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

Yerevan 2007
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# Table of Contents

List of Tables.......................................................................................................................................4

List of Figures .....................................................................................................................................5

1. Introduction ....................................................................................................................................6

2. Fundamentals of the National Program on Energy Saving and Renewable Energy ...............8

3. Macroeconomic and Energy Characteristics of Armenian Economy ......................................11


5. Energy Saving Priorities and Potential in Armenia.................................................................30

   5.1. Energy Saving Priorities ........................................................................................................30

   5.2. Energy Saving Potential in the Sectors of Economy ..........................................................33

6. Energy Saving Program ................................................................................................................35

   6.1. Targets for Energy Saving ....................................................................................................35

   6.2. Classification of Energy Saving Measures ...........................................................................38

   6.3. ENERGY SAVING PROGRAM FOR THE ARMENIAN ECONOMY ..................................42

7. Energy Saving Projections ..........................................................................................................49


   8.1. Hydroelectric potential ........................................................................................................51

   8.2. Biogas potential ....................................................................................................................52

   8.3. Solar energy potential ............................................................................................................52

   8.4. Hydrothermal energy potential ............................................................................................55

   8.5. Distribution of wind power potential in Armenia ...............................................................55

9. Financial mechanisms for implementation of the National Program on Energy Saving
   and Renewable Energy.....................................................................................................................57

10. Organizational Mechanisms of National Program...................................................................63

    10.1. Propaganda .........................................................................................................................63

    10.2. Education ............................................................................................................................65

    10.3. Statistics ..............................................................................................................................65

Bibliography......................................................................................................................................68

Appendix A. Structure of fuel-energy resource consumption by major consumers .....................73

Appendix B: Relative consumption of fuel energy resources in various economic sectors ......75

Appendix C: Saving potential for electricity for major consumers, with variable electric
   motor load, in case of new technology application .................................................................79

Appendix D: Calculation of energy saving potential from implemented measures .......................81

Appendix E: Energy saving potential in street lighting throughout Armenia: installation
   of natrium lamps in street lighting system ..............................................................................95
## LIST OF TABLES

Table 1. Macroeconomic and energy-economic description of Republic of Armenia .................................... 12
Table 2. Percentage of average annual growth for a number of countries ..................................................... 13
Table 3. Structure of fuel resources consumption based on the sector of economy and fuel type, thousand tcf ................................................................................................................................. 20
Table 4. Electricity balance in 2001-2005, million kWh. .................................................................................. 20
Table 5. Electricity losses in 0.38-220 kV networks in 2001-2005 (excluding transformation losses in power plants), million kWh ................................................................. 22
Table 6. Production of Armenian thermal power plants and relative expenses of fuel-energy sources .......... 22
Table 7. 2002-2005 natural gas balance of Republic of Armenia .................................................................... 22
Table 8. Consumption of natural gas and its structure based branches of economy for 2002-2005, m³ ....... 24
Table 9. Structure of natural gas consumption in Armenia, million m³ .......................................................... 25
Table 10. Structure of electrical energy consumption in Armenia, million kWh ........................................... 25
Table 11. Structure of fuel energy consumption, thousand tcf ...................................................................... 25
Table 12. The major consumers, based on the sector of economic activity (annual data) ............................ 30
Table 13. Companies with highest energy intensity ....................................................................................... 31
Table 14. Energy intensive technologies ...................................................................................................... 31
Table 15. Constituents of annual 1008 thousand toe energy saving potential in Armenian economy ........ 34

**Targets for Energy Saving**

Table 16. Priority sectors for energy savings ............................................................................................... 35
Table 17. Electricity production ..................................................................................................................... 35
Table 18. Copper, ore, canned food, rubber and metal industries ................................................................. 36
Table 19. Thermal energy production and heating systems ........................................................................ 36
Table 20. Electricity distribution and transmission networks ....................................................................... 36
Table 21. Gas supply system ....................................................................................................................... 37
Table 22. Thermal insulation of buildings ................................................................................................... 37
Table 23. Transportation ............................................................................................................................... 37

**Classification of Energy Saving Measures**

Table 24. Organizational-technical measures ............................................................................................... 38
Table 25. Regulation and improvement of existing technologies ................................................................. 39
Table 26. Design and application of new energy efficient technologies and equipment ............................... 40
Table 27. Classification of energy saving measures by the technological energy systems ......................... 40
Table 28. Energy Saving Program for the Armenian Economy ................................................................... 42
Table 29. Combined data on utilization of energy saving potential for 2006-2020 period ............................ 49
Table 30. Main energy and technical characteristics of small HPP’ s by the water sources (potential calculated fro 1997) ............................................................................................................. 51
Table 31. Production of biogas for the period 2006-2020 ......................................................................... 52
Table 32. Annual solar radiation indices, kWh/m² ....................................................................................... 52
Table 33. Hydrothermal energy potential .................................................................................................. 55
Table 34. Wind power potential ................................................................................................................ 55
Table 35. Economic mechanisms for implementation of National Program ............................................ 57
LIST OF FIGURES

Figure 1. GDP structure for a number of countries in 2005, % ................................................................. 14
Figure 2. GDP structure in Armenia ............................................................................................................ 14
Figure 3. GDP/capita structure of several countries in 2004 according to purchasing power ................. 15
Figure 4. GDP/capita and GDP energy intensity in several countries in 2003 .......................................... 16
Figure 5. Structure of energy consumption by economic sectors in 2003 ............................................... 17
Figure 6. Energy intensity of economy in several countries in 2003 ......................................................... 17
Figure 7. Primary fuel-energy source per capita in a number of countries in 2003 ................................. 18
Figure 8. Per capita primary fuel-energy resources and final consumption, 2001-2005 ......................... 27
Figure 9. Per capita electricity production and final consumption, 2001-2005 ......................................... 27
Figure 10. Per capita natural gas import and final consumption, 2001-2005 ........................................... 27
Figure 11. Combined data on utilization of energy saving potential for 2006-2020 period ....................... 50
Figure 12. Solar energy potential in Armenia ............................................................................................ 54
Figure 13. Potential energy saving incentive schematic ............................................................................ 61
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

<table>
<thead>
<tr>
<th>N</th>
<th>Criterion</th>
<th>Measurement unit</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GDP</td>
<td>billion AMD</td>
<td>1,175.9</td>
<td>1,362.5</td>
<td>1,624.6</td>
<td>1,896.4</td>
<td>2,228.0</td>
</tr>
<tr>
<td>2</td>
<td>Population</td>
<td>mln. people</td>
<td>3,2129</td>
<td>3,2103</td>
<td>3,2122</td>
<td>3,2158</td>
<td>3,2185</td>
</tr>
<tr>
<td>3</td>
<td>Primary fuel-energy resources</td>
<td>thousand toe</td>
<td>2,032.0</td>
<td>2,001.0</td>
<td>2,080.1</td>
<td>2,305.1</td>
<td>2,617.7</td>
</tr>
<tr>
<td>4</td>
<td>Electricity production</td>
<td>mln. kWh</td>
<td>5,744.8</td>
<td>5,518.8</td>
<td>5,500.9</td>
<td>6,030.0</td>
<td>6,316.5</td>
</tr>
<tr>
<td>5</td>
<td>Import of natural gas*</td>
<td>mln. m³</td>
<td>1,408.5</td>
<td>1,070.3</td>
<td>1,200.9</td>
<td>1,332.6</td>
<td>1,685.0</td>
</tr>
<tr>
<td>6</td>
<td>Import of oil products</td>
<td>thousand toe</td>
<td>367.6</td>
<td>378.5</td>
<td>431.6</td>
<td>411.8</td>
<td>402.2</td>
</tr>
<tr>
<td>7</td>
<td>Commercial export of electricity</td>
<td>mln. kWh</td>
<td>700.9</td>
<td>659.9</td>
<td>583.1</td>
<td>1,012.3</td>
<td>813.5</td>
</tr>
<tr>
<td>8</td>
<td>Final consumption of electricity</td>
<td>mln. kWh</td>
<td>3,872.0</td>
<td>3,400.0</td>
<td>3,655.0</td>
<td>3,991.6</td>
<td>4,374.4</td>
</tr>
<tr>
<td>9</td>
<td>Final consumption of natural gas*</td>
<td>mln. m³</td>
<td>1,299.7</td>
<td>901.4</td>
<td>977.2</td>
<td>1,155.9</td>
<td>1,443.5</td>
</tr>
<tr>
<td>10</td>
<td>Supply of domestic fuel-energy resources</td>
<td>%</td>
<td>30.33%</td>
<td>38.32%</td>
<td>33.87%</td>
<td>35.56%</td>
<td>33.51%</td>
</tr>
<tr>
<td>11</td>
<td>Final consumption of fuel-energy resources</td>
<td>thousand toe</td>
<td>1,610.3</td>
<td>1,301.8</td>
<td>1,430.0</td>
<td>1,564.1</td>
<td>1,788.8</td>
</tr>
<tr>
<td>12</td>
<td>Energy intensity of GDP</td>
<td>kg oe/1,000 AMD</td>
<td>1.728</td>
<td>1.469</td>
<td>1.280</td>
<td>1.216</td>
<td>1.175</td>
</tr>
<tr>
<td>13</td>
<td>Electric intensity of GDP</td>
<td>kWh/1,000 AMD</td>
<td>4.885</td>
<td>4.050</td>
<td>3.386</td>
<td>3.180</td>
<td>2.835</td>
</tr>
<tr>
<td>14</td>
<td>Energy efficiency of GDP</td>
<td>1,000 AMD /kg oe</td>
<td>0.579</td>
<td>0.681</td>
<td>0.781</td>
<td>0.823</td>
<td>0.851</td>
</tr>
</tbody>
</table>

