.7 thousand tons petroleum – 187.7 thousand tons)
7	State management	168	6,3

3. Companies with highest energy intensity

Table 13. Companies with highest energy intensity

N	Name
1	Zangezur cupper molibdenium factory
2	Kapan cupper molibdenium factory
3	“Agarak” cupper molibdenium factory
4	Ararat gold mining company
5	“Masis Tabak”
6	“Nairit” factory
7	“Mika cement” factory
8	“Maqur Yerkat”
9	Armenian railway
10	“Armentel”
11	Armenian water supply and sewage company
12	“Grand tobacco”
13	“Ararat cement”

4. Energy intensive technologies

Table 14. Energy intensive technologies

N	Name
1	Ore breaking, crushing,and flotation
2	Metal melting
3	Clinker production
4	Electrical transportation

5. Energy stations and technologies of mass application

N	Name
1	Technological units with variable speed electric motors
2	Heat supply station
3	Electrical lighting stations
4	Thermal insulation of buildings
5	Transportation means

5.2. ENERGY SAVING POTENTIAL IN THE SECTORS OF ECONOMY

The natural development of society and the continuous scientific development improves technologies and materials, including fuel-energy systems. As time goes by, changing conditions provide an opportunity for new energy consuming systems. This opportunity also provides the prospect for improving the energy efficiency, including the development and application of new insulation materials, energy efficient converters, development of new flexible energy efficient control systems, high precision metering-testing systems, etc.

Appendices 1 and 2 present the structure of fuel-energy consumption mix and the specific consumption by the economy sectors. Based on these numbers, the technically feasible energy saving potential in all economic sectors was calculated – Appendix 3.

The motor fuel saving potential in the transportation sector for the year 2010 is estimated to vary from 293.4 TJ to 307.6 TJ, assuming a 20% to 30% vehicle fleet growth. The energy saving measures for this sector include optimization of routes, stations, and the number and operation of traffic lights, introduction of new energy efficient public transportation, replacement of old vehicles with newer, efficient vehicles, consumption of liquid and pressurized gas instead of diesel and petroleum, street improvements, construction of new connections, and an improvement in the population's driving skills.

The annual thermal energy consumption for residential heating purposes is 11.15 million GCal. With proper thermal insulation of buildings, thermal energy consumption can be decreased by 30%. In this case, thermal energy saving potential in residential sector is equal to 3.35 million GCal. The annual energy saving potential in municipal buildings as a result of improved thermal insulation is estimated to be 0.67 million GCal.

The fuel energy resource saving potential in the Armenian economy constitutes 1,008 thousand toe. (Table 12). The potential greenhouse gas emission reduction as a result of implementation of energy saving measures adds up to 1,279 thousand tons.

Table 15. Constituents of annual 1008 thousand toe energy saving potential in Armenian economy

N	ES Targets	ES potential	ES potential, 1000 toe	CO2 emission reduction, 1000 t
1	ES excluding transport and building heating systems	1,035,658 MWh	89.05	164.8
		84,734,000 m^3 (natural gas)	75.40	161.6
2	ES in transport sector	293.4 TJ	7.01	3.9
3	ES in buildings	4.02 mln GCal	402.00	2.3
4	ES in Yerevan TPP (new technologies)	265,000,000 m^3 (natural gas)	235.82	505.2
5	ES in Hrazdan TPP (new technologies)	223,000,000 m^3 (natural gas)	198.45	425.2
Total			1,007.73	1,278.5

6. ENERGY SAVING PROGRAM

6.1. TARGETS FOR ENERGY SAVING

Table 16. Priority sectors for energy savings

N	Energy saving targets	Energy saving potential
1	Reduction of energy consumption through utilization of gravity flow of water and introduction of new technologies (in drinking water pump stations)	15%
2	Reduction of electricity consumption in 10-year period through introduction of energy efficient lamps in lighting systems	475 million kWh
3	Decrease of relative energy consumption in mining industry through application of energy efficient machinery (large flotation machines and stone-breakers)	5%
4	Increase of energy efficiency in chemical industry through improvement of technological procedures and equipment	23%
5	Introduction of modern technologies and equipment in food industry	35 - 40 %

Table 17. Electricity production

N	Energy saving targets	Energy saving potential
1	Installation of new gas-turbine station with 210 MW capacity in Yerevan TPP which will result in fuel (natural gas) saving	Around 184÷ 265 million m^3 of natural gas
2	Reconstruction of 5^{th} unit of Hrazdan TPP, which will result in fuel (natural gas) savings	223 million m^3 of natural gas
3	Efficient production of electric and thermal energy through introduction of small (under 50MW), high efficiency cogeneration units, and reduction of energy losses in distribution networks through deep penetration of energy generation in consumer sector	56 thousand tcf
4	Application of renewable energy technologies through utilization of domestic resources, which will result in increased energy independence of the country	-
5	Introduction of new, and reconstruction of existing, automatic control systems in electricity generation stations	Up to 7%
6	Annual electricity and natural gas savings through application of efficient operation procedures in energy system	Up to 120 million kWh or up to 24 million m^3 of natural

		gas

Table 18. Copper, ore, canned food, rubber and metal industries

N	Energy saving targets	Energy saving potential
1	Operational-technical and other low-cost measures	Up to 18%
2	Short-term measures on regulation and improvement of existing technologies	52%
3	Design and application of new energy efficient technologies and equipment	30%

Table 19. Thermal energy production and heating systems

N	Energy saving targets	Energy saving potential (natural gas)
1	Energy saving through improvement and automatization of combustion process	2.4 million m^3
2	Energy saving through utilization of secondary energy sources	4 million m^3
3	Natural gas savings through improvement of thermal insulation of transmission pipline and substations and application of thermal insulation with the best thermophysical characteristics	27 million m^3
4	Natural gas savings through reduction of backflow water	6 million m^3
5	Achievemnt of savings through optimization of boiler-house operation process	20 million m^3
6	Achievement of savings through securing the proper pressure of natural gas supplied to the boiler-house	7 million m^3
7	Energy savings though improvement of insulation in electric, thermal, and nuclear power plants and application of insulation materials with the best thermal-physical characteristics	700 tcf
8	Natural gas saving through reduction of water losses and weatherization of valves	300 tcf
9	Natural gas saving through improvement of the operation of thermal substations	200 tcf
10	Reduction of thermal energy losses and natural gas saving through introduction of technical and commercial automatic control systems in heat-supply systems	76 thousand m^3

Table 20. Electricity distribution and transmission networks

N	Energy saving targets	Energy saving potential
1	Electricity savings through application of optimal procedures in 6-110 kV networks, improvement of transformers output and sources of compensating reactive power	26 million kWh
2	Electricity savings through optimal division of 6-110 kV networks	15 million kWh
3	Electricity savings through reduction of disparities of load schedule and introduction of double-tariff system	Around 17 million kWh
4	Electricity savings through improvements of electricity network (construction of new sub-stations, increase of wire section, construction of missing 0.38/0.22 kV wires, provision of symetric load, etc.)	32 million kWh
5	Electirc energy savings through increasing the load of power equipment	Up to 3.1 million kWh
6	Redustion of specific losses and increase of average load through application of flexible multilayer tariff system and leveling the daily load schedule in the network	3 million kWh
7	Reduction of commercial losses through application of automatic control system for the whole commercial accounting system	Up to 1-2% (estimated saving is around 60 million kWh)
8	Electricity savings and reduction of substation triggering through improvement of relay protection and automatic control systems	12 million kWh

Table 21. Gas supply system

N	Energy saving targets	Energy saving potential
1	Reduction of natural gas losses in the network and natural gas saving	51 thousand tcf
2	Modernization of underground gas storages	20 thousand tcf

Table 22. Thermal insulation of buildings

N	Energy saving targets	Energy saving potential
1	Thermal insulation of residential buildings	3.35 million GCal
2	Thermal insulation of municipal buildings	0.67 million GCal

Table 23. Transportation

N	Energy saving targets	Energy saving potential – fuel saving
1	20% increase of vehicle number	293.4 TJ
2	30% increase of vehicle number	307.6 TJ

6.2. CLASSIFICATION OF ENERGY SAVING MEASURES

When dealing with issues of targeted energy saving it is necessary to utilize the following classification requirements:

Table 24. Organizational-technical measures

1	Development of legislative field for energy saving, design of normative-technical documentation, design of regulations for implementation of energy audit, etc.
2	Promotion of energy saving foundations activities with the involvement of local and foreign financing resources
3	Provision of financial incentives for energy saving by the state and governmental bodies
4	Provision of targeted financial-crediting and tax incentives for implementation of energy saving measures
5	Organization of laboratories for certified testing in energy saving and renewable energy fields
6	Creation and development of energy saving and renewable energy revolving funds
7	Practical implementation and popularization of energy audit in energy consuming enterprises
8	Reduction of fuel-energy consumption through implementation of organizational-technical measures
9	Organization of the process of thermal insulation of buildings with the assistance of different funds, affordable loans, etc.
10	Organization of mandatory and voluntary certification process for energy saving production
11	Implementation of teaching, advertisement, and international cooperation in the field of energy saving
12	Improvement of fuel-energy price-setting mechanism, and introduction of payment system for reactive power
13	Provision of incentives for production of local thermal insulating materials with high characteristics

14	Collection of statistical data on state fuel-energy balance
15	Implementation of organizational and educational measures
16	Introduction of economic and moral (awards, medals, etc.) incentives for energy efficiency
17	Organization and implementation of energy audit during the design and planning stages
18	Organization of pilot projects, testing areas, and exhibitions in the field of energy saving and renewable energy
19	Promotion of new directions and inventions in the field of ES and RE (heat pumps, solar photovoltaic elements, hydrogen cells, etc.)

Table 25. Regulation and improvement of existing technologies

1	Improvement of heating systems in residential areas of Armenia
2	Improvement of street lighting system in residential areas of Armenia
3	Design, definition and provision of optimal parameters for optimal control of energy system
4	Reduction of fuel-energy resource losses in production, transmission and distribution processes through implementation of technical measures
5	Reduction of water losses in the network through modernization of water pipelines
6	Implementation of thermal insulation in the apartments
7	Glazing, repair and weatherization of doors and windows in the entrances of residential buildings
8	Introduction of energy saving systems in lighting systems of entrances (50 AMD/month per apartment)
9	Application of precise equipment (0.1-0.25 accuracy rating) in fuel-energy metering systems
10	Increase of quality and autoimmunization of fuel-energy resource and water metering systems
11	Compensation of reactive power
12	Utilization of secondary fuel-energy resources (5-10 % saving)
13	Reduction of losses in natural gas network (up to 2 times)
14	Modernization of commercial accounts in natural gas system
15	Control and meeting the requirements for electricity quality indices (~5 % saving of motor load)
16	Reduction of relative fuel-energy resource consumption in electricity production
17	Application of automatic control systems in heat supply, hot water supply and cooling systems

Table 26. Design and application of new energy efficient technologies and equipment

1	Design and introduction of efficient heat plans for residential areas of Armenia
2	Reduction of relative consumption of electricity in drinking water and irrigation system through introduction of modern pumps and automatic control systems
3	Electricity saving through application of gravity flow of irrigation water
4	Application of modern burners (6% potential)
5	Introduction of new energy efficient systems in Yerevan TPP
6	Modernization of 5^{th} unit of Hrazdan TPP
7	Application of thermal insulation materials with high physical-technical characteristics
8	Increasing the number of diesel vehicles, and reduction of the number of vehicles using carburetors
9	Application of heat pumps in HVAC systems
10	Utilization of solar energy in technological and thermal processes
11	Introduction of small-scale concentration energy systems
12	Renewable energy development

Table 27. Classification of energy saving measures by the technological energy systems

1	**Electric processes**
1.1	Electric power (motors – transformation of electricity into mechanical)
1.2	Thermoelectric (transformation of electricity into thermal)
1.3	Electro-technological (transformation of electricity into light , laser, etc)
1.4	Transformation of electricity (voltage control, transformation of direct current into alternating current, etc.)
1.5	Generation of electricity
1.6	Control, monitoring and accounting of electricity consumption
1.7	Introduction of new technologies for generation and distribution of electricity
2	**Thermal processes**
2.1	Production of thermal energy (cold)
2.2	Supply, distribution and transformation of thermal energy
2.3	Consumption of thermal energy in heat and jot water supply systems
2.4	Heat supply of buildings and constructions
2.5	Consumption of thermal energy during technological processes (melting, heating, etc.)
2.6	Low-potential heat extracting (secondary fuel-energy resources)

2.7	Control of combustion process
2.8	Control, monitoring and accounting of thermal energy consumption
2.9	Introduction of new technologies
3	Technological processes
3.1	Optimal control of technological processes
3.2	Implementation of technological process according to the design requirements
3.3	Decreasing the idling process
3.4	Introduction of new energy efficient technologies
3.5	Introduction of automatic control systems
3.6	Introduction of automatic measurement systems
3.7	Utilization of renewable energy resources

6.3.. ENERGY SAVING PROGRAM FOR THE ARMENIAN ECONOMY

Based on the provided information, Table 28 presents the energy saving programs along with the associated potential energy savings in different sectors of the Armenian economy. The information is presently separated by different activities in each sector. The "thousand m^3" unit refers to natural gas, and the "MWh" unit refers to electricity.

