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CAPACITY BUILDING IN THE REPUBLIC OF ARMENIA FOR TECHNOLOGY NEEDS ASSESSMENT AND TECHNOLOGY TRANSFER FOR ADDRESSING CLIMATE CHANGE PROBLEMS

"ARMENIA - COUNTRY STUDY ON CLIMATE CHANGE" PROJECT
II PHASE

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FOREWORD

In 1993, the Republic of Armenia ratified the UN Framework Convention on Climate Change. In order to realize the main provisions of the Convention, the UNDP/GEF project “Armenia- Country study on climate change” is being implemented in the country.

Within the framework of the implementation of Phase I of the Project, Armenia’s first national communication was prepared, which was presented in 1998 in Buenos Aires at the 4th Conference of the Parties to the UN Framework Convention on Climate Change.

The first national communication incorporates results of activities in Phase I of the Project: the national cadastre of greenhouse gases, projection of greenhouse gas emissions until 2010, impacts of global climate change on Armenia’s climate and possible impacts of these changes on country's economy, ecosystems and population's health. The Communication also incorporates materials on information provision, systematic observations and climatic system in Armenia and a number of studies pertaining to the latter.

The objective of Phase II of the Project is to ensure the continuation of activities and further development and strengthening of national capacities for solving climate change related problems.

This Communication incorporates the results of activities in Phase II of the Project. The main focus has been on identification and assessment of technological needs for reducing greenhouse gas emissions and eradicating the consequences of expected changes in climate, as well as creation and consolidation of conditions for transfer of these technologies. It must be noted that although Armenia, as a non-Annex I party to the Convention, does not have quantitative commitments for reducing greenhouse gas emissions, nevertheless the transfer of modern technologies for reducing emissions and their introduction will make a significant contribution to the sustainable development of the country and is fully in line with Armenia’s interests. This is particularly true with regard to projects to be implemented by clean development mechanisms within the framework of Kyoto protocol. Considering the multi-sectoral nature of the issue, particular attention was paid to inter-agency cooperation and establishment of an information data base on technological needs and technologies.

Leading experts in fields of energy, industry, transportation, forestry and agriculture, health, climatology, etc. participated in activities of the Phase II of the Project and preparation of the communication.

Activities conducted within the framework of Phase II of the Project have contributed to the development of institutional, organizational and human resources capacities.

A proposal for establishing a structure contributing to the transfer and introduction of advanced, as well as innovative, technologies for solving climate change problems has been developed. The proposal was presented and discussed in a seminar held in Vienna Climate Change Meetings on 28-31 October 2003 by the Climate Technology Initiative organization formed within the framework of climate change convention processes.

Project Coordinator **A. Gabrielyan**

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Abbreviations

Armhydromet	Hydro-Meteorological Department of the Republic of Armenia
CIS	Commonwealth of Independent States
DH	District Heating
GDP	Gross Domestic Product
GEF	Global Environmental Facility
GHG	Greenhouse Gas
GIS	Geographical Information System
GWP	Global Warming Potential
HPP	Hydro-Electric Power Plant
IPCC	Inter-Governmental Panel on Climate Change
NPP	Nuclear Power Plant
PPP	Purchasing Power Parity
RSE	Renewable Sources of Energy
SDW	Solid Domestic Waste
TPP	Thermal Power Plant
UN FCCC	UN Framework Convention on Climate Change
UNDP	United Nations Development Programme
VAT	Value Added Tax
WMO	UN World Meteorological Organization
WTO	World Trade Organization

Chemical compounds

CO_2	carbon dioxide
CH_4	methane
N_2O	nitrous oxide

Units

eq.	equivalent
eq. fuel	equivalent fuel
g	gram
Gcal	gigacalorie (10^9 cal)
Gg	Gigagram (10^9 g)
GJ	gigajoule (10^9 J)
GWh	gigawatt-hour (10^9 Wh)
ha	hectare
J	Joule
kcal	kilocalorie (10^6 cal)
kg	kilogram
km	kilometer
kWh	kilowatt-hour (10^8 Wh)
m	meter
m^3	cubic meter
m^3/sec	cubic meter per second
Mt	megaton (10^6 t)
MW	megawatt
^oC	degrees Celsius
oil eq.	oil equivalent
PJ	petajoule (10^{15}J)
t	ton
TWh	terawatt-hour (10^{12} Wh)
Wh	watt-hour

INTRODUCTION

During the first phase of the project “Armenia: Country Study on Climate Change” the first National Communication of the Republic of Armenia on climate change was prepared and presented at the Fourth Conference of the Parties to the UN Framework Convention on Climate Change held in Buenos Aires in 1998.