* The 2001 data 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.

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

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, %**

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**

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**

![GDP structure of a number of countries in 2004 according to purchasing power, USD/capita](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.
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.

![Structure of energy consumption by sectors of economy, 2003]

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

![Energy intensity of sectors of economy in a number of countries 2003, kg.o.e./$1000 USD]


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. e.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

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

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 m³ in 2005 (Table 7).

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

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

<table>
<thead>
<tr>
<th>N</th>
<th>Name of characteristics</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Electricity supplied by &quot;HVEN&quot; CJSC</td>
<td>5,678</td>
<td>5,484</td>
<td>5,495</td>
<td>5,906</td>
<td>6,027</td>
</tr>
<tr>
<td>2</td>
<td>Inflow</td>
<td>326</td>
<td>302</td>
<td>307</td>
<td>260</td>
<td>338</td>
</tr>
<tr>
<td>3</td>
<td>Outflow</td>
<td>699</td>
<td>658</td>
<td>583</td>
<td>1,004</td>
<td>1,151</td>
</tr>
<tr>
<td>4</td>
<td>Technical losses in 0.38-220 kV networks</td>
<td>708</td>
<td>669</td>
<td>663</td>
<td>638</td>
<td>605</td>
</tr>
<tr>
<td>4.1</td>
<td>Including:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.2</td>
<td>Distribution losses</td>
<td>347</td>
<td>329</td>
<td>345</td>
<td>324</td>
<td>302</td>
</tr>
<tr>
<td>4.3</td>
<td>Losses in transformers</td>
<td>344</td>
<td>323</td>
<td>303</td>
<td>301</td>
<td>290</td>
</tr>
<tr>
<td>4.4</td>
<td>Other</td>
<td>17</td>
<td>18</td>
<td>15</td>
<td>13</td>
<td>12</td>
</tr>
<tr>
<td>5</td>
<td>Measured losses</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1,077</td>
<td>932</td>
</tr>
</tbody>
</table>

Source: Scientific Research Institute of Energy

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

<table>
<thead>
<tr>
<th>N</th>
<th>Production type</th>
<th>Measurement Unit</th>
<th>Yerevan TPP</th>
<th>Hrazdan TPP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>2001</td>
<td>2002</td>
</tr>
<tr>
<td>1</td>
<td>Thermal Energy</td>
<td>Thousand GCal</td>
<td>342</td>
<td>216</td>
</tr>
<tr>
<td>2</td>
<td>Electrical energy</td>
<td>Million KWh</td>
<td>281</td>
<td>267</td>
</tr>
<tr>
<td>3</td>
<td>Relative expenses of fuel-energy resources for production of thermal energy</td>
<td>kg c.f./GCal</td>
<td>181</td>
<td>175</td>
</tr>
<tr>
<td>4</td>
<td>Relative expenses of fuel-energy resources for production of electrical energy</td>
<td>g c.f./kWh</td>
<td>373</td>
<td>391</td>
</tr>
</tbody>
</table>

Source: Ministry of Energy of Republic of Armenia

Table 7. 2002-2005 natural gas balance of Republic of Armenia thousand m³

<table>
<thead>
<tr>
<th>N</th>
<th>Name</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Gas remnant at the beginning of the month</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- In the system</td>
<td>5,977.0</td>
<td>6,224.0</td>
<td>5,223.1</td>
<td>3,680.0</td>
</tr>
<tr>
<td></td>
<td>- In the underground gas station</td>
<td>15,781.0</td>
<td>19,784.0</td>
<td>71,202.0</td>
<td>57,231.0</td>
</tr>
<tr>
<td>2</td>
<td>Total received from</td>
<td>1,140,428.0</td>
<td>1,272,893.9</td>
<td>1,403,440.1</td>
<td>1,744,124.0</td>
</tr>
<tr>
<td></td>
<td>- From “Karmir Kamurj” measurement unit</td>
<td>1,070,292.0</td>
<td>1,200,945.0</td>
<td>1,332,570.0</td>
<td>1,685,031.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6,746.0</td>
<td>7,707.9</td>
<td>7,162.1</td>
<td>4,880.0</td>
<td></td>
</tr>
<tr>
<td>- Underground gas station, total</td>
<td>63,390.0</td>
<td>64,241.0</td>
<td>63,708.0</td>
<td>54,213.0</td>
<td></td>
</tr>
<tr>
<td>Pumped into the underground gas storage station</td>
<td>69,511.0</td>
<td>116,684.0</td>
<td>52,257.0</td>
<td>83,944.0</td>
<td></td>
</tr>
<tr>
<td>Left in the gas-transportation system</td>
<td>6,993.0</td>
<td>6,707.0</td>
<td>5,619.0</td>
<td>9,811.0</td>
<td></td>
</tr>
<tr>
<td><strong>3 In the “Transgas” LTD system</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Technological loses</td>
<td>45,819.3</td>
<td>51,733.2</td>
<td>61,699.0</td>
<td>69,140.7</td>
<td></td>
</tr>
<tr>
<td>- Construction needs</td>
<td>25.4</td>
<td>67.0</td>
<td>370.1</td>
<td>134.6</td>
<td></td>
</tr>
<tr>
<td>- Emergency leakage</td>
<td>679.2</td>
<td>452.1</td>
<td>1,046.1</td>
<td>945.5</td>
<td></td>
</tr>
<tr>
<td>- Loses of underground gas storing station</td>
<td>215.0</td>
<td>980.0</td>
<td>2,473.0</td>
<td>1,996.0</td>
<td></td>
</tr>
<tr>
<td>- Emergency leakage of underground gas storing station</td>
<td>1,854.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>4 Total distributed</strong></td>
<td>1,017,425.5</td>
<td>1,097,317.6</td>
<td>1,282,819.0</td>
<td>1,580,282.8</td>
<td></td>
</tr>
<tr>
<td>- Gas distribution system</td>
<td>959,675.9</td>
<td>1,031,926.3</td>
<td>1,211,352.8</td>
<td>1,499,557.3</td>
<td></td>
</tr>
<tr>
<td>- To pressurized gas filling station</td>
<td>41,279.4</td>
<td>45,203.7</td>
<td>50,754.1</td>
<td>54,734.7</td>
<td></td>
</tr>
<tr>
<td>Technological needs of “Transgas” LTD</td>
<td>7,047.5</td>
<td>8,364.9</td>
<td>5,840.8</td>
<td>8,183.1</td>
<td></td>
</tr>
<tr>
<td>- Technological needs of underground gas storing station</td>
<td>49.0</td>
<td>45.0</td>
<td>47.0</td>
<td>46.0</td>
<td></td>
</tr>
<tr>
<td>- For “Artsakhgas”</td>
<td>9,397.4</td>
<td>11,755.7</td>
<td>14,501.2</td>
<td>17,627.1</td>
<td></td>
</tr>
<tr>
<td><strong>5 Gas remnant at the end of the month</strong></td>
<td>26,008.0</td>
<td>76,425.1</td>
<td>60,911.0</td>
<td>93,531.0</td>
<td></td>
</tr>
<tr>
<td>- In the system</td>
<td>6,224.0</td>
<td>5,223.1</td>
<td>3,680.0</td>
<td>8,611.0</td>
<td></td>
</tr>
<tr>
<td>- In the underground gas station</td>
<td>19,784.0</td>
<td>71,202.0</td>
<td>57,231.0</td>
<td>84,920.0</td>
<td></td>
</tr>
<tr>
<td><strong>6 Utilized through gas distribution system</strong></td>
<td>901,389.1</td>
<td>977,187.8</td>
<td>1,155,893.5</td>
<td>1,443,539.1</td>
<td></td>
</tr>
<tr>
<td>In the gas distribution system</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Technological losses</td>
<td>53,888.5</td>
<td>53,028.7</td>
<td>53,616.9</td>
<td>54,051.7</td>
<td></td>
</tr>
<tr>
<td>- Technological needs</td>
<td>3,976.0</td>
<td>1,253.6</td>
<td>1,534.8</td>
<td>1,334.3</td>
<td></td>
</tr>
<tr>
<td>- Emergency leakage</td>
<td>422.2</td>
<td>456.2</td>
<td>307.7</td>
<td>632.2</td>
<td></td>
</tr>
<tr>
<td><strong>7 Total in the system</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Technological losses</td>
<td>99,707.9</td>
<td>105,741.9</td>
<td>117,788.8</td>
<td>125,188.4</td>
<td></td>
</tr>
<tr>
<td>- Technological needs</td>
<td>11,023.5</td>
<td>9,618.5</td>
<td>7,375.6</td>
<td>9,517.4</td>
<td></td>
</tr>
<tr>
<td>- Emergency leakage</td>
<td>1,117.4</td>
<td>908.3</td>
<td>1,353.8</td>
<td>1,577.7</td>
<td></td>
</tr>
</tbody>
</table>