Table 28. Energy Saving Program for the Armenian Economy

N	Energy Saving measures, by the sphere of activity	Total energy saving potential			
		Natural volume		toe	%
		Unit	Value		
1	**Agriculture and provision of services (irrigation)**				
	Elimination of failures and improvement of technological processes, organizational measures, decrease of idling process	MWh	5,078	436.7	5.5
	Introduction of new energy efficient technological units and automation of electric drives	MWh	12,506	1,075.3	13.6
	Utilization of gravity flow in irrigation systems	MWh	40,360	3,470.3	44.0
Total				**4,982.3**	**58.9**
2	**Metal ore extraction**				
	Elimination of failures and improvement of technological processes, organizational measures, decrease of idling process	MWh	12,986	1,116.6	3.5
	Introduction of new energy efficient technological units and automation of electric drives	MWh	53,875	4,632.4	14.6
	Utilization of secondary energy resources	MWh	7,721	663.9	2.1
	Improvement of thermal insulation of furnaces and heating networks	1000 m^3	2,843	2,529.6	11.5
	Use of energy efficient electric lamps	MWh	381	32.7	0.1
Total				**8,975.2**	**16.7**
3	**Other branches of mining industry**				
	Improvement of thermal insulation of furnaces and heating networks	1000 m^3	18	16.1	1.0
Total				**16.1**	**0.9**
4	**Food production (including beverages)**				

N	Energy Saving measures, by the sphere of activity	Total energy saving potential			
		Natural volume		toe	%
		Unit	Value		
	Introduction of new energy efficient technological units and automation of electric drives	MWh	25,400	2,184.0	23.3
	Improvement of thermal insulation of furnaces and heating networks	1000 m^3	7,484	6,659.9	22.0
	Use of energy efficient electric lamps	MWh	11,058	950.8	10.1
Total				**9,794.7**	**24.7**
5	**Tobacco production**				
	Organizational measures	MWh	1,307	112.4	1.0
	Introduction of new energy efficient technological units and automation of electric drives	MWh	10,923	939.2	8.6
	Improvement of thermal insulation of furnaces and heating networks	1000 m^3	37	32.8	4.2
	Use of efficient fuel-energy resources	MWh	3,725	320.3	2.9
Total				**1,404.7**	**12.0**
6	**Textile production**				
	Introduction of energy efficient motors and new control systems and options	MWh	109	9.4	4.4
	Use of energy efficient electric lamps	MWh	457	39.3	18.5
Total				**48.7**	**10.8**
7	**Publishing and printing industry**				
	Use of energy efficient electric lamps	MWh	66	5.6	4.1
Total				5.6	4.1
8	**Chemical industry**				
	Elimination of failures and improvement of technological processes, organizational measures, decrease of idling process	MWh	11,688	1,005	5.1
	Introduction of new energy efficient technological units and automation of electric drives	MWh	29,800	2,562.3	13.1
	Improvement of thermal insulation in energy stations	1000 m^3	3,203	2,850.3	4.4
	Utilization of secondary energy resources	MWh	6,882	591.8	3.0
	Use of efficient fuel-energy resources	MWh	4,150	356.8	1.8
	Use of energy efficient electric lamps	MWh	213	18.3	0.1

N	Energy Saving measures, by the sphere of activity	Total energy saving potential			
		Natural volume		toe	%
		Unit	Value		
Total				**7,384.5**	**8.7**
9	**Production of rubber and plastic goods**				
	Organizational measures	MWh	60	5.2	0.8
	Introduction of new energy efficient technological units and motors	MWh	379	32.6	5.1
	Utilization of secondary energy resources	MWh	78	6.7	1.0
	Improvement of thermal insulation in energy stations	1000 m^3	1.2	1.1	1.5
Total				**45.5**	**6.4**
10	**Other, non-metal ore extraction**				
	Decrease of idling process and organizational measures	MWh	6,067	521.7	5.9
	Introduction of new energy efficient technological units and automation of electric drives	MWh	22,003	1,891.9	21.5
	Improvement of thermal insulation of furnaces and heating networks	1000 m^3	5,952	5,296.6	3.5
	Reactive power compensation	MWh	1,051	90.4	1.0
	Introduction of new control systems and options	MWh	3,314	285.0	3.2
	Use of energy efficient electric lamps	MWh	340	29.2	0.3
Total				**8,114.8**	**5.1**
11	**Metallurgical industry**				
	Decrease of idling process and organizational measures	MWh	1,601	137.7	5.8
	Introduction of new energy efficient technological units and automation of electric drives	MWh	2,677	230.2	9.7
	Improvement of thermal insulation of furnaces and heating networks	1000 m^3	4,047	3,601.4	11.2
	Application of diamond processing instruments	MWh	2,678	230.3	9.7
	Use of efficient fuel-energy resources	MWh	253	21.8	0.9
	Use of energy efficient electric lamps	MWh	1,858	159.8	6.7
Total				**4,381.1**	**12.7**
12	**Production of ready-made metal products**				
	Introduction of new energy efficient technological	MWh	42	3.6	1.5

N	Energy Saving measures, by the sphere of activity	Total energy saving potential			
		Natural volume		toe	%
		Unit	Value		
	units				
	Improvement of thermal insulation of furnaces and heating networks	1000 m^3	25	21.8	2.0
Total				**25.4**	**1.9**
13	**Production of machinery and equipment**				
	Decrease of idling process and organizational measures	MWh	317	27.2	2.5
	Introduction of new energy efficient technological units and automation of electric drives	MWh	840	72.2	6.6
	Application of diamond processing instruments	MWh	1,128	97.0	8.8
Total				**196.4**	**9.8**
14	**Production of electrical machines and equipment**				
	Decrease of idling process and organizational measures	MWh	101	8.7	0.5
	Introduction of new energy efficient technological units and automation of electric drives	MWh	1,556	133.8	8
	Improvement of thermal insulation of furnaces and heating networks	1000 m^3	291	259	10.4
	Use of efficient fuel-energy resources	MWh	365	31.4	1.9
	Application of diamond processing instruments	MWh	471	40.5	2.4
	Use of energy efficient electric lamps	MWh	2,283	196.3	11.7
Total				**669.6**	**16.0**
15	**Production of radio, TV and communication equipment**				
	Decrease of idling process and organizational measures	MWh	58	5	2.3
	Introduction of automatic metering for electricity	MWh	27	2.3	1.1
Total				**7.4**	**3.3**
16	**Other branches of industry**				
	Introduction of new control systems and options	MWh	181	15.5	3.2
	Improvement of thermal insulation of furnaces and heating networks	1000 m^3	5	4.2	3.0
Total				**19.8**	**3.1**
17	**Production and distribution of electricity, natural gas, hot water and vapor**				

N	Energy Saving measures, by the sphere of activity	Total energy saving potential			
		Natural volume		toe	%
		Unit	Value		
	Elimination of failures and improvement of technological processes, organizational measures, decrease of idling process	MWh	24,972	2,147.2	9.1
	Introduction of new energy efficient technological units and automation of electric drives	MWh	42,495	3,653.9	15.5
	Installation of gas turbine units in TPPs	1000 m^3	488,000	434,274.1	78.7
	Improvement of thermal insulation of furnaces and heating networks; decrease of losses in gas distribution system	1000 m^3	57,936	51,557.4	9.3
	Reactive power compensation	MWh	15,088	1,297.3	5.5
	Introduction of automatic metering for electricity	MWh	5,898	507.1	2.2
	Use of secondary energy and efficient fuel-energy resources	MWh	5,935	510.3	2.2
	Valve system improvement	MWh	2,850	245.1	1.0
Total				**494,192.5**	**85.9**
18	**Accumulation, purification and distribution of drinking water**				
	Elimination of failures and improvement of technological processes, organizational measures, decrease of idling process	MWh	4,683	402.7	3.0
	Introduction of new energy efficient technological units and automation of electric drives	MWh	68,087	5,854.5	43.9
	Introduction of energy efficient motors	MWh	4,849	417	3.1
	Reactive power compensation	MWh	2,865	246.3	1.8
	Introduction of automatic metering for electricity	MWh	4,714	405.4	3.0
	Utilization of gravity flow in drinking water system	MWh	13,098	1,126.2	8.4
	Valve system improvement	MWh	4,863	418.2	3.1
Total				**8,870.3**	**66.5**
19	**Construction**				
	Introduction of energy efficient motors	MWh	45	3.9	1.8
	Organizational measures	MWh	49	4.2	2
Total				**8.1**	**0.2**
20	**Car trading, maintenance and repair**				

N	Energy Saving measures, by the sphere of activity	Total energy saving potential			
		Natural volume		toe	%
		Unit	Value		
	Introduction of new energy efficient technological units	MWh	2,217	190.6	4.6
	Decrease of idling process and organizational measures	MWh	4,532	389.7	9.4
Total				**580.3**	**0.7**
21	**Retail sale**				
	Use of energy efficient electric lamps	MWh	559	48	11.4
Total				**48**	**4.2**
22	**Hotels and restaurants**				
	Valve system improvement	MWh	256	22	2
	Improvement of thermal insulation	1000 m^3	141	125.2	4.9
	Use of energy efficient electric lamps	MWh	1,049	90.2	8.2
Total				**237.5**	**6.5**
23	**Ground transportation**				
	Decrease of idling process	MWh	1,658	142.6	1.7
	Introduction of new energy efficient technological units	MWh	4,067	349.7	4.2
Total				**492.3**	**5.8**
24	**Air transportation**				
25	**Communication**				
	Organizational measures	MWh	1,393	119.8	2
	Introduction of new energy efficient technological units	MWh	15,200	1,307	22.1
	Use of energy efficient electric lamps	MWh	7,276	625.6	10.6
Total				**2,052.4**	**32.7**
26	**Financial intermediation**				
27	**Real estate operations**				
28	**Research and development**				
29	**State governance**				
	Decrease of idling process	MWh	1,685	144.9	1

N	Energy Saving measures, by the sphere of activity	Total energy saving potential			
		Natural volume		toe	%
		Unit	Value		
	Introduction of new energy efficient technological units	MWh	8,801	756.8	5.2
	Use of energy efficient electric lamps	MWh	8,778	754.7	5.2
Total				**1,656.4**	**8.2**
30	**Education**				
	Improvement of thermal insulation	1000 m^3	373	331.6	6.1
	Valve system improvement	MWh	171	14.7	2.9
Total				**346.3**	**5.8**
31	**Healthcare and provision of social services**				
	Decrease of idling process	MWh	2,701	232.3	4.6
	Automation of electric drives	MWh	3,174	272.9	5.4
	Improvement of thermal insulation	1000 m^3	2,380	2,118.2	28
	Use of energy efficient electric lamps	MWh	2,819	242.4	4.8
	Valve system improvement	MWh	1,101	94.6	1.9
	Use of efficient fuel-energy resources	MWh	2,349	202	4
Total				**3,162.4**	**25.1**
32	**Activities of social units**				
	Decrease of idling process	MWh	13,721	1,179.8	2
	Automation of electric drives	MWh	24,269	2,086.7	3.5
	Use of energy efficient electric lamps	MWh	135,524	11,653	19.6
Total				**14.919.5**	**15.9**
33	**Residential sector**				
	Use of energy efficient electric lamps	MWh	302,946	26,048.6	21
Total				**26,048.6**	**6.5**
34	**Leisure and cultural activities**				
	Valve system improvement	MWh	128	11	1
	Use of efficient fuel-energy resources	MWh	378	32.5	3.1
Total				**43.5**	**2.7**
35	**Foreign companies activities**				

N	Energy Saving measures, by the sphere of activity	Total energy saving potential			
		Natural volume		toe	%
		Unit	Value		
TOTAL: ELECTRICITY		**MWh**	**1,035,658**	**89,051**	**5.4168**
TOTAL: NATURAL GAS		**1000 m^3**	**572,734**	**509,679**	**31.003**
TOTAL IN ALL SPHERES OF ACTIVITIES				**598,730**	**36.4**

7. ENERGY SAVING PROJECTIONS

The annual energy saving potential of Armenian economy is estimated to be 1 million toe., of which about 16.5 % is the share of major economy sectors (excluding the expected installation of modern equipment in TPPs, thermal insulation of buildings, and modernization of vehicle fleet). Through implementation of thermal insulation, it will be possible to utilize 40% of the energy saving potential, and with the installation of modern equipment in TPPs, this figure will increase to 43.4 %:

Assuming equal utilization of energy saving potential during the period of 2006-2020, and using the MAED software, 3 scenarios were analyzed:

- Pessimistic scenario with 30% utilization of energy saving potential
- Average scenario with 65% utilization of energy saving potential
- Optimistic scenario with 100% utilization of energy saving potential.