The first national communication incorporates the main results of activities in the first phase of the project: the national cadastre of greenhouse gases prepared based on the inventory of sources and absorbents of greenhouse gases with 1990 as the baseline year, strategy and projections of greenhouse gas emissions until 2010, preliminary assessment of the vulnerability of individual components of the environment, population, economic sectors affected by climate and measures for their adaptation to possible climate changes, as well as information on systematic observations and studies of Armenia’s climatic system.

The objective of the second phase of the project is capacity building in Armenia for solution to climate change problems in the following main directions:

- to determine the priority technological needs of Armenia’s economic sectors in the areas of reduction of greenhouse gas emissions, development of proposals for key technologies and assessment of possibilities for their practical application, development and assessment of specific technological projects;
- to develop proposals for adaptation measures and technologies for mitigation of the consequences of climate change for the environment and Armenia’s economic sectors;
- to determine the technological needs for the development of the monitoring system and strengthening of the national monitoring network for participation in the Global System of Climate Monitoring (GSCM);

This report incorporated the results of activities in the second phase of the project. In the first chapter the main economic sectors are analyzed from the viewpoint of greenhouse gas emissions, technological needs and technologies for reduction of GHG emissions, as well as technological needs for increasing the absorption of carbon oxide by the forestry sector are identified. A fair amount of attention is paid to the assessment of the potential and use of alternative sources of energy.

The second chapter presents the results of vulnerability assessments for water resources, agriculture, environment and population’s health, as well as the technological needs and adaptation technologies for mitigation of climate change impacts in the mentioned areas.

The third chapter incorporates information on the activities of the national hydro-meteorological service and conditions of the monitoring network, the analysis of the trends of climatic anomalies and assessment of their impact on the economy. Priority needs for strengthening the environmental observation and monitoring networks and wider participation in the GSCM are identified.

The last chapters discuss the conditions for technology transfer to the country (investment environment, financial market, legal framework, etc.), and present the results of activities for development and strengthening of national capacity (organizational,

informational, human) for assessment of technological needs and transfer of technologies, as well as activities for increasing public and stakeholder awareness and interagency coordination in climate change related issues.

Background information on the Republic of Armenia. Armenia is situated in southern Trans-Caucasus, at the border of Caucasus and Asia Minor and occupies a small area of the vast Armenian highland. It borders Georgia and Azerbaijan from the north and the east, and Turkey and Iran from the west and south-east.

It covers an area of 29800 sq km. The capital city is Yerevan.

Armenia is a typical mountainous country. Around 90 percent of its territory has altitudes of more than 1000 m above sea level, including 40 percent at altitudes of 2000 m and higher. Because of its highly fragmented terrain, almost half of the territory is not suitable for settlements and economic activity.

Armenia is characterized by distinctly underlined vertical distribution of six main types of climate, from arid sub-tropical to high mountainous, and the corresponding temperature contrasts. In low altitude areas the average air temperature in June-August reaches 24-26 ^{o}C, while in high mountainous zone it does not exceed 10 ^{o}C. In January, the temperature, depending on the altitude and specifics of the terrain, varies between 1 ^{o}C and -13 ^{o}C. The absolute maximum and minimum temperatures in Armenia are +41 ^{o}C and -42 ^{o}C.

Armenia’s population is 3.8 million (3.0 million according to the preliminary results of the 2001 census), with 67 percent urban and 33 percent rural population.

Sectoral structure of industry (2000): energy 30.4 percent, food industry 36.6 percent, mining 5.4 percent, metallurgy 5.5 percent, chemical 3.3 percent, metal processing and machinery 2.2 percent, construction material 2.4 percent, jewelry production 5.6 percent, light industry 1.2 percent.

Farming is mainly based on irrigation. Structure of agriculture (2000): crops farming 64.7 percent, livestock production 33.3 percent.

After the rapid economic decline in 1991-1993, a stable economic growth was recorded in Armenia with average annual GDP growth rate of 5.4 percent for 1994-2000.

GDP composition (2000): industrial production 22.1 percent, agricultural production 23.1 percent, services 35.2 percent.