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 m³

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

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 m³

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

Source: ArmRusGasprom CJSC

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

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

Source: Ministry of Energy of Republic of Armenia

### Table 11. Structure of fuel energy consumption, thousand tcf
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 m³/capita to 448.5 m³/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 m³/capita to 313 m³/capita. The national average was 217.9 m³/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 m³, and varied from 33.8 million m³/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 m³ to 1,600 thousand m³) 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)

<table>
<thead>
<tr>
<th>N</th>
<th>Name</th>
<th>Electrical energy mln. kWh</th>
<th>Natural gas, mln.m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Consumption of a household</td>
<td>1,440</td>
<td>310</td>
</tr>
<tr>
<td>2</td>
<td>Manufacturing industry, including:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- chemical production</td>
<td>659.1</td>
<td>324.6</td>
</tr>
<tr>
<td></td>
<td>- food industry</td>
<td>227</td>
<td>73.4</td>
</tr>
<tr>
<td></td>
<td>- other</td>
<td>236</td>
<td>39.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>183.7</td>
<td>211.8</td>
</tr>
<tr>
<td>3</td>
<td>Electricity, natural gas, water production and distribution</td>
<td>428.6</td>
<td>620.1</td>
</tr>
<tr>
<td>4</td>
<td>Mining industry</td>
<td>371</td>
<td>26.7</td>
</tr>
<tr>
<td>5</td>
<td>Transportation and communication (except, auto transportation)</td>
<td>181.8</td>
<td>2.8</td>
</tr>
<tr>
<td>6</td>
<td>Autotransportation</td>
<td>-</td>
<td>93.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(liquid gas- 2.05 thousand. ton, diesel fuel’-60.7 thousand tons)</td>
</tr>
</tbody>
</table>
3. Companies with highest energy intensity

Table 13. Companies with highest energy intensity

<table>
<thead>
<tr>
<th>N</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Zangezur copper molybdenium factory</td>
</tr>
<tr>
<td>2</td>
<td>Kapan copper molybdenium factory</td>
</tr>
<tr>
<td>3</td>
<td>“Agarak” copper molybdenium factory</td>
</tr>
<tr>
<td>4</td>
<td>Ararat gold mining company</td>
</tr>
<tr>
<td>5</td>
<td>“Masis Tabak”</td>
</tr>
<tr>
<td>6</td>
<td>“Nairit” factory</td>
</tr>
<tr>
<td>7</td>
<td>“Mika cement” factory</td>
</tr>
<tr>
<td>8</td>
<td>“Maqur Yerkat”</td>
</tr>
<tr>
<td>9</td>
<td>Armenian railway</td>
</tr>
<tr>
<td>10</td>
<td>“Armentel”</td>
</tr>
<tr>
<td>11</td>
<td>Armenian water supply and sewage company</td>
</tr>
<tr>
<td>12</td>
<td>“Grand tobacco”</td>
</tr>
<tr>
<td>13</td>
<td>“Ararat cement”</td>
</tr>
</tbody>
</table>

4. Energy intensive technologies

Table 14. Energy intensive technologies

<table>
<thead>
<tr>
<th>N</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ore breaking, crushing, and flotation</td>
</tr>
<tr>
<td>2</td>
<td>Metal melting</td>
</tr>
<tr>
<td>3</td>
<td>Clinker production</td>
</tr>
<tr>
<td>4</td>
<td>Electrical transportation</td>
</tr>
</tbody>
</table>

5. Energy stations and technologies of mass application

<table>
<thead>
<tr>
<th>N</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Technological units with variable speed electric motors</td>
</tr>
<tr>
<td></td>
<td>Description</td>
</tr>
<tr>
<td>---</td>
<td>-----------------------------------</td>
</tr>
<tr>
<td>2</td>
<td>Heat supply station</td>
</tr>
<tr>
<td>3</td>
<td>Electrical lighting stations</td>
</tr>
<tr>
<td>4</td>
<td>Thermal insulation of buildings</td>
</tr>
<tr>
<td>5</td>
<td>Transportation means</td>
</tr>
</tbody>
</table>
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

<table>
<thead>
<tr>
<th>N</th>
<th>ES Targets</th>
<th>ES potential</th>
<th>ES potential, 1000 toe</th>
<th>CO2 emission reduction, 1000 t</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ES excluding transport and building heating systems</td>
<td>1,035,658 MWh</td>
<td>89.05</td>
<td>164.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>84,734,000 m³ (natural gas)</td>
<td>75.40</td>
<td>161.6</td>
</tr>
<tr>
<td>2</td>
<td>ES in transport sector</td>
<td>293.4 TJ</td>
<td>7.01</td>
<td>3.9</td>
</tr>
<tr>
<td>3</td>
<td>ES in buildings</td>
<td>4.02 mln GCal</td>
<td>402.00</td>
<td>2.3</td>
</tr>
<tr>
<td>4</td>
<td>ES in Yerevan TPP (new technologies)</td>
<td>265,000,000 m³ (natural gas)</td>
<td>235.82</td>
<td>505.2</td>
</tr>
<tr>
<td>5</td>
<td>ES in Hrazdan TPP (new technologies)</td>
<td>223,000,000 m³ (natural gas)</td>
<td>198.45</td>
<td>425.2</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>1,007.73</strong></td>
<td><strong>1,278.5</strong></td>
<td></td>
</tr>
</tbody>
</table>
6. ENERGY SAVING PROGRAM

6.1. TARGETS FOR ENERGY SAVING

Table 16. Priority sectors for energy savings

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

Table 17. Electricity production

<table>
<thead>
<tr>
<th>N</th>
<th>Energy saving targets</th>
<th>Energy saving potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Installation of new gas-turbine station with 210 MW capacity in Yerevan TPP which will result in fuel (natural gas) saving</td>
<td>Around 184÷265 million m³ of natural gas</td>
</tr>
<tr>
<td>2</td>
<td>Reconstruction of 5th unit of Hrazdan TPP, which will result in fuel (natural gas) savings</td>
<td>223 million m³ of natural gas</td>
</tr>
<tr>
<td>3</td>
<td>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</td>
<td>56 thousand tcf</td>
</tr>
<tr>
<td>4</td>
<td>Application of renewable energy technologies through utilization of domestic resources, which will result in increased energy independence of the country</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>Introduction of new, and reconstruction of existing, automatic control systems in electricity generation stations</td>
<td>Up to 7%</td>
</tr>
<tr>
<td>6</td>
<td>Annual electricity and natural gas savings through application of efficient operation procedures in energy system</td>
<td>Up to 120 million kWh or up to 24 million m³ of natural gas</td>
</tr>
</tbody>
</table>
### Table 18. Copper, ore, canned food, rubber and metal industries