The GDP growth is presented the following way: 6% growth in 2006-2009, 5.5% in 2010, and 5 % in the year 2011-2020, according to the energy sector development strategy (Government decision from 23.06.2005).

During the calculation period (2006-2020) the fuel-energy consumption according to the aforementioned scenarios will be 48.2, 43.3 and 38.4 million toe, and the energy efficiency of GDP will accordingly be 1.042, 1.16 and 1.398 thousand AMD/kg oe, which means that compared to the year 2005 it will grow 1.09, 1.21, and 1.36 times correspondingly.

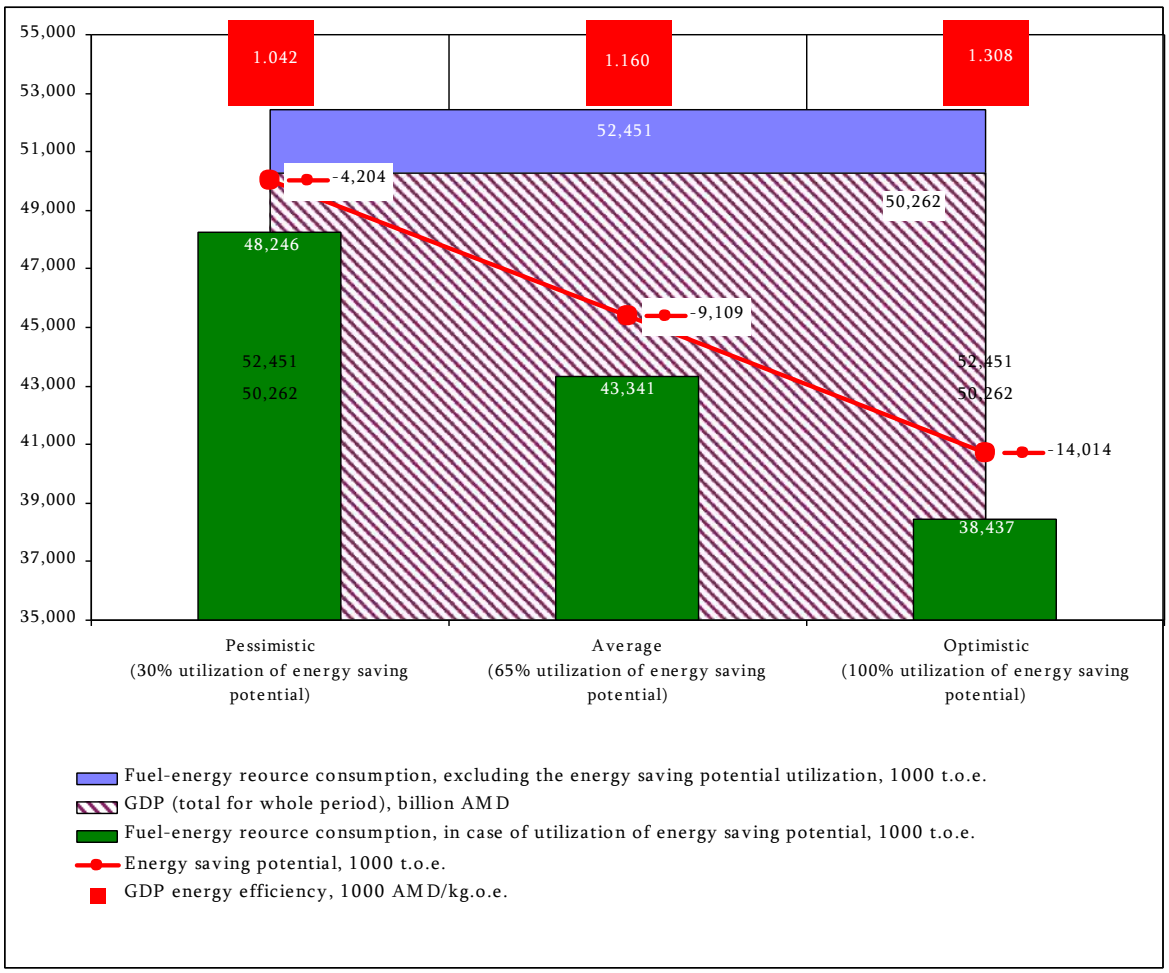
The forecasting results are presented in Tables 29 and 30.

Table 29. Combined data on utilization of energy saving potential for 2006-2020 period

Annual GDP growth, 6% (2006-2009.), 5.5% (2010.), 5% (2011-2020.) Energy saving Maximum potential - 1001 thousand toe/year."				
Name	**Measurement unit**	**Energy saving options**		
		Pessimistic **(30% utilization of energy saving potential)**	***Average*** **(65% utilization of energy saving potential)**	***Optimistic*** **(100% utilization of energy saving potential)**
GDP (cumulative for the whole timeline)	bln. Amd	50,262	50,262	50,262

Consumption of fuel energy resources, without utilization of energy saving potential	thousand toe	52,451	52,451	52,451
Consumption of fuel energy resources, with utilization of energy saving potential	thousand toe	48,217	43,278	38,339
Energy saving potential	thousand toe	-4,234	-9,173	-14,112
Energy efficiency of GDP	thousand AMD/ kg oe	1.042	1.161	1.311

Figure 11. Combined data on utilization of energy saving potential for 2006-2020 period



8. RENEWABLE ENERGY POTERNTIAL IN ARMENIA

8.1. HYDROEELECTRIC POTENTIAL

Table 30. Main energy and technical characteristics of small HPP' s by the water sources (potential calculated fro 1997)

N	Name of water reservoir	Number HPP-s units	Total installed capacity, kW	Average yearly production *mln. kWh*	Level, m		Static pressure m	Designed expenses m^3/s	Total water flow through HPPs, min. m^3
					max	min			
1	2	3	4	5	6	7	8	9	10
1	r. Debet	79	35,501	123,47	2,075	635	1,440	0,12 - 2,8	682,09
2	r. Aghstev	67	58,270	159,27	1,725	610	1,115	0,3 - 4,5	958,5
3	r. Akhuryan	14	24,985	79,75	2,500	1,109	1,381	0,5 - 29	653,1
4	r. Qasakh	14	7,905	19,16	2,805	2,055	750	0,6 - 1,8	117
5	r. Hrazdan	13	9,070	27,37	2,225	1,490	735	0,5 - 4,0	188,1
6	Lake Sevan	20	22,965	66,03	2,760	1,960	800	0,6 - 4,0	262
7	Azat and Vedi rivers	20	18,215	56,15	2,455	1,310	1,145	0,7 - 2,6	394,5
8	r. Arpa	26	35,410	88,58	2,523	1,165	1,358	0,26 - 4,8	593,7
9	Meghri and Vokhchi rivers	52	21,245	72,63	2,960	690	2,270	0,3 - 6,0	803,5
10	r. Vorotan	8	9,800	44,97	2,208	1,440	768	0,5 - 11,6	263,4
11	**Total**	**313**	**243,366**	**737,38**					

Before 2020, it is expected that the Meghri HPP with 140 MW capacity and the Loriberd HPP with 60 MW capacity will be built with cumulative generation of 1,012 million kWh/year.

8.2. BIOGAS POTENTIAL

Table 31. Production of biogas for the period 2006-2020

Source of biogas	Volume of investments million USD	Yearly volume of biogas, mln. m^3/year	Yearly saving of organic fuel thousand tcf	Payback period, year	Decrease in greenhouse gas emissions, thousand ton CO_2/ year	The ratio of yearly fuel savings and investments, thousand tcf/mln. USD
Cattle manure from farms	0.73	1.06	0.83	8	15.57	1.15
Pig manure from farms	0.21	0.3	0.24	8	4.41	1.15
Excrement from poultry farms	16.55	9.79	7.69	8	206.84	0.46
Nubarashen city land fill	6.83	9.72	7.62	8	135.0	1.12
Land fills of other Armenian cities	3.85	5.47	4.29	8	76.08	1.12
Clean-up of sewage	6.01	12	9.43	8	106.7	1.57
Total	**34.17**	**38.34**	**30.10**		**544.6**	

8.3. SOLAR ENERGY POTENTIAL

Table 32. Annual solar radiation indices, kWh/m^2

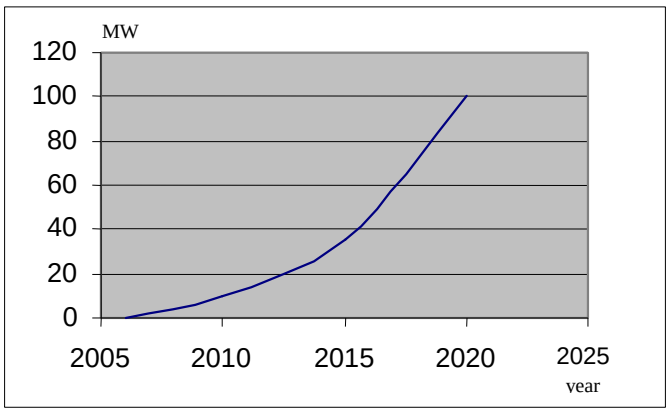
Area	Radiation index
Yerevan	1,647.2
Kalinino	1,404
Gyumri	1,624
Sevan	1,670
Martuni	1,740
Jermuk	1,682
Kochbek	1,786.4
Kapan	1,647.2

Total	13,200.8

The investment cost for a solar photoelectric power plant in Armenia is around $2,520 USD for 1 kW capacity. The technically and economically justified solar energy capacity under 100 MW can be utilized before the year 2020, with total $ 250 million USD investment program.