The GDP per capita in 2000 (calculated for population at 3.8 million) was US$503.6, and taking into account the purchasing power US$2545.

CHAPTER 1.

TECHNOLOGICAL NEEDS IN ARMENIA’S ECONOMIC SECTORS FOR REDUCTION OF GREENHOUSE GAS EMISSIONS

Technological modernization, energy savings and increasing efficiency in the use of energy resources based on the application of new, ecologically clean technologies, are important preconditions for the sustainable development of the country.

The use of technologies contributing to the reduction in greenhouse gas emissions and mitigation of the negative impacts of climate change in economic sectors affected by the climate has a significant role in ensuring the mentioned preconditions.

National technological needs relating to the reduction in GHG emissions are determined based on the following:

- identification of the main sectors of economy, which are sources of GHG emissions;
- assessments of technologies used and technical conditions of equipment;
- assessment of the potential for reduction in GHG emissions through meeting technological needs.

1.1. Main greenhouse gas emitting sectors of Armenian economy and analysis of changes in emissions for the period 1990-2000

The priority sectors of Armenian economy, where urgent measures for reducing GHG emissions are necessary, are determined based on their ranking with regard to the volume of emissions. It must be noted that ecological problems and technological need of various sectors are closely intertwined. Changes in the situation in one sector have a significant impact on the others. Such links are evident between, for example, energy and industrial production sectors. Nevertheless, in this document sectors are classified in accordance with the requirements of the Convention and IPCC Guidelines.

The technological needs of the priority economic sectors are based on the national GHG cadastre, prepared by using emission inventory data from 1990 constituting a part of the First National Communication and also emission data projected for the period ending in 2000.

Emissions of greenhouse gases in economic sectors. Cadastre and projected GHG emissions are determined, in accordance with IPCC guidelines, by five main categories of sources (“Energy”, “Production processes”, “Agriculture”, Changes in land use and forestry", "Wastes"), encompassing 11 types of activities (sectors) characteristic to Armenia. Emissions are evaluation for three gases with direct greenhouse effects: carbon dioxide, methane and nitrous oxide.

The comparative indicators of GHG emissions by sources and economic sectors for 1990-2000 are presented in Table 1.1.

Table 1.1. Greenhouse gas emissions by economic sectors

Source category and sector of economy	GHG	1990 (cadastre)		2000 (evaluation)	
		Gg CO_2 eq.*	%	Gg CO_2 eq.*	%
GHG emissions - total		**25249.72**	**100**	**5719.98**	**100.00**
Energy sources total		**23062.15**	**91.29**	**4699.36**	**82.16**
a. Fuel burning		***21382.78***	***84.64***	***3904.86***	***68.27***
Energy- production and transmission of energy	CO_2	11332.87	44.88	1672.50	29.24
Production	CO_2	2138.28	8.47	332.19	5.81
Municipal services	CO_2	3848.90	15.24	1071.50	18.73
Transportation	CO_2	3635.07	14.40	757.07	13.24
Other	CO_2	427.66	1.65	71.60	1.25
b. Fuel leaks		***1679.37***	***6.65***	***794.50***	***13.89***
gas-transportation system	CH_4	1679.37	6.65	794.50	13.89
Production processes		**630.30**	**2.49**	**109.00**	**1.91**
Cement production	CO_2	630.30	2.49	109.00	1.91
Agriculture		**1031.77**	**4.08**	**503.38**	**8.80**
Livestock animals and livestock production waste	CH_4	982.17	3.88	490.98	8.58
Agricultural land	N_2O	49.60	1.76	12.40	0.22
Wastes		**535.50**	**2.12**	**408.24**	**7.14**
Disposal of solid waste	CH_4	497.70	1.97	378.00	6.61
Industrial and domestic sewerage	CH_4	37.80	0.15	30.24	0.53

* For calculation of CO_2 eq. emissions the following values of potential global warming are used: CO_2 – 1, CH_4 – 21, N_2O – 310 (IPCC, 1995).

As presented in the table, GHG emissions in 2000 were 77.4 percent less than in 1990. This sharp reduction is the result of the deep economic decline and energy crisis in 1991-94. The largest reduction in emissions at 81 percent took place in sectors under “Energy" category, including the production of electricity and heat with 85.3 percent, industrial production with 84.5 percent, transportation with 79.2 percent, municipal sector with 72 percent.