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

### Table 19. Thermal energy production and heating systems

<table>
<thead>
<tr>
<th>N</th>
<th>Energy saving targets</th>
<th>Energy saving potential (natural gas)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Energy saving through improvement and automatization of combustion process</td>
<td>2.4 million m³</td>
</tr>
<tr>
<td>2</td>
<td>Energy saving through utilization of secondary energy sources</td>
<td>4 million m³</td>
</tr>
<tr>
<td>3</td>
<td>Natural gas savings through improvement of thermal insulation of transmission pipeline and substations and application of thermal insulation with the best thermophysical characteristics</td>
<td>27 million m³</td>
</tr>
<tr>
<td>4</td>
<td>Natural gas savings through reduction of backflow water</td>
<td>6 million m³</td>
</tr>
<tr>
<td>5</td>
<td>Achievement of savings through optimization of boiler-house operation process</td>
<td>20 million m³</td>
</tr>
<tr>
<td>6</td>
<td>Achievement of savings through securing the proper pressure of natural gas supplied to the boiler-house</td>
<td>7 million m³</td>
</tr>
<tr>
<td>7</td>
<td>Energy savings through improvement of insulation in electric, thermal, and nuclear power plants and application of insulation materials with the best thermal-physical characteristics</td>
<td>700 tcf</td>
</tr>
<tr>
<td>8</td>
<td>Natural gas saving through reduction of water losses and weatherization of valves</td>
<td>300 tcf</td>
</tr>
<tr>
<td>9</td>
<td>Natural gas saving through improvement of the operation of thermal substations</td>
<td>200 tcf</td>
</tr>
<tr>
<td>10</td>
<td>Reduction of thermal energy losses and natural gas saving through introduction of technical and commercial automatic control systems in heat-supply systems</td>
<td>76 thousand m³</td>
</tr>
</tbody>
</table>

### Table 20. Electricity distribution and transmission networks

<table>
<thead>
<tr>
<th>N</th>
<th>Energy saving targets</th>
<th>Energy saving potential</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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 Electricity savings through reduction of disparities of load schedule and introduction of double-tariff system

6 Reduction 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**

<table>
<thead>
<tr>
<th>N</th>
<th>Energy saving targets</th>
<th>Energy saving potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Reduction of natural gas losses in the network and natural gas saving</td>
<td>51 thousand tcf</td>
</tr>
<tr>
<td>2</td>
<td>Modernization of underground gas storages</td>
<td>20 thousand tcf</td>
</tr>
</tbody>
</table>

**Table 22. Thermal insulation of buildings**

<table>
<thead>
<tr>
<th>N</th>
<th>Energy saving targets</th>
<th>Energy saving potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Thermal insulation of residential buildings</td>
<td>3.35 million GCal</td>
</tr>
<tr>
<td>2</td>
<td>Thermal insulation of municipal buildings</td>
<td>0.67 million GCal</td>
</tr>
</tbody>
</table>

**Table 23. Transportation**

<table>
<thead>
<tr>
<th>N</th>
<th>Energy saving targets</th>
<th>Energy saving potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20% increase of vehicle number</td>
<td>293.4 TJ</td>
</tr>
</tbody>
</table>
### 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

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Development of legislative field for energy saving, design of normative-technical documentation, design of regulations for implementation of energy audit, etc.</td>
</tr>
<tr>
<td>2</td>
<td>Promotion of energy saving foundations activities with the involvement of local and foreign financing resources</td>
</tr>
<tr>
<td>3</td>
<td>Provision of financial incentives for energy saving by the state and governmental bodies</td>
</tr>
<tr>
<td>4</td>
<td>Provision of targeted financial-crediting and tax incentives for implementation of energy saving measures</td>
</tr>
<tr>
<td>5</td>
<td>Organization of laboratories for certified testing in energy saving and renewable energy fields</td>
</tr>
<tr>
<td>6</td>
<td>Creation and development of energy saving and renewable energy revolving funds</td>
</tr>
<tr>
<td>7</td>
<td>Practical implementation and popularization of energy audit in energy consuming enterprises</td>
</tr>
<tr>
<td>8</td>
<td>Reduction of fuel-energy consumption through implementation of organizational-technical measures</td>
</tr>
<tr>
<td>9</td>
<td>Organization of the process of thermal insulation of buildings with the assistance of different funds, affordable loans, etc.</td>
</tr>
<tr>
<td>10</td>
<td>Organization of mandatory and voluntary certification process for energy saving production</td>
</tr>
<tr>
<td>11</td>
<td>Implementation of teaching, advertisement, and international cooperation in the field of energy saving</td>
</tr>
<tr>
<td>12</td>
<td>Improvement of fuel-energy price-setting mechanism, and introduction of payment system for reactive power</td>
</tr>
<tr>
<td>13</td>
<td>Provision of incentives for production of local thermal insulating materials with high characteristics</td>
</tr>
<tr>
<td>14</td>
<td>Collection of statistical data on state fuel-energy balance</td>
</tr>
<tr>
<td>15</td>
<td>Implementation of organizational and educational measures</td>
</tr>
<tr>
<td>16</td>
<td>Introduction of economic and moral (awards, medals, etc.) incentives for energy efficiency</td>
</tr>
<tr>
<td>17</td>
<td>Organization and implementation of energy audit during the design and planning stages</td>
</tr>
<tr>
<td>18</td>
<td>Organization of pilot projects, testing areas, and exhibitions in the field of energy saving and renewable energy</td>
</tr>
</tbody>
</table>
Table 25. Regulation and improvement of existing technologies

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Improvement of heating systems in residential areas of Armenia</td>
</tr>
<tr>
<td>2</td>
<td>Improvement of street lighting system in residential areas of Armenia</td>
</tr>
<tr>
<td>3</td>
<td>Design, definition and provision of optimal parameters for optimal control of energy system</td>
</tr>
<tr>
<td>4</td>
<td>Reduction of fuel-energy resource losses in production, transmission and distribution processes through implementation of technical measures</td>
</tr>
<tr>
<td>5</td>
<td>Reduction of water losses in the network through modernization of water pipelines</td>
</tr>
<tr>
<td>6</td>
<td>Implementation of thermal insulation in the apartments</td>
</tr>
<tr>
<td>7</td>
<td>Glazing, repair and weatherization of doors and windows in the entrances of residential buildings</td>
</tr>
<tr>
<td>8</td>
<td>Introduction of energy saving systems in lighting systems of entrances (50 AMD/month per apartment)</td>
</tr>
<tr>
<td>9</td>
<td>Application of precise equipment (0.1-0.25 accuracy rating) in fuel-energy metering systems</td>
</tr>
<tr>
<td>10</td>
<td>Increase of quality and autoimmunization of fuel-energy resource and water metering systems</td>
</tr>
<tr>
<td>11</td>
<td>Compensation of reactive power</td>
</tr>
<tr>
<td>12</td>
<td>Utilization of secondary fuel-energy resources (5-10 % saving)</td>
</tr>
<tr>
<td>13</td>
<td>Reduction of losses in natural gas network (up to 2 times)</td>
</tr>
<tr>
<td>14</td>
<td>Modernization of commercial accounts in natural gas system</td>
</tr>
<tr>
<td>15</td>
<td>Control and meeting the requirements for electricity quality indices (~5 % saving of motor load)</td>
</tr>
<tr>
<td>16</td>
<td>Reduction of relative fuel-energy resource consumption in electricity production</td>
</tr>
<tr>
<td>17</td>
<td>Application of automatic control systems in heat supply, hot water supply and cooling systems</td>
</tr>
</tbody>
</table>
Table 26. Design and application of new energy efficient technologies and equipment