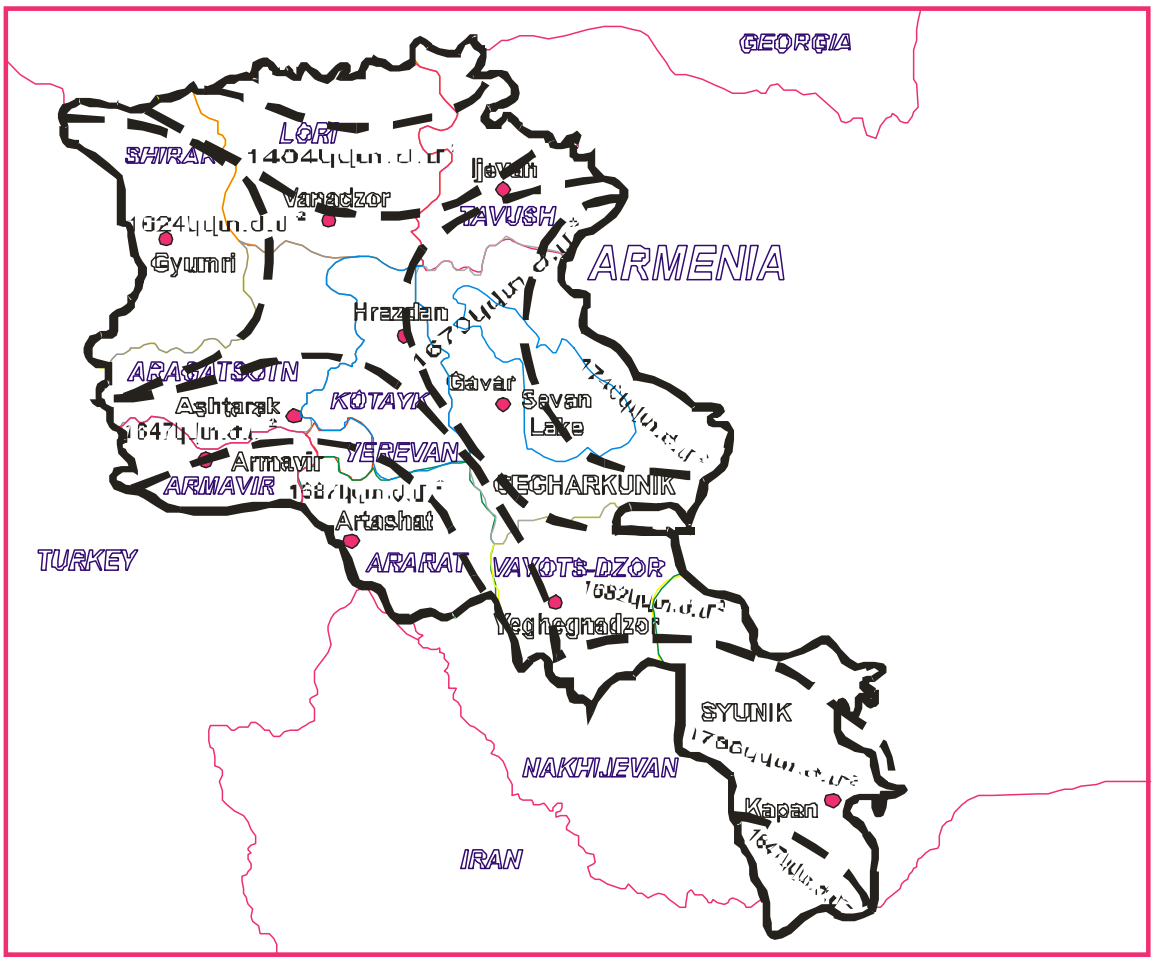
Considering the payback period for solar energy plants to be 13.5 years (for $0.07 USD/kWh tariff), and taking into consideration the 25% cost reduction during a 10-year period due to technological progress, then the growth of solar energy can be presented the following way: before 2010 – 10 MW, 2015 – 25 MW, and 2020 – 65 MW.

For a solar energy plant with 100 MW power capacity the annual electricity generation will be 270 million kWh, reducing the yearly CO_2 emissions by 42,960 tons.



Source: *Energy for future: Second renewable energy conference materials, 2005.*

Figure 12. Solar energy potential in Armenia



Source: Energy for future: Second renewable energy conference materials, 2005.

8.4. HYDROTHERMAL ENERGY POTENTIAL

Table 33. Hydrothermal energy potential

N	Area	Low potential t < 100°C	High potential t > 100°C	Depth, m	Thermal potential, 1000 GCal/year
1	Jermuk	64		>300	12.7
2	Jermuk	47.5			
3	Hanqavan	42		>400	20
4	Hanqavan	36			
5	Arzaqan	54	-	>800	5.5
6	Martuni	52	-	>800	22
7	Sisian*	45		1,100	101
8	Sisian	37			
9	Sevaberd	83	-	3,100	25.2**
10	Azatavan	42		2,600	**
11	Mkhchyan	-	-		0.6
12	Kechut	31.6			
13	Artashat	41			**
14	Ptghni	60			
15	Yerevan area	79		2,500	0.49 million GJ
16	Yerevan area	70		2,400	
17	Yerevan area		110-125	4,000	
18	Jermaghbyur		115-310	1,000-2,500	>

* investigation process not finished

** high concentration of minerals

8.5. DISTRIBUTION OF WIND POWER POTENTIAL IN ARMENIA

Table 34. Wind power potential

	Area	Design capacity, W/m^2	Strength of the wind, * m/s	Area of the zone **, km^2	Collective capacity of wind power generators,

					MW
1	Qarakhach mountain pass	300 – 400	6.5 – 7.0	-	
2	Pushkin mountain pass	500 – 600	7 – 8.0	-	2.5
3	Jajur mountain pass	200 – 300	5.0 – 5.6	-	
4	Sevan western mountain range	300 - 450	5.8 – 6.0	-	
5	Aragats	400 – 450	7.0 – 7.5	-	
6	Geghama mountain range	200 – 300	5.8 – 6.8	-	
7	Zodi area	500 – 600	7.5 – 8.0	-	20
8	Sisian-Goris	300 – 400	6.8 – 7.0	-	
9	Sisian mountain range	200 – 300	5.6 – 6.5	-	
10	Meghri area	400 – 450	7.5 – 7.8	-	

* Wind speed is presented 50 m height

** N/A

The cost of installed power capacity of wind power plants is around $1,000 - $1,300 USD per kW.

In order to have 100 MW wind power capacity installed before 2020, it is necessary to invest $100-130 million USD.

The growth of wind power can be presented the following way: year 2010 – 26 MW, 2015 – 45 MW, and 2020 – 29 MW.

9. FINANCIAL MECHANISMS FOR IMPLEMENTATION OF THE NATIONAL PROGRAM ON ENERGY SAVING AND RENEWABLE ENERGY

Having adopted the EU policy on development of energy saving and renewable energy, the Republic of Armenia is going to gradually adopt the most successful and widely applied economic mechanisms in this sphere. The main attention in the beginning of the program will be paid to the search for financial sources for investments as well as provision of incentives for market-oriented mechanisms.

The Government of Armenia will come up with proposals for application of the following economic mechanisms:

Table 35. Economic mechanisms for implementation of National Program

N	Name	Financial sources	Overview
1	Taxes imposed on energy carriers	Taxes imposed on the following energy carriers: – Diesel fuel for transport – Natural and liquid oil gas for transport – Natural gas for heat supply – Fuel resources for boiler houses and mazut (residual fuel-oil) – Liquid oil gas and kerosene for heat supply – Electricity	The list of taxes imposed on energy carriers is harmonized with the similar taxes applied in EU. Discussions will be organized on the minimal sizes of such taxes and their duration. The budget inflows acquired from these taxes will be analyzed. In order to avoid double taxing, these taxes should be imposed on end-users.
2	Energy Saving and Renewable Energy Fund of Armenia	– Energy carrier taxes – Budget allocations – Assistance from the international financial institutions	The Fund is proposed as the main source of financing for the projects under the National Program. The activities of the Fund are conducted according to the governmental normative-legal acts and with the immediate participation of the Government of Armenia.
3	Energy audit for sector-based developmental programs, as well as for the national and socially	– Budget allocations	Provision of grants and allowances should be limited. The grants and allowances should be targeted to diffusion of new technologies and materials in the market and overcoming the market entry barrier. Improper application of this mechanism

N	Name	Financial sources	Overview
	targeted programs		may lead to the distortion of people's understanding of the market price for goods and services.
4	Provision of credit lines by international financial institutions	– EBRD – World Bank – IMF – KfW – Global Ecological Fund, etc.	Successful implementation of projects, especially in the beginning, largely depends on assistance from international financial institutions. The negotiations on provision of credit lines will be significantly intensified.
5	Technical assistance programs	EU and USAID sponsored technical assistance programs from	The priority areas of assistance include development of national and social programs, organization of marketing research, education of specialists, and implementation of advertisement measures.
6	Loans from Revolving Fund	Energy Saving and Renewable Energy Fund of Armenia	The Fund should have a low interest rate in order to attract clients. The main idea of such funds' operation is provision of loans that are repaid with funds saved through energy saving. The repaid funds are used for financing new projects. There is a mandatory requirement for commercial institutions to co-finance the projects.
7	Energy examination	Energy Saving and Renewable Energy Fund of Armenia	The energy audit will serve as a criterion for receiving funds from the Energy Saving and Renewable Energy Fund. The application should correspond to the requirements of Ordinance on Conducting Energy Examination. Additional requirements should include techno-economic assessment with detailed discussion of expected results and cash flows.
8	Mechanism of partial subsidizing of interest rates of commercial loans	Energy Saving and Renewable Energy Fund of Armenia	This mechanism will ensure participation of commercial banks in financing the energy saving and renewable energy projects, will increase the authority of such projects, and also broaden the financing possibilities.
9	ESCOs	Co-funding ESCOs from the Energy Saving and Renewable Energy Fund of Armenia	Application of this mechanism is market driven. The ESCOs will serve as the project initiators, investors and implementers, bearing all the investment

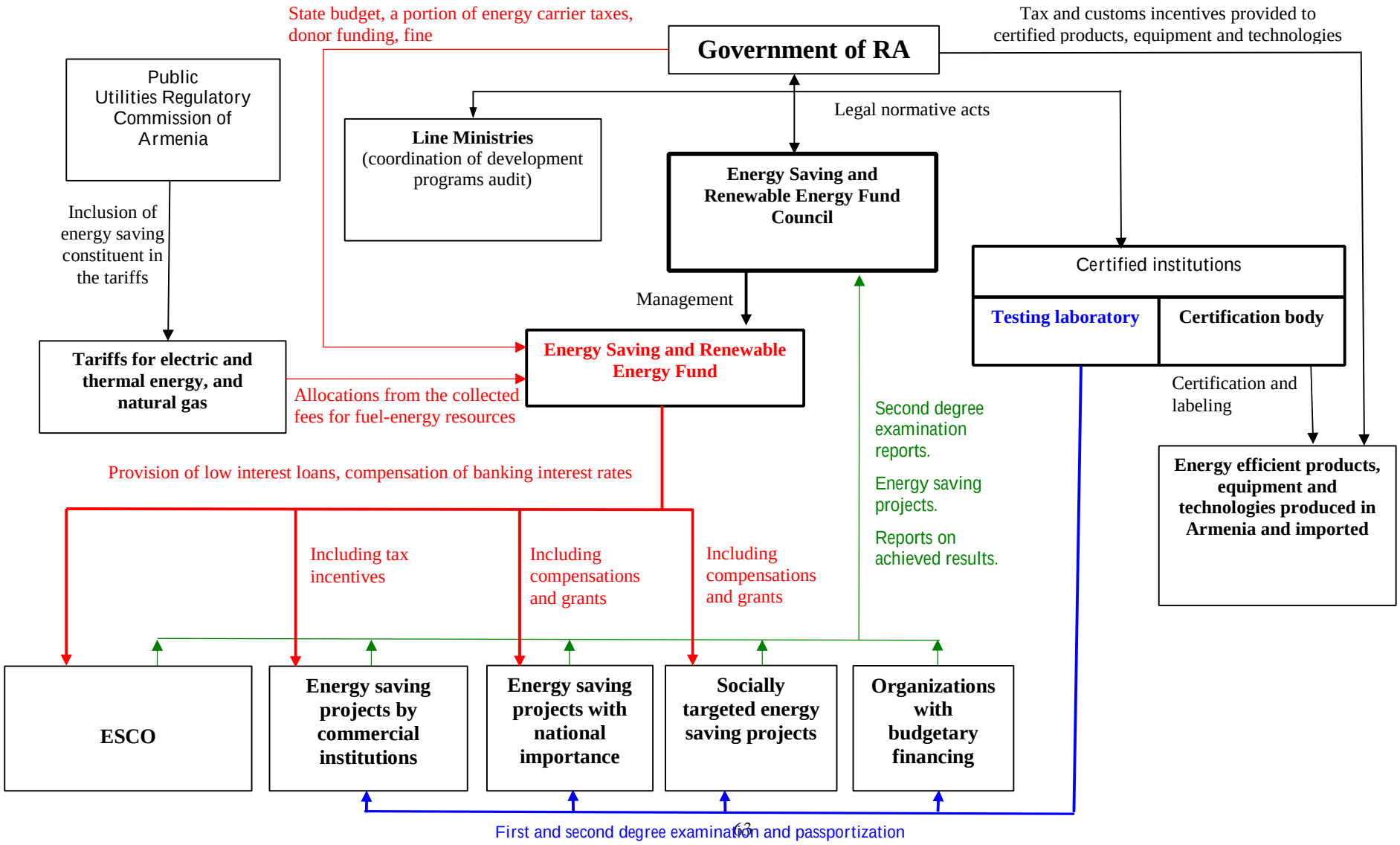
N	Name	Financial sources	Overview
			risks. The return of investments will be done through future energy savings. During the initial stage of this mechanism there should be a co-funding of ESCOs from the Energy Saving and Renewable Energy Fund through provision of loans.
10	Low-budget projects	ESCOs	Low-budget projects are not attractive enough for banks. Such projects should be implemented in bundle packages. The funding should be done using the mechanism described in the 9th row of this table.
11	State (fiscal) mechanisms, "diverted taxes"	– Taxes imposed on energy carriers – Nature protection taxes	Along with the taxes described in previous rows, tax incentives – "diverted taxes" should be provided, in order to promote energy saving. A part of the budget inflows acquired from the energy carrier taxes (electricity and natural gas) should be directed to the Energy Saving and renewable Energy Fund. The other part should be targeted to compensation of tax incentives. The most appropriate mechanism is provision of profit tax incentives, based on temporary decrease of income tax on the monetary amount of energy, saved as a result of implementation of energy saving measures.
12	Voluntary agreement mechanism	Tax incentives	The purpose of this mechanism is to guarantee achieving energy efficiency indices, technology development, etc. As a compensation for their work, the companies may receive temporary tax incentives. Agreements should be signed between the Government (ministries) and the companies. The applicant should decide the amount of investments and will bear all the investment risks. The role of the State is to alleviate those risks.
13	Provision of incentives to producers and	Tax incentives	Tax incentives should be provided to producers and importers of energy saving and renewable energy technologies,