The dynamics of GDP and GHG emissions for 1990-2000 is presented in Figure 1.1. After the sharp economic decline, economic growth was recorded starting in 1994, and GHG emissions have been stabilized at a fairly low level. Similar trends are recorded in the dynamics of energy production and CO_2 emissions in the energy sector (Figure 1.2).

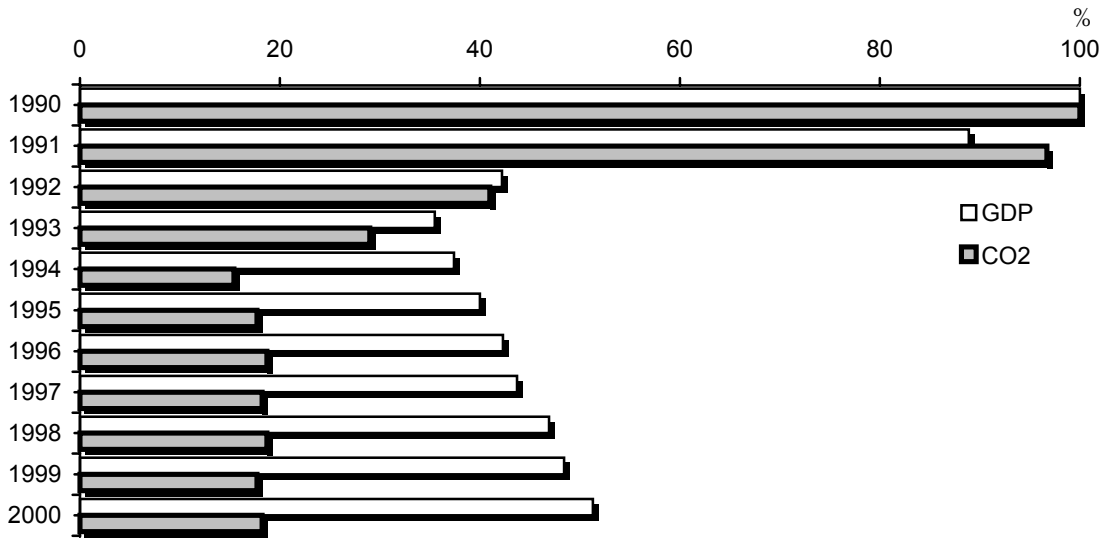


Figure 1. 1. Dynamics of GDP and greenhouse gas emissions in Armenia, 1990-2000

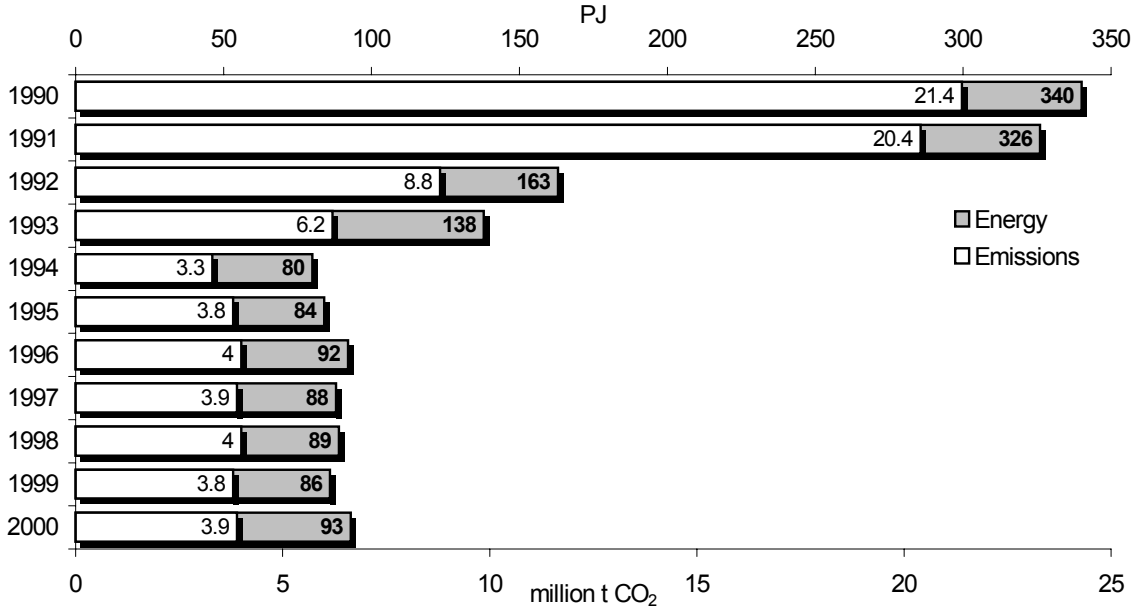


Figure 1. 2 Dynamics of energy production and CO_2 emissions in Armenia’s energy sector, 1990-2000