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

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

<table>
<thead>
<tr>
<th></th>
<th>Electric processes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Electric power (motors – transformation of electricity into mechanical)</td>
</tr>
<tr>
<td>1.1</td>
<td>Thermoelectric (transformation of electricity into thermal)</td>
</tr>
<tr>
<td>1.2</td>
<td>Electro-technological (transformation of electricity into light, laser, etc)</td>
</tr>
<tr>
<td>1.3</td>
<td>Transformation of electricity (voltage control, transformation of direct current into alternating current, etc.)</td>
</tr>
<tr>
<td>1.4</td>
<td>Generation of electricity</td>
</tr>
<tr>
<td>1.5</td>
<td>Control, monitoring and accounting of electricity consumption</td>
</tr>
<tr>
<td>1.6</td>
<td>Introduction of new technologies for generation and distribution of electricity</td>
</tr>
<tr>
<td>2</td>
<td>Thermal processes</td>
</tr>
<tr>
<td>2.1</td>
<td>Production of thermal energy (cold)</td>
</tr>
<tr>
<td>2.2</td>
<td>Supply, distribution and transformation of thermal energy</td>
</tr>
<tr>
<td>2.3</td>
<td>Consumption of thermal energy in heat and hot water supply systems</td>
</tr>
<tr>
<td>2.4</td>
<td>Heat supply of buildings and constructions</td>
</tr>
<tr>
<td>2.5</td>
<td>Consumption of thermal energy during technological processes (melting, heating, etc.)</td>
</tr>
<tr>
<td>2.6</td>
<td>Low-potential heat extracting (secondary fuel-energy resources)</td>
</tr>
<tr>
<td>2.7</td>
<td>Control of combustion process</td>
</tr>
<tr>
<td>2.8</td>
<td>Control, monitoring and accounting of thermal energy consumption</td>
</tr>
<tr>
<td>Section</td>
<td>Description</td>
</tr>
<tr>
<td>---------</td>
<td>-------------</td>
</tr>
<tr>
<td>2.9</td>
<td>Introduction of new technologies</td>
</tr>
<tr>
<td>3.0</td>
<td>Technological processes</td>
</tr>
<tr>
<td>3.1</td>
<td>Optimal control of technological processes</td>
</tr>
<tr>
<td>3.2</td>
<td>Implementation of technological process according to the design requirements</td>
</tr>
<tr>
<td>3.3</td>
<td>Decreasing the idling process</td>
</tr>
<tr>
<td>3.4</td>
<td>Introduction of new energy efficient technologies</td>
</tr>
<tr>
<td>3.5</td>
<td>Introduction of automatic control systems</td>
</tr>
<tr>
<td>3.6</td>
<td>Introduction of automatic measurement systems</td>
</tr>
<tr>
<td>3.7</td>
<td>Utilization of renewable energy resources</td>
</tr>
</tbody>
</table>
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 m³” unit refers to natural gas, and the “MWh” unit refers to electricity.

**Table 28. Energy Saving Program for the Armenian Economy**

<table>
<thead>
<tr>
<th>N</th>
<th>Energy Saving measures, by the sphere of activity</th>
<th>Natural volume</th>
<th>Natural</th>
<th>Value</th>
<th>toe</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Total energy saving potential</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Unit</td>
<td>Value</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Agriculture and provision of services (irrigation)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Elimination of failures and improvement of technological processes, organizational measures, decrease of idling process</td>
<td>MWh</td>
<td>5,078</td>
<td>436.7</td>
<td>5.5</td>
<td></td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>----</td>
<td>-------------------------------------------------</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td></td>
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<td>Natural volume</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Unit</td>
<td>Value</td>
<td>toe</td>
<td>%</td>
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18  Accumulation, purification and distribution of drinking water

<table>
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<th>Elimination of failures and improvement of technological processes, organizational measures, decrease of idling process</th>
<th>MWh</th>
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19  Construction

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20  Car trading, maintenance and repair

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21  Retail sale

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<th>48</th>
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<td></td>
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<td></td>
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<td>48</td>
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22  Hotels and restaurants

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<th>MWh</th>
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</tr>
<tr>
<td>----</td>
<td>-------------------------------------------------</td>
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<td>Natural volume</td>
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<td></td>
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<td></td>
<td></td>
<td>Unit</td>
<td>Value</td>
<td>toe</td>
<td>%</td>
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<tr>
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<td>Improvement of thermal insulation</td>
<td>1000 m³</td>
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<td>90.2</td>
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<td>6.5</td>
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<td>Ground transportation</td>
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<td>5.8</td>
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<td>31</td>
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</tr>
<tr>
<td>----</td>
<td>--------------------------------------------------</td>
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<tr>
<td></td>
<td></td>
<td>Natural volume</td>
<td>toe</td>
<td>%</td>
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<tr>
<td></td>
<td></td>
<td>Unit</td>
<td>Value</td>
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</tr>
<tr>
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<td>Activities of social units</td>
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<td>1,179.8</td>
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<td>2,086.7</td>
<td>3.5</td>
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<td>MWh</td>
<td>135,524</td>
<td>11,653</td>
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<td><strong>Total</strong></td>
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<td>14,919.5</td>
<td>15.9</td>
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<td>Residential sector</td>
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<td></td>
<td></td>
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<td>11</td>
<td>1</td>
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<td>32.5</td>
<td>3.1</td>
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<td></td>
<td>43.5</td>
<td>2.7</td>
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<td>35</td>
<td>Foreign companies activities</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td><strong>TOTAL: ELECTRICITY</strong></td>
<td>MWh</td>
<td>1,035,658</td>
<td>89,051</td>
<td>5.4168</td>
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<td><strong>TOTAL: NATURAL GAS</strong></td>
<td>1000 m³</td>
<td>572,734</td>
<td>509,679</td>
<td>31.003</td>
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<td><strong>TOTAL IN ALL SPHERES OF ACTIVITIES</strong></td>
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<td>598,730</td>
<td>36.4</td>
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</table>
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**

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Energy saving options</td>
<td>Pessimistic (30% utilization of energy saving potential)</td>
</tr>
<tr>
<td>Name</td>
<td>Measurement unit</td>
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<tr>
<td>GDP (cumulative for the whole timeline)</td>
<td>bln. Amd</td>
</tr>
<tr>
<td>Consumption of fuel energy resources, without utilization of energy saving potential</td>
<td>thousand toe</td>
</tr>
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</table>
### Figure 11. Combined data on utilization of energy saving potential for 2006-2020 period

#### Consumption of fuel energy resources, with utilization of energy saving potential

<table>
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<tr>
<th></th>
<th>thousand toe</th>
<th>48,217</th>
<th>43,278</th>
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<td>Energy saving potential</td>
<td>thousand toe</td>
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<td>-9,173</td>
<td>-14,112</td>
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<tr>
<td>Energy efficiency of GDP</td>
<td>thousand AMD/kg oe</td>
<td>1.042</td>
<td>1.161</td>
<td>1.311</td>
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</tbody>
</table>

#### Notes
- Pessimistic (30% utilization of energy saving potential)
- Average (65% utilization of energy saving potential)
- Optimistic (100% utilization of energy saving potential)
8. RENEWABLE ENERGY POTENTIAL IN ARMENIA