N	Name	Financial sources	Overview
	importers of energy saving and renewable energy technologies, equipment and materials		equipment and materials. There should be a mandatory certification of such technologies, equipment and materials by a certified institution, in compliance with the Law of Armenia on Compliance Appraisal.
14	State procurement mechanism	State budget	The mechanism of state procurement can support the distribution of new technologies in the market and decrease the prices. The normative documents regarding the state procurement should be modified to include regulations on energy efficiency indices. Positive outcomes of this mechanism include: – Purchasing energy efficient products will save funds that can be targeted to other investments into energy efficiency, – The state will provide information on positive results of energy efficiency measures to the public, – State procurement will lead to significant increase of demand and may also lead to application of new technologies. The state and local government bodies should develop projects and implement measures, including procurement policy, for utilization of energy efficient technologies, equipment and materials.
15	Involvement of private capital through privatization		The Government of Armenia considers different schemes for privatization or leasing of the projects and adopted technologies, funded with loans from international financial institutions. This mechanism will increase private capital involvement opportunities through decreasing a number of risks associated with the implementation of projects.
16	Assistance to implementation		The Government of Armenia will promote implementation of collaborative projects.

N	Name	Financial sources	Overview
	of collaborative projects		Such projects result in efficient collaboration between developed and developing countries. Special attention is paid to assisting projects aimed at environment protection with the application of Kyoto Protocol and the clean development mechanism.

The scheme of possible incentive mechanisms for energy saving is presented in Figure 13.

Figure 13. Scheme of possible incentive mechanisms for energy saving



10. ORGANIZATIONAL MECHANISMS OF NATIONAL PROGRAM

10.1. PROPAGANDA

Organization of public outreach and wide informational-educational work of mass media play a significant role in development of energy saving and renewable energy overcoming the market entry barrier for efficient technologies, equipment and materials, providing information to the public on supply and demand, and developing a of positive public opinion.

1) Main purpose of informational-educational work:
   a) Media coverage of responses received from the state and local government bodies, as well as from public and commercial organizations on the energy saving and renewable energy development issues,
   b) Media coverage of state policy and implementation mechanisms,
   c) Formation of public opinion on implementation of specific measures,
   d) Educational and advertisement activities.

2) In order to achieve aforementioned goals it is necessary to solve the following issues:
   a) Continuous analysis of public opinion and the socio-psychological environment,
   b) Continuous analysis of international experience, available technologies, equipment, and materials in the field for energy saving and development of renewable energy resources,
   c) Analysis of results acquired from implementation of energy saving measures and development of renewable energy resources projects, taking into consideration market trends on the technologies, equipment and materials,
   d) Formation of positive public opinion on price formation and modernization issues in the field of energy saving and renewable energy resource development,
   e) Dissemination of information on legal basis and opportunities on implementation of energy saving and renewable energy resource development projects, as well as their results, to the general public.

   In order to achieve the aforementioned goals it is necessary to involve mass media (newspapers, magazines, radio, television), as well as publish and disseminate in general public booklets, brochures and leaflets, that will ensure the public nature of the proposed goals.

3) Funding sources for the proposed informational-educational work include:
   a) USAID, EU and other technical assistance programs,
   b) Special expenditure lines in loans received from international financial institutions,

c) Grants from the State Budget, humanitarian programs, etc.

d) Allocations from the Energy Saving and Renewable Energy Fund,

e) Other sources.

4) Methodology of the informational-educational work is based on:

Operative work

a) Analysis of critique and advices received from the publications, messages and mass media,

b) Analysis of market trends, the demand and supply indices,

c) Analysis of public opinion,

d) Media coverage of operative information from mass media programs and other projects.

Media coverage

e) Organization of international and national scientific and practical educational seminars and congresses,

f) Organization and participation in international exhibitions,

g) Media coverage of international news on energy saving and renewable energy development,

h) Media coverage of state policy in the sphere of energy saving and renewable energy development, the goals of this Program, and the public opinion,

i) Media coverage of ecological issues of energy saving,

j) Media coverage of results achieved in certain projects,

i) Promotion of affordable technologies, equipment and materials in domestic markets,

ii) Promotion of efficiency of projects available for the public (energy efficient lamps, domestic equipment, thermal insulation of apartments, etc),

iii) Agitation and advertisement measures,

iv) Implementation of pilot projects in the sphere of energy saving and renewable energy development, and their promotion,

v) Publishing of annual reports on energy saving and renewable energy development of stakeholder ministries and other state bodies,

vi) Production and dissemination of video clips on technologies, equipment and materials available in domestic market,

vii) Establishment of internet site devoted to energy saving and renewable energy development, providing an interactive communication option with the visitors, production of informational materials for children “Energy Saving for Children”

viii) Provision of affordable coverage on issues and trends in energy saving and renewable energy development to the broad public; publishing and free

distribution of brochures, booklets and notes, as well as special literature for kids on energy saving and renewable energy, etc.

10.2. EDUCATION

The preparation of specialists in the field of energy saving will be targeted to implementation and development of tasks mentioned in the Article 10 of the law on Energy Saving and Renewable Energy of Armenia.

It is proposed to develop a multi-level educational system in the field of energy saving for preparation of specialists, with an open education system approach.

1) Improvement of manpower development mechanism:
   a) Development of Energy Efficient Technologies and Energy Management subject in the department of Energy of the State Engineering University of Armenia,
   b) Development and improvement of educational material on energy efficient buildings and constructions for the faculty of the Yerevan State Architectural University,
   c) Development of educational system in renewable energy field,
   d) Development of educational system in environmental field (for energy specialists),
   e) Development and improvement of educational programs, laboratory practices, and trainings for specialists,
   f) Increase of proficiency of energy saving specialists in different spheres of economy and different social environments,
   g) Establishment and modernization of energy examination certified testing laboratories,
   h) Organization of seminars and congresses on energy saving, renewable energy and environmental issues,
   i) Organization of educational programs for national specialists abroad,
   j) Introduction of new subjects on energy saving, renewable energy and environmental issues in schools,
   k) Organization of open classes on energy saving, renewable energy and environmental issues,
   l) Introduction of elective courses on energy saving, renewable energy and environmental issue sin educational systems,
   m) Organization of educational trips to energy objects,
   n) Organization of Marz and city-level competitions in the field of energy saving, renewable energy and environment protection, etc.

10.3. STATISTICS

The collection and analysis of statistical data will be aimed at implementation of measures proposed in Article 9 of the Law on Energy Saving and Renewable Energy of Armenia.

Conduct accounting of extraction, production, import, processing, transformation, distribution, storing and consumption of energy resources and development of energy balances is done by the National Statistical Service.

According to the requirements of the International Energy Agency, the energy balance should have the following structure:

1) Fuel-energy resources:
    a) Natural thermal resources,
    b) Wood,
    c) Oil (including the gas condensate),
    d) Natural gas,
    e) Underground gasification gas,
    f) Natural energy resources,
    g) Hydro energy,
    h) Nuclear energy
    i) Geothermal energy,
    j) Products of fuel processing,
        i) Diesel fuel,
        ii) Petroleum,
        iii) Kerosene,
        iv) Dry gas from oil processing,
        v) Liquid gas,
        vi) Domestic stove fuel,
        vii) Mazut (residual fuel-oil),
        viii) Motor fuel,
        ix) Electricity,
    k) Pressurized air,
        i) Thermal energy (vapor and hot water)
2) Supply structure:
    a) Own supplies,
    b) Import,
    c) Export,
    d) Storing,

3) Transformation structure:
    a) Electricity,
    b) Thermal energy,
4) Losses:
    a) Electric system,
    b) Gas system,
    c) Heat supply system,
5) Consumption structure:
    a) Industry,
    b) Ferrous and copper metallurgy ,
    c) Chemical and oil industry,
    d) Non-ferrous metallurgy,
    e) Non-metal minerals (non-ore fossils),
    f) Transportation equipment,
    g) Machinery,
    h) Lode discovery and processing,
    i) Food and tobacco production,
    j) Paper, cellulose and publishing,
    k) Wood production,
    l) Construction,
    m) Textile and leather production,
    n) Other industry types.
6) Transport:
    a) International airlines,
    b) Domestic airlines,
    c) Long-range transportation,
    d) Railway transport,
    e) Pipelines,
    f) Domestic shipping,
    g) Other transport,
7) Other sectors:
    a) Agriculture,
    b) Commercial and public service,
    c) Real estate, Etc.

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APPENDIX A. STRUCTURE OF FUEL-ENERGY RESOURCE CONSUMPTION BY MAJOR CONSUMERS

N	Economic activity sector		2005 consumption of fuel-energy resources		
	Name of the sector	Sector code	Electricity, thousand kWh	Natural gas thousand m3	Fuel, toe
1	2	3	4	5	6
1	Agriculture, hunting and forest economy	01-02	286,826.8	638.4	0.0
2	Mining Industry	10-14	370,959.8	26,664.6	10,682.4
3	Manufacturing Industry	15-37	649,128.0	320,082.7	1,572.8
3.1	Food Industry, including beverage and tobacco production	15-16	236,646.1	34,928.0	656.0
3.2	Textile and clothing industry	17-18	2,472.5	265.6	0.0
3.3	Production of paper and card board, publishing work		1,583.6	0.0	0.0
3.4	Chemical industry	24.0	227,585.6	73,393.4	185.6
3.5	Production of rubber and plastic products	25.0	7,465.0	78.5	0.0
3.6	Productions of other non metal mining	26.0	102,342.1	170,054.8	365.8
3.7	Metal industry, and production of metal products	27-28	30,462.1	37,390.3	275.8
3.8	Automobile and equipment production	29.0	12,780.0	1,007.9	0.0
3.9	Production of electric, electronic and optical equipment	30-33	22,079.0	2,805.7	32.9
3.10	Other sectors of economy	36-37	5,711.8	158.5	56.7
4	Production and distribution of electricity, gas, and water	40-41	428,623.6	620,115.1	28.3
5	Construction	45.0	2,455.7	3,449.1	0.0
6	Commerce, repair of automobiles, consumer and personal use products	50-52	53,130.2	94,694.9	0.0
7	Hotels and Restaurants	55.0	12,795.4	2,861.7	0.0
8	Transportation and communication	60-64	181,785.0	2,848.3	252.0
9	Financial activity	65-67	1,411.9	377.0	0.0
10	Activities connected with real estate, property rental and customer services	70-74	7,456.0	783.0	0.0
11	State Management	75.0	168,541.0	6,305.1	0.0
12	Education	80.0	5,898.3	6,082.6	0.0
13	Health care and social services	85.0	58,701.2	8,491.6	112.6