8.1. HYDROELECTRIC POTENTIAL

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

<table>
<thead>
<tr>
<th>N</th>
<th>Name of reservoir</th>
<th>Number HPP-s units</th>
<th>Total installed capacity, kW</th>
<th>Average yearly production mln. kWh</th>
<th>Level, m</th>
<th>Static pressure m</th>
<th>Designed expenses m³/s</th>
<th>Total water flow through HPPs, min. m³</th>
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<td>1</td>
<td>r. Debet</td>
<td>79</td>
<td>35,501</td>
<td>123,47</td>
<td>2,075</td>
<td>635</td>
<td>1,440</td>
<td>0.12 - 2.8</td>
</tr>
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<td>2</td>
<td>r. Aghstev</td>
<td>67</td>
<td>58,270</td>
<td>159,27</td>
<td>1,725</td>
<td>610</td>
<td>1,115</td>
<td>0.3 - 4.5</td>
</tr>
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<td>3</td>
<td>r. Akhuryan</td>
<td>14</td>
<td>24,985</td>
<td>79,75</td>
<td>2,500</td>
<td>1,109</td>
<td>1,381</td>
<td>0.5 - 29</td>
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<td>4</td>
<td>r. Qasakh</td>
<td>14</td>
<td>7,905</td>
<td>19,16</td>
<td>2,805</td>
<td>2,055</td>
<td>750</td>
<td>0.6 - 1.8</td>
</tr>
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<td>r. Hrazdan</td>
<td>13</td>
<td>9,070</td>
<td>27,37</td>
<td>2,225</td>
<td>1,490</td>
<td>135</td>
<td>0,5 - 4.0</td>
</tr>
<tr>
<td>6</td>
<td>Lake Sevan</td>
<td>20</td>
<td>22,965</td>
<td>66,03</td>
<td>2,760</td>
<td>1,960</td>
<td>800</td>
<td>0.6 - 4.0</td>
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<td>7</td>
<td>Azat and Vedi rivers</td>
<td>20</td>
<td>18,215</td>
<td>56,15</td>
<td>2,455</td>
<td>1,310</td>
<td>1,145</td>
<td>0.7 - 2.6</td>
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<td>r. Arpa</td>
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<td>35,410</td>
<td>88,58</td>
<td>2,523</td>
<td>1,165</td>
<td>1,358</td>
<td>0.26 - 4.8</td>
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<td>9</td>
<td>Meghri and Vokhchi rivers</td>
<td>52</td>
<td>21,245</td>
<td>72,63</td>
<td>2,960</td>
<td>690</td>
<td>2,270</td>
<td>0.3 - 6.0</td>
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<td>r. Vorotan</td>
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<td>9,800</td>
<td>44,97</td>
<td>2,208</td>
<td>1,440</td>
<td>768</td>
<td>0.5 - 11.6</td>
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<td>243,366</td>
<td>737,38</td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Source of biogas</th>
<th>Volume of investments million USD</th>
<th>Yearly volume of biogas, mln. m³/year</th>
<th>Yearly saving of organic fuel thousand tcf</th>
<th>Payback period, year</th>
<th>Decrease in greenhouse gas emissions, thousand ton CO₂/year</th>
<th>The ratio of yearly fuel savings and investments, thousand tcf/mln. USD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle manure from farms</td>
<td>0.73</td>
<td>1.06</td>
<td>0.83</td>
<td>8</td>
<td>15.57</td>
<td>1.15</td>
</tr>
<tr>
<td>Pig manure from farms</td>
<td>0.21</td>
<td>0.3</td>
<td>0.24</td>
<td>8</td>
<td>4.41</td>
<td>1.15</td>
</tr>
<tr>
<td>Excrement from poultry farms</td>
<td>16.55</td>
<td>9.79</td>
<td>7.69</td>
<td>8</td>
<td>206.84</td>
<td>0.46</td>
</tr>
<tr>
<td>Nubarashen city land fill</td>
<td>6.83</td>
<td>9.72</td>
<td>7.62</td>
<td>8</td>
<td>135.0</td>
<td>1.12</td>
</tr>
<tr>
<td>Land fills of other Armenian cities</td>
<td>3.85</td>
<td>5.47</td>
<td>4.29</td>
<td>8</td>
<td>76.08</td>
<td>1.12</td>
</tr>
<tr>
<td>Clean-up of sewage</td>
<td>6.01</td>
<td>12</td>
<td>9.43</td>
<td>8</td>
<td>106.7</td>
<td>1.57</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>34.17</strong></td>
<td><strong>38.34</strong></td>
<td><strong>30.10</strong></td>
<td><strong>544.6</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

8.3. SOLAR ENERGY POTENTIAL

Table 32. Annual solar radiation indices, kWh/m²

<table>
<thead>
<tr>
<th>Area</th>
<th>Radiation index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yerevan</td>
<td>1,647.2</td>
</tr>
<tr>
<td>Kalinino</td>
<td>1,404</td>
</tr>
<tr>
<td>Gyumri</td>
<td>1,624</td>
</tr>
<tr>
<td>Sevan</td>
<td>1,670</td>
</tr>
<tr>
<td>Martuni</td>
<td>1,740</td>
</tr>
<tr>
<td>Jermuk</td>
<td>1,682</td>
</tr>
<tr>
<td>Kochbek</td>
<td>1,786.4</td>
</tr>
<tr>
<td>Kapan</td>
<td>1,647.2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>13,200.8</strong></td>
</tr>
</tbody>
</table>
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 CO₂ emissions by 42,960 tons.

Figure 12. Solar energy potential in Armenia

### 8.4. HYDROTHERMAL ENERGY POTENTIAL

Table 33. Hydrothermal energy potential

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

* investigation process not finished
** high concentration of minerals

### 8.5. DISTRIBUTION OF WIND POWER POTENTIAL IN ARMENIA

Table 34. Wind power potential

<table>
<thead>
<tr>
<th>Area</th>
<th>Design capacity, W/m²</th>
<th>Strength of the wind, * m/s</th>
<th>Area of the zone **, km²</th>
<th>Collective capacity of wind power generators, MW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qarakhach mountain pass</td>
<td>300 – 400</td>
<td>6.5 – 7.0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Pushkin mountain pass</td>
<td>500 – 600</td>
<td>7 – 8.0</td>
<td>-</td>
<td>2.5</td>
</tr>
<tr>
<td></td>
<td>Location</td>
<td>Height Range</td>
<td>Wind Speed Range</td>
<td>Notes</td>
</tr>
<tr>
<td>---</td>
<td>-----------------------------------</td>
<td>--------------</td>
<td>-----------------</td>
<td>-------</td>
</tr>
<tr>
<td>3</td>
<td>Jajur mountain pass</td>
<td>200 – 300</td>
<td>5.0 – 5.6</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>Sevan western mountain range</td>
<td>300 - 450</td>
<td>5.8 – 6.0</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>Aragats</td>
<td>400 – 450</td>
<td>7.0 – 7.5</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td>Geghama mountain range</td>
<td>200 – 300</td>
<td>5.8 – 6.8</td>
<td>-</td>
</tr>
<tr>
<td>7</td>
<td>Zodi area</td>
<td>500 – 600</td>
<td>7.5 – 8.0</td>
<td>-</td>
</tr>
<tr>
<td>8</td>
<td>Sisian-Goris</td>
<td>300 – 400</td>
<td>6.8 – 7.0</td>
<td>-</td>
</tr>
<tr>
<td>9</td>
<td>Sisian mountain range</td>
<td>200 – 300</td>
<td>5.6 – 6.5</td>
<td>-</td>
</tr>
<tr>
<td>10</td>
<td>Meghri area</td>
<td>400 – 450</td>
<td>7.5 – 7.8</td>
<td>-</td>
</tr>
</tbody>
</table>

* 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

<table>
<thead>
<tr>
<th>N</th>
<th>Name</th>
<th>Financial sources</th>
<th>Overview</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Taxes imposed on energy carriers</td>
<td>Taxes imposed on the following energy carriers:</td>
<td>The list of taxes imposed on energy carriers is harmonized with the similar taxes applied in EU. Discussion 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.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Diesel fuel for transport</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Natural and liquid oil gas for transport</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Natural gas for heat supply</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Fuel resources for boiler houses and mazut (residual fuel-oil)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Liquid oil gas and kerosene for heat supply</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Electricity</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Energy Saving and Renewable Energy Fund of Armenia</td>
<td>- Energy carrier taxes</td>
<td>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.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Budget allocations</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Assistance from the international financial institutions</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Energy audit for sector-based developmental programs, as well as for the national and socially targeted programs</td>
<td>- Budget allocations</td>
<td>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 may lead to the distortion of people’s understanding of the market price for goods and services.</td>
</tr>
<tr>
<td>N</td>
<td>Name</td>
<td>Financial sources</td>
<td>Overview</td>
</tr>
<tr>
<td>----</td>
<td>----------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>4</td>
<td>Provision of credit lines by international financial institutions</td>
<td>- EBRD</td>
<td>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.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- World Bank</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- IMF</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- KfW</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Global Ecological Fund, etc.</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Technical assistance programs</td>
<td>EU and USAID sponsored technical assistance programs from</td>
<td>The priority areas of assistance include development of national and social programs, organization of marketing research, education of specialists, and implementation of advertisement measures.</td>
</tr>
<tr>
<td>6</td>
<td>Loans from Revolving Fund</td>
<td>Energy Saving and Renewable Energy Fund of Armenia</td>
<td>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.</td>
</tr>
<tr>
<td>7</td>
<td>Energy examination</td>
<td>Energy Saving and Renewable Energy Fund of Armenia</td>
<td>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.</td>
</tr>
<tr>
<td>8</td>
<td>Mechanism of partial subsidizing of interest rates of commercial loans</td>
<td>Energy Saving and Renewable Energy Fund of Armenia</td>
<td>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.</td>
</tr>
<tr>
<td>9</td>
<td>ESCOs</td>
<td>Co-funding ESCOs from the Energy Saving and Renewable Energy Fund of Armenia</td>
<td>Application of this mechanism is market driven. The ESCOs will serve as the project initiators, investors and implementers, bearing all the investment 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.</td>
</tr>
<tr>
<td>N</td>
<td>Name</td>
<td>Financial sources</td>
<td>Overview</td>
</tr>
<tr>
<td>----</td>
<td>------------------------------------------------</td>
<td>-------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>10</td>
<td>Low-budget projects</td>
<td>ESCOs</td>
<td>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.</td>
</tr>
<tr>
<td>11</td>
<td>State (fiscal) mechanisms, “diverted taxes”</td>
<td></td>
<td>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.</td>
</tr>
<tr>
<td>12</td>
<td>Voluntary agreement mechanism</td>
<td>Tax incentives</td>
<td>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.</td>
</tr>
<tr>
<td>13</td>
<td>Provision of incentives to producers and importers of energy saving and renewable energy technologies, equipment and materials</td>
<td>Tax incentives</td>
<td>Tax incentives should be provided to producers and importers of energy saving and renewable energy technologies, 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.</td>
</tr>
<tr>
<td>14</td>
<td>State procurement mechanism</td>
<td>State budget</td>
<td>The mechanism of state procurement can support the distribution of new technologies in the market and decrease</td>
</tr>
<tr>
<td>N</td>
<td>Name</td>
<td>Financial sources</td>
<td>Overview</td>
</tr>
<tr>
<td>----</td>
<td>-----------------------------------------------</td>
<td>-------------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>15</td>
<td>Involvement of private capital through privatization</td>
<td></td>
<td>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.</td>
</tr>
<tr>
<td>16</td>
<td>Assistance to implementation of collaborative projects</td>
<td></td>
<td>The Government of Armenia will promote implementation 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.</td>
</tr>
</tbody>
</table>