14	Provision of public, social, and individual services	90-93	2,145,057.0	349,613.4	0.0
15	Activities of foreign organizations	99.0	1,535.7	531.4	0.0
16	TOTAL		4,374,305.6	1,443,538.9	12,648.1

APPENDIX B: RELATIVE CONSUMPTION OF FUEL-ENERGY RESOURCES IN VARIOUS SECTORS OF ECONOMY

N	Economic activity, type of production	Sector code	Relative expenses of electricity thousand kWh/AMD (1)	Consumption of electricity for 1 unit of production(in natural appearance)			Electricity consumption for1 unit of production KWh, best existing technologies used (4)	Relative consumption of boiler fuel		Consumption of motor fuel for 1 unit of production (in natural appearance) 2005 actual data kg cf(3)	Consumption of fuel energy resources for 1 unit of production (in natural appearance) kg cf		Description
				Measurment unit	based on reference books (2), kWh	Actual data (3), kWh		based on reference books (2),kg cf	2005 Actual data (3), kg cf		2005 Actual data (3)	best existing technologies used (4)	
1	Agriculture, hunting and service provision in those sectors	01	8.12										
4	Extraction of iron ore	13	3.38								299.7		
4.2	Cupper ore extraction and dressing (in the converters)2	13.20.2	*2.44*	tonne	1,700-2,251	2,580-12,820	250-280 340-381	50.5-53.8	513.57	94	2,088.59	411-2,161	Kapan Mining factory (insufficient data)
6	*Food Industry, including beverage production*	15	0.43										
6.1	Poultry, egg and rabbit meat production	15.12.0	0.91	thousand eggs	58	41.08			21.93	4.56	31.53		"Lusakert" poultry farm LTD
6.2	Macaroni production	15.85.0	*3.06*	ï	100	716.48	190		4.80	120.50	213.3	74	
6.3	Beer production	15.96.0	*2.30*	decalitre	533-830	2,300-3,972	4450		1,614-2,301	84-643	2,540-2,873	546	"Yerevan beer" CJSC "Kotayk" beer factory LTD
6.4	Fruit and vegetable processing and canning	15.33.9	*0.67*	tonne	71	250.00	584		479.71	14.98	525.40	75	"Artashat" factory of canned goods OJSC
6.5	Production of mineral water, including mineral water bottling	15.98.2	*2.83*	100 litre	4.47	27.54			6.09	0.23	9.70	3.93	"Bjni" mineral water factory CJSC
8	*Textile production*	17	0.50										
8.1	Production of knited socks	17.71.0	*5.40*	thousand pairs of socks	745	785.4					96.5		"Arhsluys" OJSC
14	*Chemical industry*	24	24.53										
14.1	Production of synthetic rubber	24.17.0	*20.94*	tonne	15,000	28,321			10,838.1	24.18	21,060		47 GcalÉ/t thermal

													en.
14.2	Production of sinthetic cautchuouk	24.13.0	*49.60*	tonne	2,916-4,147	19,702			669.46		3,090	503	"Prometey chem-prom" CJSC chemical plant
15	*Production of rubber and plastic products*	25	0.75										
15.1	Production of mechanical rubber products	25.13.1	5.15	tonne	10,800	3,508							
16	*Productions of other non metal ore products*	26	6.17										
16.1	Cement production (with gas) using wet method (in Hrazdan)	26.51.0	7.31	tonne	70-135	148	90	241.6-269	173.53	2.82	191-255	223	"Mika cement" CJSC
16.2	Cement production (with gas) using dry method (in Ararat)	26.51.1	14.8	tonne	88.2	390	100	135	357.42		405	157	"Ararat Cement" CJSC the data is insufficient
16.3	Gypsum and plaster production	26.53.0	7.35	tonne	18-80 16-20	101.68			238.68	0.33	251.50	209	"Gajegorts" CJSC
17	*Metal industry*	27	0.23										
17.1	Cast iron, iron and ferro-alloy production	27.10.0	46.75	tonne	116-300	421			462.86	27.50	542.14	519	"Dzulakentron" "Avtolit"
17.2	ferro-alloy and other metal production	27.35.0	0.13	tonne	819	2,710			1,467.71		1,800.6	519	"Clean metal" factory
18.1	Ready metal goods production produced through hardening, stamping, or rolling	28.40.1	3.38	thousand	890	3,277				218.51	621.07	379.1	"Hydroeconstruction"
19	*Production of machines and equipment*	29	2.81										
19.1	Production of equipment for metal covering	29.40.6	4.08	number produced	12	18.3				4.04	6.29		"Autogen"
26	*Other products not included in the main categories*	36	0.08										
26.1	Diamond production	36.22.2	1.21	number produced	2.2	17.8			0.32	0.39	2.89		"Shoghakn"

26.2	Diamond (presiouce stone) production	36.22.2	7.16	number produced	2.2	0.59				3.24	0.08		"Sapfire"
34	*Ground transportation*	60	6.18										
34.1	Troleybus	60.21.3	0.57	number of people transferred	0.67	28.7				0.54	4.07	0.13	"Yerevan lectric transportation" CJSC
34.2	Metro	60.21.4	28.53	number of people transferred	850	1,150				4.06	145.40	104.43	"Metropoliten" CJSC

APPENDIX C: ELECTRICITY SAVING POTENTIAL FOR MAJOR CONSUMERS, WITH VARIABLE ELECTRIC MOTOR LOAD, IN CASE OF NEW TECHNOLOGY APPLICATION

N	Sector			Name of the company	Cumulative installed electric power KW	Electric power of electric motors with variable load, KW	Annual consumption of electricity, MWh	Energy saving potential of electric motors with variable load, in case of new technology application *	
	Name		code					MWh	%
1	2	3	4	5	6	7	8	9	10
1	INDUSTRY	Other branches of industry	15.33.9	Artachat canned food factory	3,393.80	323.70	1,000.00	93.23	9.32
2			15.98.2	"Bjni" mineral water factory CJSC	990.00	51.70	1,983.00	34.74	1.75
3			15.85.0	AAFPC NGO LTD	316.65	25.80	1,024.56	57.96	5.66
4			15.96.0	"Yerevan beer" CJSC	2,968.19	155.91	4,010.00	121.23	3.02
5			15.96.0	"Kotayk beer" factory	735.00	28.00	1,156.00	24.51	2.12
6			24.17.0	"Nairit factory" CJSC	130,121.00	11,667.80	217,391.00	665.30	0.31
7			24.13.0	"Prometey-chemprom" CJSC, chemical plant	117,004.00	1,180.65	7,185.14	615.56	8.57
8			13.20.9	"Ararat gold mining company" CJSC	22,167.64	1,262.00	46,506.64	1,047.43	2.25
9			13.20.2	"Akhtala Mining Factory" CJSC	4,092.70	409.86	4,938.01	449.66	9.11
10			13.20.2	Alaverdi metalurgy factory	11,534.00	448.60	11,150.13	1,154.70	10.36
11			13.20.2	"Kapan Mining Factory" CJSC	24,246.23	927.31	27,971.46	1,836.08	6.56
12			27.42.0	"Rusal Armenal" CJSC	51,143.00	742.40	*8,611.11*	317.12	3.68
13			15.12.0	"Luskert" poultry factory LTD	2,373.59	95.00	4,178.93	208.05	4.98
14			***Total***		***371,085.80***	***17,318.73***	***337,105.98***	***6,625.56***	***1.97***
15		non metal ore	26.53.0	"Gajegorts" CJSC	1,285.00	180.00	1,720.00	72.28	4.20
16			***Total***		***1,285.00***	***180.00***	***1,720.00***	***72.28***	***4.20***
17		Iron and cast iron	27.10.0	"Dzulakentron" OJSC	8,880.00	270.00	*1,685.99*	174.54	10.35
18			27.10.0	"Autolit" factory	22,170.00	320.00	*7,353.00*	42.24	0.57
19			27.35.0	"Clean metal" OJSC	1,350.00	80.00	8,684.00	122.30	1.41
20			***Total***		***32,400.00***	***670.00***	***17,722.99***	***339.08***	***1.91***
21	***Total***				***404,770.80***	***18,168.73***	***356,548.97***	***7,036.92***	***1.97***
22	Other	Trade and service	85.11.1	"Erebuni medical center" CJSC	526.80	51.00	3,297.77	66.10	2.00
23			85.11.1	"Mikaelyan surgery center" CJSC	283.00	30.00	1,399.00	62.21	4.45

24			85.11.1	St. Grigor Lusavorich medical center	9,900.00	44.00	1,798.00	38.54	2.14
25			41.00.0	"Water supply and sewage company" SCJSC	28,139.20	8,942.20	155,080.47	45,000.00	29.02
26			***Total***		***38,849.00***	***9,067.20***	***161,575.23***	***45,166.85***	***27.95***
27		agriculture	01.41.0	"Vorogum Jrar" CJSC	165,657.19	16,565.72	109,967.37	4,000.00	3.64
28			***Total***		***165,657.19***	***16,565.72***	***109,967.37***	***4,000.00***	***3.64***
29		***Total***			***204,506.19***	***25,632.92***	***271,542.60***	***49,166.85***	***18.11***
30	***Total***				***609,276.99***	***43,801.65***	***628,091.57***	***56,203.77***	***20.08***

APPENDIX D: CALCULATION OF ENERGY SAVING POTENTIAL BY IMPLEMENTED MEASURES

N	Type of activity	Code of economic activity	Electricity		Natural gas	
			Number of companies	total consumption of electricity, MWh	number of companies	total consumption of natural gas, thousand sq.m.
1	2	3	4	5	6	7
1	Provision of agricultural services	01	1	91,702	2	638
2	Metal ore pruduction	13	8	370,122	4	24,767
3	Other branches of mining industry	14	1	838	1	1,898
4	Food and beverage production	15	29	109,120	47	34,049
5	Tabaco production	16	2	127,526	3	879
6	Tekstile production	17	2	2,473	1	266
7	Publishing, and printing business	22	1	1,584	0	0
8	Chemical industry	24	4	227,586	5	73,393
9	Rubber-plastics production	25	3	7,465	1	79
10	Other branches of non-metal mining industry	26	9	102,342	18	170,055
11	Metal industry	27	7	27,734	9	36,134
12	Ready metal goods production	28	2	2,728	6	1,257
13	Machinery-equipment production	29	4	12,780	2	1,008
14	Production of electric machines and equipment	31	5	19,494	3	2,806
15	Production of radio and TV equipment	32	2	2,585	0	0
16	Other bvranches of industry	36	3	5,712	3	159
17	Production and distribution of electricity, gas, hot water and steam	40	7	273,543	11	620,115
18	Collection, purification and distribution of water	41	1	155,080	0	0
19	Construction	45	2	2,456	4	3,449
20	Trade, technical maintenance and repair of vehicles	50	7	48,209	3	93,899
21	Retail trade	52	4	4,921	6	796
22	Hotels-restaurants	55	3	12,795	3	2,862
23	Ground transportation	60	4	97,541	1	60
24	Air transportation	62	2	15,614	3	2,356
25	Communication	64	6	68,630	5	432

26	Financial agent	65	1	1,412	4	377
27	Real estate business	70	1	712	1	235
28	Experiments-design	73	2	6,744	7	548
29	State government	75	8	168,541	2	6,305
30	Education	80	5	5,898	13	6,083
31	Provision of healthcare and social services	85	23	58,701	20	8,492
32	Civil activities	91	45,963	692,964	45971	38,492
33	Population	91	848,507	1,439,831	156,668	310,515
34	Organization of leisure and entertainment activates	92	6	12,262	7	607
35	Foreing companies' activities	99	1	1536	2	531
36	***TOTAL***		894,635	4,179,181	202,836	1,443,539

Appendix D - continued

Energy saving measure [Fo]														
Elimination of defects and improvement of technological process [F1]					Decrease of idle process [F2]					Automation of electric drives [F3]				
α_1	β_1	$\gamma_{1,}$ mln. AMD	$\pi_{l,}$ MWh	$C_{l,}$ mln. AMD	α_2	β_2	$\gamma_{2,}$ mln. AMD	$\pi_{2,}$ MWh	$C_{2,}$ mln. AMD	α_3	β_3	$\gamma_{3,}$ mln. AMD	$\pi_{3,}$ MWh	$C_{3,}$ mln. AMD
8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
0.369	0.081	32.8	2,730	67.50	0.081	0.250	22.23	1853	55.59	0.330	0.132	48.0	4,000	337.5
0.235	0.086	89.8	7,484	460.70	0.011	0.124	6.0	496.7	13.2	0.994	0.031	137.7	11,472	183.5
										0.858	0.058	65.2	5,432.6	203.0
0.448	0.045	55.3	4,606	37.17	0.076	0.270	55.91	4,659	139.77	0.448	0.017	20.9	1,741.2	47.1
					0.185	0.258	58.6	4,884.8	263.8	0.356	0.451	197.2	16,432	644.4
0.868	0.025	7.2	604	30.87	0.115	0.220	8.43	702	14.33	0.211	0.280	19.7	1,638.5	64.3
					0.056	0.200	1.72	143	2.58					
					0.102	0.051	1.2	101.4	5.5					
					0.076	0.150	0.35	29	0.53					
0.208	0.146	99.5	8,288	3.98	0.350	0.092	105.8	8,817.7	428.5	0.200	0.076	49.6	4,137.0	450.0
					0.082	0.130	19.74	1,645	29.61	0.355	0.817	540.0	45,000	1,700
					0.820	0.092	43.7	3,640.9	8.7					
					0.250	0.068	19.9	1,658.2	55.7					

					0.080	0.125	20.22	1,685	10.11	0.36	0.088	63.75	5,312	58.01
					0.086	0.310	18.7	1,556.8	49.3	0.097	0.401	27.4	2,282	60.8
					0.150	0.132	164.6	13,721	32.93	0.33	0.107	291.23	24,269	250.5
0.298	0.019	284.5	23,712	600.2	0.229	0.05	547.1	45,595	1,110.1	0.421	0.069	1,460.6	121,716	3,999

Appendix D - continued

N	Energy saving measure [Fo]														
	Introduction of new energy efficient technological aggregates, with replacement of old ones [F4]					Introduction of new energy efficient technological aggregates, with replacement of old ones (natural gas) [F4]					Introduction of energy efficient motors [F5]				
	α_4	β_4	$\gamma_{4,}$ mln. AMD.	$\pi_{4,}$ MWh	$C_{4,}$ mln. AMD	$\alpha_{4\cdot}$	$\beta_{4\cdot}$	$\gamma_{4\cdot,}$ mln. AMD	$\pi_{4\cdot,}$ thousand m3	$C_{4\cdot,}$ mln. AMD	α_5	β_5	$\gamma_{5,}$ mln. AMD	$\pi_{5,}$ MWh	$C_{5,}$ mln. AMD
23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
1	0.23	0.09	24.0	2,000.00	90.0										
2	0.21	0.15	144.5	12,044.1	650.4						0.36	0.05	82.9	6,905	314.9
3															
4	0.32	0.14	59.4	4,952.49	181.6						0.86	0.03	32.8	2,735	50.8
5	0.32	0.12	61.4	5,115.20	251.7										
6											0.78	0.04	1.0	79.2	2.7
7															
8	0.42	0.12	133.3	11,110.2	517.3						0.33	0.06	51.5	4,290	187.9
9	0.27	0.08	1.8	152.24	10.7						0.26	0.04	0.95	79.2	3.52
10	0.40	0.08	37.6	3,132.01	145.8						0.04	0.12	5.3	441	8.2
11	0.25	0.06	5.2	429.71	25.2						0.08	0.05	1.4	118	4.6
12	0.32	0.05	0.5	41.64	2.1										
13	0.39	0.07	3.9	325.69	18.0						0.29	0.07	3.15	263	11.03
14	0.43	0.06	5.8	486.72	23.9						0.12	0.06	1.8	148	6.6
15															
16															
17	0.50	0.24	388.3	32,361.5	1,216.6	0.85	0.93	17,348	488,000	69,394					
18	0.39	0.33	240.0	20,000.0	5,500.0						0.25	0.13	58.2	4,849	227.0
19											0.18	0.10	0.54	45	2.11
20	0.53	0.06	17.5	1,458.76	68.3						0.13	0.12	9.10	758	28.21
21															
22															
23	0.43	0.10	48.8	4,067.35	156.2										
24															
25	0.35	0.63	182.4	15,200.3	954.0										
26															

27															
28															
29															
30															
31															
32															
33															
34															
35															
36	0.39	0.07	1,355	112,878	9,811.7	0.85	0.93	17,348	488,000	69,394	0.37	0.01	249	20,711	847.5

Appendix D - continued

Energy saving measure [Fo]														
Compensation of reactive power [F6]					Introduction of automatic electricity measuring systems [F7]					Organizational measures [F8]				
α_6	β_6	$\gamma_{6,}$ mln. AMD	$\pi_{6,}$ MWh	$C_{6,}$ mln. AMD	α_7	β_7	$\gamma_{7,}$ mln. AMD	$\pi_{7,}$ MWh	$C_{7,}$ mln. AMD	α_8	β_8	$\gamma_{8,}$ mln. AMD	$\pi_{8,}$ MWh	$C_{8,}$ mln. AMD
39	40	41	42	43	44	45	46	47	48	49	50	51	52	53
0.86	0.01	11.3	942	36.2	0.95	0.03	36.0	3000	45.0	0.300	0.018	5.94	495	0.59
0.62	0.02	62.9	5,245	176	1.00	0.01	44.4	3,701	91.8	0.520	0.026	60.06	5,005	4.80
					1.00	0.09	112	9,355	14.2					
					0.99	0.04	52.8	4,396	95.0	0.410	0.025	15.69	1,307	0.78
1.00	0.00	0.5	40.9	3.1	1.00	0.03	75.4	6,281	67.5	0.380	0.028	29.07	2,422	0.87
										0.450	0.018	0.73	60	0.04
0.52	0.02	12.6	1,051	37.7	0.93	0.02	24.0	1,999	45.6	0.550	0.021	14.19	1,182	0.50
0.89	0.00	0.89	74.0	5.62	0.91	0.02	5.00	416	8.49	0.665	0.016	3.54	295	0.13
0.69	0.01	1.39	116	4.72	0.95	0.01	1.63	136	3.10	0.715	0.019	2.08	174	0.31
0.62	0.02	2.30	191	8.27	0.92	0.01	2.80	233	4.90					
					0.96	0.01	0.33	27.3	0.64	0.532	0.021	0.35	29	0.19
0.48	0.12	181	15,088	305	0.98	0.02	70.8	5,898	95.5	0.385	0.075	94.4	7,867.0	4.7
0.49	0.04	34.4	2,865	110	0.95	0.03	56.6	4,714	76.4	0.632	0.031	36.46	3,038	9.48
										0.513	0.039	0.59	49	0.13
										0.313	0.059	10.69	891	1.18
										0.350	0.058	16.72	1,393	3.18

										0.250	0.078	13.74	1,145	1.79
0.52	0.01	307	25,613	687	0.98	0.01	482	40,157	548	0.444	0.014	304.2	25,353	28.7

Appendix D - continued

N	Energy saving measure [Fo]									
	Improvement of thermal insulation in heaters and pipelines, reduction of losses in natural gas distribution system [F9]					Utilization of secondary fuel energy resources [F10]**				
	α_9	β_9	$\gamma_{9,}$ mln. AMD	$\pi_{9,}$ thousand m3	$C_{9,}$ mln. AMD	α_{10}	β_{10}	$\gamma_{10,}$ mln. AMD	$\pi_{10,}$ MWh	$C_{10,}$ mln. AMD
54	55	56	57	58	59	60	61	62	63	64
1						0.790	0.557	484.3	40,360	9,5 53.5
2	0.95	0.083	69.50	1,955	206.41	0.212	0.098	92.65	7,721	22 2.4
3										
4	0.68	0.168	138.53	3,897	290.91					
5	0.61	0.053	1.01	28.4	3.00					
6										
7										
8	0.51	0.043	57.22	1,609.5	169.94	0.180	0.168	82.59	6,882	19 8.2
9						0.080	0.130	0.93	78	2.0
10	0.86	0.041	211.59	5,952	488.77					
11	0.73	0.153	143.87	4,047	592.75					
12	0.31	0.063	0.87	24.5	2.64					
13										
14	0.88	0.112	9.88	278	68.04					
15										
16	0.42	0.071	0.17	4.7	0.56					
17	0.98	0.095	2,052.7	57,742	1,884	0.105	0.201	69.28	5,773	14 5.5
18						0.212	0.398	157.18	13,098	1,9 49.0
19										
20										
21										
22	0.38	0.078	3.03	85.3	10.55					
23										
24										
25										
26										

27										
28										
29										
30	0.41	0.098	8.69	244.4	30.24					
31	0.78	0.052	12.17	342	141.12					
32										
33										
34										
35										
36	0.927	0.057	2,709.2	76,209	3,889.3	0.516	0.034	886.9	73,912	12,071

Appendix D - continued

Energy saving measure [Fo]														
Utilization of efficient type of fuel-energy resources [F11]					Application of diamond coated instruments [F12]					Improvement of valve system [F13]				
α_{11}	β_{11}	$\gamma_{11,\ mln.\ AMD}$	$\pi_{11,\ MWh}$	$C_{11,\ mln.\ AMD}$	α_{12}	β_{12}	$\gamma_{12,\ mln.\ AMD}$	$\pi_{12,\ MWh}$	$C_{12,\ mln.\ AMD}$	α_{13}	β_{13}	$\gamma_{13,\ mln.\ AMD}$	$\pi_{13,\ MWh}$	$C_{13,\ mln.\ AMD}$
65	66	67	68	69	70	71	72	73	74	75	76	77	78	79
										0.250	0.042	11.438	953.2	36.7
										0.150	0.032	21.0	1,753.1	50.5
										0.250	0.086	28.0	2,334.5	78.4
0.091	0.321	44.70	3,725.2	122.5										
0.035	0.521	49.80	4,150.0	104.6						0.280	0.098	74.6	6,217.9	208.9
0.021	0.435	3.04	253.3	8.5	0.785	0.123	32.1	2,677.8	9.6					
					0.000	0.000	0.0	0.0	0.0					
					0.857	0.103	13.5	1,127.8	4.1					
0.056	0.334	4.38	365.0	10.9	0.661	0.037	5.6	470.7	2.8	0.110	0.092	2.4	198.3	6.9
					0.225	0.093	1.43	119.4	0.29					
0.056	0.334	1.94	161.4	8.0						0.110	0.095	34.2	2,850.0	88.9

										0.320	0.098	58.4	4,863.3	169.2
										0.220	0.091	3.1	256.2	8.9
										0.180	0.115	41.9	3,488.8	33.5
										0.220	0.132	2.1	171.3	3.7
0.095	0.421	28.2	2,349.2	222.4						0.150	0.125	13.2	1,100.6	14.5
0.080	0.385	4.53	377.7	11.3						0.110	0.095	1.5	128.1	1.8
0.068	0.040	136.6	11,382	488.3	0.775	0.001	52.7	4396	16.8	0.231	0.025	291.8	24,315	702.1