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

- **Government of RA**
  - Legal normative acts

- **Energy Saving and Renewable Energy Fund Council**
  - Inclusion of energy saving constituent in the tariffs
  - Tax and customs incentives provided to certified products, equipment and technologies
  - Energy efficient products, equipment and technologies produced in Armenia and imported

- **Line Ministries**
  - (coordination of development programs audit)
  - Management

- **Energy Saving and Renewable Energy Fund**
  - Allocations from the collected fees for fuel-energy resources

- **Public Utilities Regulatory Commission of Armenia**
  - Tariffs for electric and thermal energy, and natural gas
  - Inclusion of energy saving constituent in the tariffs

- **Certified institutions**
  - Testing laboratory
  - Certification body
  - Certification and labeling

- **ESCO**
  - Energy saving projects by commercial institutions
  - Energy saving projects with national importance
  - Socially targeted energy saving projects
  - Organizations with budgetary financing

- **First and second degree examination and passportization**
  - Provision of low interest loans, compensation of banking interest rates
  - Including tax incentives
  - Including compensations and grants
  - Including compensations and grants

- **Organizations with budgetary financing**
  - Inclusion of energy saving constituent in the tariffs
  - Tax and customs incentives provided to certified products, equipment and technologies

- **Line Ministries**
  - (coordination of development programs audit)
  - Management
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 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.
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.
17. Recommendation regarding strategy development in the sphere of energy efficiency. Energy Chapter Secretary, page 42.

68


29. Agriculture. September 1996. TACIS/93/EAR001


43. Renewable Energy in Russia. From opportunity to reality. 2004, page 120.


90. Websites.
91. Economic development and research center EDRC - www.edrc.am
92. British Petroleum- www.bp.com
94. IEA- www.iea.org
95. AEPLAC- www.aeplac.am
96. RA Government- www.gov.am
98. The World Energy Council- www.worldenergy.org
99. Ministry of Nature Protection RA- www.nature.am
100. National Statistical Survey RA- www.armstat.am
101. ARKA Agency www.arka.am
102. Residential heat project. - www.heat.am (from November 10th an information database will be available on the website, Gayane Dalaqyan has more information on this tel. 268982, 210883, 091 210256)
104. International Monetary Fund- www.imf.org
105. Ecoteam- http://ecoteam.iatp.irex.am
## APPENDIX A. STRUCTURE OF FUEL-ENERGY RESOURCE CONSUMPTION BY MAJOR CONSUMERS

<table>
<thead>
<tr>
<th>N</th>
<th>Economic activity sector</th>
<th>Sector code</th>
<th>2005 consumption of fuel-energy resources</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Name of the sector</td>
<td>Sector code</td>
<td>Electricity, thousand kWh</td>
</tr>
<tr>
<td>1</td>
<td>Agriculture, hunting and forest economy</td>
<td>01-02</td>
<td>286,826.8</td>
</tr>
<tr>
<td>2</td>
<td>Mining Industry</td>
<td>10-14</td>
<td>370,959.8</td>
</tr>
<tr>
<td>3</td>
<td>Manufacturing Industry</td>
<td>15-37</td>
<td>649,128.0</td>
</tr>
<tr>
<td>3.1</td>
<td>Food Industry, including beverage and tobacco production</td>
<td>15-16</td>
<td>236,646.1</td>
</tr>
<tr>
<td>3.2</td>
<td>Textile and clothing industry</td>
<td>17-18</td>
<td>2,472.5</td>
</tr>
<tr>
<td>3.3</td>
<td>Production of paper and card board, publishing work</td>
<td></td>
<td>1,583.6</td>
</tr>
<tr>
<td>3.4</td>
<td>Chemical industry</td>
<td>24.0</td>
<td>227,585.6</td>
</tr>
<tr>
<td>3.5</td>
<td>Production of rubber and plastic products</td>
<td>25.0</td>
<td>7,465.0</td>
</tr>
<tr>
<td>3.6</td>
<td>Productions of other non metal mining</td>
<td>26.0</td>
<td>102,342.1</td>
</tr>
<tr>
<td>3.7</td>
<td>Metal industry, and production of metal products</td>
<td>27-28</td>
<td>30,462.1</td>
</tr>
<tr>
<td>3.8</td>
<td>Automobile and equipment production</td>
<td>29.0</td>
<td>12,780.0</td>
</tr>
<tr>
<td>3.9</td>
<td>Production of electric, electronic and optical equipment</td>
<td>30-33</td>
<td>22,079.0</td>
</tr>
<tr>
<td>3.10</td>
<td>Other sectors of economy</td>
<td>36-37</td>
<td>5,711.8</td>
</tr>
<tr>
<td>4</td>
<td>Production and distribution of electricity, gas, and water</td>
<td>40-41</td>
<td>428,623.6</td>
</tr>
<tr>
<td>5</td>
<td>Construction</td>
<td>45.0</td>
<td>2,455.7</td>
</tr>
<tr>
<td>6</td>
<td>Commerce, repair of automobiles, consumer and personal use products</td>
<td>50-52</td>
<td>53,130.2</td>
</tr>
<tr>
<td>7</td>
<td>Hotels and Restaurants</td>
<td>55.0</td>
<td>12,795.4</td>
</tr>
<tr>
<td>8</td>
<td>Transportation and communication</td>
<td>60-64</td>
<td>181,785.0</td>
</tr>
<tr>
<td>9</td>
<td>Financial activity</td>
<td>65-67</td>
<td>1,411.9</td>
</tr>
<tr>
<td>10</td>
<td>Activities connected with real estate, property rental and customer services</td>
<td>70-74</td>
<td>7,456.0</td>
</tr>
<tr>
<td>11</td>
<td>State Management</td>
<td>75.0</td>
<td>168,541.0</td>
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<tr>
<td>12</td>
<td>Education</td>
<td>80.0</td>
<td>5,898.3</td>
</tr>
<tr>
<td>13</td>
<td>Health care and social services</td>
<td>85.0</td>
<td>58,701.2</td>
</tr>
<tr>
<td>14</td>
<td>Provision of public, social, and individual services</td>
<td>90-93</td>
<td>2,145,057.0</td>
</tr>
<tr>
<td>15</td>
<td>Activities of foreign organizations</td>
<td>99.0</td>
<td>1,535.7</td>
</tr>
<tr>
<td>16</td>
<td>TOTAL</td>
<td>4,374,305.6</td>
<td>1,443,538.9</td>
</tr>
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</table>
APPENDIX B: RELATIVE CONSUMPTION OF FUEL-ENERGY RESOURCES IN VARIOUS SECTORS OF ECONOMY