Appendix D - continued

N	Energy saving measure [Fo]														
	Introduction of modern control systems [F14]					Modernization of thermal insulation plants [F15]					Application of energy efficient lamps [F16]				
	α_{14}	β_{14}	γ_{14}, mln. AMD	π_{14}, MWh	C_{14}, mln. AMD	α_{15}	β_{15}	γ_{15}, mln. AMD	π_{15}, thousand m3	C_{15}, mln. AMD	α_{16}	β_{16}	γ_{16}, mln. AMD.	π_{16}, MWh	C_{16}, mln. AMD
80	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
1	0.342	0.051	19.32	1,610.3	59.90										
2	0.483	0.071	153.05	12,754.5	535.7	0.64	0.056	31.6	887.6	97.8	0.001	0.714	4.6	380.5	4.3
3						0.34	0.028	0.6	18.1	2.0					
4	0.142	0.038	7.1	590.6	5.6	0.74	0.1424	127.5	3587	522.8	0.142	0.714	132.7	11,058.3	28.7
5	0.353	0.031	16.94	1411.3	60.8	0.53	0.018	0.3	8.4	1.1					
6	0.423	0.028	0.36	29.7	2.0						0.217	0.852	5.5	457.3	3.3
7											0.100	0.41	0.79	65.565	0.94
8	0.003	0.206	1.4	118.5	2.7	0.33	0.065	56.6	1593.4	147.3	0.003	0.372	2.6	213.2	2.7
9	0.385	0.051	1.77	147.6	8.6	0.252	0.061	0.04	1.21	0.2					
10	0.555	0.058	39.77	3,314.2	152.7						0.004	0.872	4.1	339.6	3.7
11											0.119	0.563	22.3	1,858.1	26.8
12															
13															
14	0.318	0.048	3.57	297.6	11.1	0.152	0.031	0.47	13.22	1.5	0.196	0.598	27.4	2,282.6	28.5
15															
16	0.185	0.058	0.74	61.3	2.7										
17	0.259	0.085	71.96	5,996.7	237.5	0.022	0.014	6.9	194.25	0.8					
18	0.210	0.095	37.05	3087.3	77.8										
19															
20															
21											0.250	0.45	6.70	558.546	8.71
22						0.230	0.084	2.0	55.45	0.8	0.200	0.41	12.59	1,049.2	18.89
23															
24															
25											0.180	0.589	87.3	7,276.2	54.1
26															
27															

28															
29											0.120	0.434	105.3	8,777.6	45.3
30						0.241	0.087	4.6	128.21	17.8					
31	0.258	0.059	10.70	892.0	22.5	0.86	0.2791	72.5	2,038	1,391.1	0.114	0.421	33.8	2,819.0	5.1
32											0.558	0.350	1,626.3	135,524.5	2,925.3
33											0.496	0.424	3,635.3	302,945.6	6,788.1
34															
35															
36	0.387	0.019	363.7	30,312	1,179.5	0.653	0.009	303.1	8,525	2,183.1	0.486	0.234	5,707.3	47,5606	9,,944.4

Appendix D - continued

Energy saving measure [Fo]									
Total energy saving measures [Fo]									
Electricity					Natural gas				
α_0	β_0	γ_0, mln. AMD	π_0, MWh	C_0, mln. AMD	a_0	β_0	γ_0, mln. AMD	π_0, thousand m3	C_0, mln. AMD
95	96	97	98	99	100	101	102	103	104
0.680	0.929	695	57,944	10,282	0.000	0.000	0	0	0
0.477	0.424	900	74,962	2,708	0.854	0.134	101	2,843	304
0.000	0.000	0	0	0	0.340	0.028	0.6	18.1	2.0
0.554	0.603	437	36,458	562	0.709	0.310	266	7,484	814
0.460	0.272	191	15,956	531	0.593	0.071	1.3	36.9	4.1
0.307	0.746	6.8	566.1	8.0	0.000	0.000	0.0	0.0	0.0
0.100	0.414	1	66	1	0.000	0.000	0.0	0.0	0.0
0.372	0.622	633	52,733	1,518	0.422	0.103	114	3,203	317
0.292	0.237	6	517	25	0.252	0.061	0	1	0
0.394	0.813	393	32,775	1,302	0.856	0.041	212	5,,952	489
0.445	0.734	109	9,067	198	0.731	0.153	144	4,047	593
0.324	0.047	0	42	2	0.310	0.063	1	25	3
0.661	0.271	27.4	2,284.6	43.8	0.000	0.000	0	0	0
0.307	0.798	57.3	4,775.3	109.4	0.848	0.122	10	291	70
0.512	0.065	1.0	85.6	1.4	0.000	0.000	0	0	0
0.211	0.150	2.2	180.8	2.9	0.420	0.071	0	5	1
4.678	0.076	1,166.9	97,238	2,984.0	0.863	1.020	19408	545,936	71,279
0.367	1.811	1,237.9	103,161	9,848.5	0.000	0.000	0	0	0

0.354	0.108	1	94	2	0.000	0.000	0	0	0
0.613	0.228	81	6,749	106	0.000	0.000	0	0	0
0.250	0.454	7	559	9	0.000	0.000	0	0	0
0.204	0.500	16	1,305	28	0.322	0.153	5	141	11
0.377	0.156	69	5,726	212	0.000	0.000	0	0	0
0.000	0.000	0	0	0	0.000	0.000	0	0	0
0.299	1.164	286	23,870	1,011	0.000	0.000	0	0	0
0.000	0.000	0	0	0	0.000	0.000	0	0	0
0.000	0.000	0	0	0	0.000	0.000	0	0	0
0.000	0.000	0	0	0	0.000	0.000	0	0	0
0.193	0.592	231	19,264	147	0.000	0.000	0	0	0
0.220	0.132	2	171	4	0.352	0.174	13	373	48
0.130	1.589	146	12,145	376	0.849	0.330	85	2,380	1,532
0.494	0.507	2,082	173,514	3,209	0.000	0.000	0	0	0
0.496	0.424	3,635	302,946	6,788	0.000	0.000	0	0	0
0.088	0.471	6	506	13	0.000	0.000	0	0	0
0.000	0.000	0	0	0	0.000	0.000	0	0	0
0.860	0.288	12,428	1,035,658	42,034	0.857	0.463	20361	572,734	75,466

α_i the share of i-th measure, relative unit, based on expert and research estimates

β_i relative potential of i-th measure

γ_i, energy (natural gas) saved as a result of implementation of i-th measure, million AMD, γ_i $\gamma_i = A\alpha\beta 12$, (1kWh=12 AMD), or $\gamma_i = A\alpha\beta 39{,}105$ (1 thousand m^3 of natural gas is 39,105 AMD)

πi, potential of i-th measure, in natural unit, MWh or thousand m^3, $\pi_i = A\alpha\beta$

Ci, cost of energy saving measures in the i-th industrial company, billion AMD, $C_i = \gamma_i T$, where T is the payback period

A total consumption of electricity or natural gas.

APPENDIX E: ENERGY SAVING POTENTIAL IN STREET LIGHTING THROUGHOUT ARMENIA. INSTALLATION OF NATRIUM LAMPS IN STREET LIGHTING SYSTEM, MWH

N	Location (marzes, cities, villages)	Annual electricity consumption			Annual energy saving
		Designed	Actual	Proposed	
1	Yerevan	13,528.00	13,040.00	11,260.00	2,268.00
2	Aragatsotn Marz	888.50	235.10	505.60	382.80
	c. Ashtarak	168.80	168.80	42.00	126.80
	c. Talin	490.56	63.51	318.86	171.70
	c. Aparan	191.63	2.74	107.31	84.32
	v. Tsaghkahovit	37.50	0.00	37.50	0.00
3	Lori Marz	1,231.40	1,076.40	846.80	384.60
	c. Alaverdi	72.54	72.54	41.34	31.21
	c. Stepanavan	53.28	30.96	10.66	42.62
	c. Spitak	7.04	4.85	3.94	3.10
	c. Tashir	43.53	26.55	29.57	13.96
	c. Vanadzor	990.00	935.00	728.75	261.25
	c. Akhtala	65.00	6.50	32.50	32.50
4	Armavir Marz	1,641.50	756.90	960.10	681.40
	c. Armavir	392.40	67.50	219.74	172.66
	c. Echmiadzin	135.00	135.00	88.80	46.20
	c. Metsamor	382.85	261.95	214.40	168.45
5	Syunik Marz	731.20	292.40	437.20	294.00
	c. Kapan	253.58	184.28	83.16	170.42
	c. Goris	48.31	24.34	29.47	18.84
	c. Meghri	54.03	8.93	34.20	19.83
	c. Sisian	182.50	11.41	128.66	53.84
	c. Qajaran	123.19	10.95	119.17	4.02
	c. Agarak	69.64	52.54	42.53	27.11
6	Vayots Dzor Marz	584.00	102.20	327.00	257.00
	c. Vayq	175.20	10.95	98.11	77.09
	c. Jermuk	219.00	73.00	122.64	96.36
	c. Yeghegnadzor	189.90	18.25	106.29	83.51

N	Location (marzes, cities, villages)	Annual electricity consumption			Annual energy saving
		Designed	Actual	Proposed	
7	Kotayk Marz	1,892.90	654.30	1,063.10	829.80
	c. Hrazdan	245.44	54.19	137.45	107.99
	c. Tsaghkadzor	68.99	68.99	38.63	30.35
	c. Charentsavan	237.46	181.58	131.53	105.92
	c. Abovyan	147.83	147.83	66.43	81.40
	c. Byureghavan	23.10	11.00	12.94	10.16
	c. Eghvard	150.00	0.00	84.00	66.00
	c. Nor Hachn	88.61	24.23	51.61	37.00
	v. Aghavnadzor	78.84	5.84	44.15	34.69
	v. Meghradzor	119.72	10.22	67.04	52.68
	v. Solak	91.25	18.25	51.10	40.15
	v. Qaghsi	35.04	4.38	19.62	15.42
	v. Alapars	124.10	14.60	69.50	54.60
	v. Argel	68.14	8.21	68.14	0.00
	v. Nor Geghi	174.24	15.84	87.12	87.12
	v. Proshyan	72.00	22.50	21.00	51.00
	v. Arinj	40.50	37.80	22.68	17.82
	v. Balahovit	27.00	13.50	15.12	11.88
	v. Akunq	51.30	13.30	25.65	25.65
	v. Qasakh	49.35	2.10	49.35	0.00
8	Gegharqunik Marz	2,507.90	293.20	874.70	1,633.10
	c. Gavar	2,340.00	151.20	777.60	1,562.40
	c. Martuni	25.92	23.76	16.20	9.72
	c. Sevan	90.09	76.44	51.87	38.22
	c. Vardenis	51.84	41.76	29.03	22.81
9	Ararat Marz	252.76	252.76	71.14	181.62
	c. Ararat	21.90	21.90	4.38	17.52
	c. Vedi	9.13	9.13	1.83	7.30
	c. Artashat	67.53	67.53	13.51	54.02
	c. Masis	62.05	62.05	12.41	49.64
	v. Argavand	0.73	0.73	0.73	0.00
	v. Vedi	10.20	10.22	3.29	6.94

N	Location (marzes, cities, villages)	Annual electricity consumption			Annual energy saving
		Designed	Actual	Proposed	
	v. Nor Kyanq	11.86	11.86	3.36	8.50
	v. Mrgavan	22.63	22.63	11.75	10.88
	v. Mkhchyan	39.42	39.42	15.51	23.91
	v. Kanachut	7.30	7.30	4.38	2.92
10	Tavush Marz	628.20	413.07	473.97	154.23
11	Shirak Marz	7,857.36	1,925.10	6,145.92	1,711.44
	c. Gyumri	7,263.00	1,739.00	5,898.00	1,366.00
	c. Maralik	270.00	60.30	151.20	118.80
	c. Artik	324.00	126.00	97.20	226.80
	TOTAL	31,744.00	19,041.40	22,965.70	8,778.40

The energy efficiency of lighting fixtures is determined by the following equation:

$$K_E = P_{old} / P_{new} = 2.19,$$

where P_{old} and P_{new} are the old and new power capacity of the lamps.

The lighting efficiency is determined by the following equation:

$$K_L = \Phi_{old} / \Phi_{new} = 1.38,$$

where Φ_{old} and Φ_{new} are the old and new light emission capacity of the lamps.

Abbreviations

AEN	Armenian Electricity Netwroks CJSC
ANPP	Armenian Nuclear power Plant
AMD	Armenian drams
CIS	Commonwealth of Independent States
CJSC	Closed Joint Stock Company
ES	Energy Saving
RE	Renewable Energy
ETL	Electricity transmission lines
GDP	Gross Domestic Product
HPP	Hydroelectric Power Plant
HVEN	High Voltage Electricity Networks CJSC
LLC	Limited Liability Company
MD	Ministry of Defense
MIA	Ministry of Internal Affairs, the Police of RA
NSS	national security service
oe	oil equivalent
PGFS	pressurized gas filling station
RA	Republic of Armenia
RF	Russian Federation
tcf	tons of conditional fuel
TPP	Thermal Power Plant
toe	tons of oil equivalent
USA	United States of America
USSR	Union of Soviet Sociualistic Republics