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

Description:
- Agriculture, hunting and service provision in those sectors
- Extraction of iron ore
- Copper ore extraction and dressing (in the converters)
- Food Industry, including beverage production
- Poultry, egg and rabbit meat production
- Macaroni production
- Beer production
- Fruit and vegetable processing and canning
- Production of mineral water, including mineral water bottling
- Textile production
- Production of knitted socks
- Chemical industry
- Production of synthetic rubber
<table>
<thead>
<tr>
<th>Code</th>
<th>Category</th>
<th>Subcategory</th>
<th>Code</th>
<th>Description</th>
<th>Unit</th>
<th>Quantity</th>
<th>Unit Price</th>
<th>Revenue</th>
<th>Expenses</th>
<th>Profit</th>
<th>Main Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.2</td>
<td>Production of synthetic cauchoouk</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&quot;Prometey chem-prom&quot; CJSC</td>
</tr>
<tr>
<td>15</td>
<td>Production of rubber and plastic products</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15.1</td>
<td>Production of mechanical rubber products</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Productions of other non metal ore products</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16.1</td>
<td>Cement production (with gas) using wet method (in Hrazdan)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&quot;Mika cement&quot; CJSC</td>
</tr>
<tr>
<td>16.2</td>
<td>Cement production (with gas) using dry method (in Ararat)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&quot;Ararat Cement&quot; CJSC</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>The data is insufficient</td>
</tr>
<tr>
<td>16.3</td>
<td>Gypsum and plaster production</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&quot;Gajegorts&quot; CJSC</td>
</tr>
<tr>
<td>17</td>
<td>Metal industry</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17.1</td>
<td>Cast iron, iron and ferro-alloy production</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&quot;Dzulakentron&quot; &quot;Avtolit&quot;</td>
</tr>
<tr>
<td>17.2</td>
<td>Ferro-alloy and other metal production</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&quot;Clean metal&quot; factory</td>
</tr>
<tr>
<td>18.1</td>
<td>Ready metal goods production produced through hardening, stamping, or rolling</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&quot;Hydroeconstruction&quot;</td>
</tr>
<tr>
<td>19</td>
<td>Production of machines and equipment</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19.1</td>
<td>Production of equipment for metal covering</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&quot;Autogen&quot;</td>
</tr>
<tr>
<td>26</td>
<td>Other products not included in the main categories</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26.1</td>
<td>Diamond production</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&quot;Shoghakn&quot;</td>
</tr>
<tr>
<td></td>
<td>Diamond (precious stone) production</td>
<td>36.22.2</td>
<td>7.16</td>
<td>number produced</td>
<td>2.2</td>
<td>0.59</td>
<td>3.24</td>
<td>0.08</td>
<td><em>Sapfire</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>------------------------------------</td>
<td>---------</td>
<td>------</td>
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<tr>
<td>34</td>
<td>Ground transportation</td>
<td>60</td>
<td>6.18</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>34.1</td>
<td>Troleybus</td>
<td>60.21.3</td>
<td>0.57</td>
<td>number of people transferred</td>
<td>0.67</td>
<td>28.7</td>
<td>0.54</td>
<td>4.07</td>
<td>0.13</td>
<td><em>Yerevan electric transportation</em> CJSC</td>
<td></td>
</tr>
<tr>
<td>34.2</td>
<td>Metro</td>
<td>60.21.4</td>
<td>28.53</td>
<td>number of people transferred</td>
<td>850</td>
<td>1,150</td>
<td>4.06</td>
<td>145.40</td>
<td>104.43</td>
<td>&quot;Metropoliten&quot; CJSC</td>
<td></td>
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</table>
APPENDIX C: ELECTRICITY SAVING POTENTIAL FOR MAJOR CONSUMERS, WITH VARIABLE ELECTRIC MOTOR LOAD, IN CASE OF NEW TECHNOLOGY APPLICATION

<table>
<thead>
<tr>
<th>N</th>
<th>Sector</th>
<th>Name code</th>
<th>Name of the company</th>
<th>Cumulative installed electric power KW</th>
<th>Electric power of electric motors with variable load, KW</th>
<th>Annual consumption of electricity, MWh</th>
<th>Energy saving potential of electric motors with variable load, in case of new technology application</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15.33.9</td>
<td>Artachat canned food factory</td>
<td>3,393.80</td>
<td>323.70</td>
<td>1,000.00</td>
<td>93.23</td>
<td>9.32</td>
</tr>
<tr>
<td>2</td>
<td>15.98.2</td>
<td>&quot;Bjni&quot; mineral water factory CJSC</td>
<td>990.00</td>
<td>51.70</td>
<td>1,983.00</td>
<td>34.74</td>
<td>1.75</td>
</tr>
<tr>
<td>3</td>
<td>15.85.0</td>
<td>AAFPC NGO LTD</td>
<td>316.65</td>
<td>25.80</td>
<td>1,024.56</td>
<td>57.96</td>
<td>5.66</td>
</tr>
<tr>
<td>4</td>
<td>15.96.0</td>
<td>&quot;Yerevan beer&quot; CJSC</td>
<td>2,968.19</td>
<td>155.91</td>
<td>4,010.00</td>
<td>121.23</td>
<td>3.02</td>
</tr>
<tr>
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## APPENDIX D: CALCULATION OF ENERGY SAVING POTENTIAL BY IMPLEMENTED MEASURES

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### Appendix D - continued

| Energy saving measure [Fo] | | |
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| Elimination of defects and improvement of technological process [F1] | Decrease of idle process [F2] | Automation of electric drives [F3] |
| | | |
| $\alpha_1$ | $\beta_1$ | $\gamma_1$, min. AMD | $\pi_1$, MWh | $C_1$, min. AMD | $\alpha_2$ | $\beta_2$ | $\gamma_2$, min. AMD | $\pi_2$, MWh | $C_2$, min. AMD | $\alpha_3$ | $\beta_3$ | $\gamma_3$, min. AMD | $\pi_3$, MWh | $C_3$, min. 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 |
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| 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 |
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### Energy saving measure [F0]

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<td>relative potential of i-th measure</td>
<td>energy (natural gas) saved as a result of implementation of i-th measure, million AMD, γ_i = Aαβ12, (1kWh=12 AMD), or γ_i = Aαβ39,105 (1 thousand m³ of natural gas is 39,105 AMD)</td>
<td>potential of i-th measure, in natural unit, MWh or thousand m³, π_i = Aαβ</td>
<td>cost of energy saving measures in the i-th industrial company, billion AMD, C_i = γ_i T, where T is the payback period</td>
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APPENDIX E: ENERGY SAVING POTENTIAL IN STREET LIGHTING THROUGHOUT ARMENIA. INSTALLATION OF NATRIUM LAMPS IN STREET LIGHTING SYSTEM, MWH

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<td>c. Artik</td>
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<td>19,041.40</td>
<td>22,965.70</td>
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The energy efficiency of lighting fixtures is determined by the following equation:

$$K_e = \frac{P_{\text{old}}}{P_{\text{new}}} = 2.19,$$

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

The lighting efficiency is determined by the following equation:

$$K_L = \frac{\Phi_{\text{old}}}{\Phi_{\text{new}}} = 1.38,$$

where $\Phi_{\text{old}}$ and $\Phi_{\text{new}}$ are the old and new light emission capacity of the lamps.
### Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>AEN</td>
<td>Armenian Electricity Networks CJSC</td>
</tr>
<tr>
<td>ANPP</td>
<td>Armenian Nuclear Power Plant</td>
</tr>
<tr>
<td>AMD</td>
<td>Armenian Drams</td>
</tr>
<tr>
<td>CIS</td>
<td>Commonwealth of Independent States</td>
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<tr>
<td>CJSC</td>
<td>Closed Joint Stock Company</td>
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<td>ES</td>
<td>Energy Saving</td>
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<td>RE</td>
<td>Renewable Energy</td>
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<td>ETL</td>
<td>Electricity Transmission Lines</td>
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<td>GDP</td>
<td>Gross Domestic Product</td>
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<td>HPP</td>
<td>Hydroelectric Power Plant</td>
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<td>HVEN</td>
<td>High Voltage Electricity Networks CJSC</td>
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<tr>
<td>LLC</td>
<td>Limited Liability Company</td>
</tr>
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<td>MD</td>
<td>Ministry of Defense</td>
</tr>
<tr>
<td>MIA</td>
<td>Ministry of Internal Affairs, the Police of RA</td>
</tr>
<tr>
<td>NSS</td>
<td>National Security Service</td>
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<tr>
<td>oe</td>
<td>Oil Equivalent</td>
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<tr>
<td>PGFS</td>
<td>Pressurized Gas Filling Station</td>
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<tr>
<td>RA</td>
<td>Republic of Armenia</td>
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<td>RF</td>
<td>Russian Federation</td>
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<tr>
<td>tcf</td>
<td>Tons of Conditional Fuel</td>
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<tr>
<td>TPP</td>
<td>Thermal Power Plant</td>
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<td>toe</td>
<td>Tons of Oil Equivalent</td>
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<td>United States of America</td>
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<td>USSR</td>
<td>Union of Soviet Socialist Republics</td>
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