Currently, as a result of technological processes related to fuel burning, there are 82 percent of GHG emissions in the category of "Energy" and 68 percent general GHG emissions. As a result of the poor technical conditions of the gas supply system the total share of methane emissions has increased significantly (13.9 percent). With regard to fuel burning, the main source of GHG emissions is electricity production (thermal power plants), municipal sector and transportation. They constitute around 90 percent of all emissions related to fuel burning. The main source of GHG emissions in the category of "Agriculture" is the intestine fermentation of livestock; cement production in the category of "Production processes"; solid waste disposal in the category of “Wastes”.

The analysis of the distribution of greenhouse gas emissions in 2000 (Table 1.1) allowed for the identification of priority sectors of Armenia's economy, where there is a need for priority introduction of technologies contributing to their reduction (Figure 1.3).

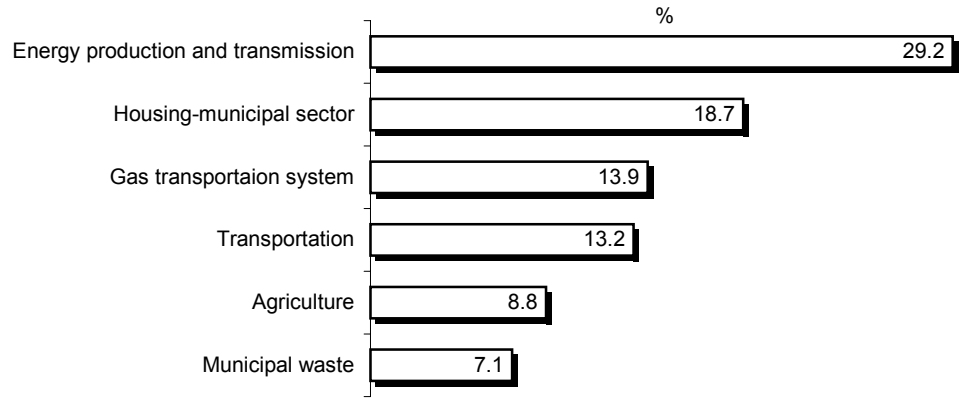


Figure 1.3 Distribution of greenhouse gas emissions by sectors of Armenia's economy, 2000

The main greenhouse gas in Armenia is carbon dioxide. In 2000, the share of carbon dioxide in the total GHG emissions amounted to 68.2 percent, methane 29.8 percent, nitrous oxide 2 percent.

Potential for emission reduction. The main indicator for the effectiveness of energy use is the energy utilization of GDP and, correspondingly, GHG emissions per unit of GDP (Figure 1.4). The mentioned indicators are somewhat higher in Armenia compared to developed countries, which indicates the significant potential for energy savings and reduction of GHG emissions.

Figure 1.4 Per unit indicators of energy consumption and greenhouse gas emissions in Armenia, for 1990 and 2000

A – energy consumption of GDP, t oil eq./million US$

B- energy consumption per capita, kg oil eq./person

C- emissions of $CO_{2eq.}$ per unit of GDP, kg/thousand US$

D- emissions of $CO_{2eq.}$ per capita kg/person

Main measures for energy saving and reduction of GHG emissions are:

- modernization of energy production facilities;

- reduction of energy losses during transmission and distribution;
- introduction of a distributional energy supply system;
- introduction of energy consumption metering devices;
- energy supply at individual consumer level;
- exploitation of new hydro-resources and non-traditional sources of energy.

Armenia has a large potential for energy saving, which should be regarded as an internal source of energy.

Sectors of economy included in the “Energy” category have the largest potential for energy saving and reduction of GHG emissions (electricity and heat production, heating of housing and municipal sectors, transportation). The technical potential of GHG reduction (excluding the potential of renewable sources) resulting from the implementation of the above-mentioned energy saving measures in 2000-2020 is evaluated at 22 million ton CO_2 eq.

Currently, with the support of the USAID, the Advanced Engineering association is implementing a wide-scale program on energy efficiency, energy consumption regulation and renewable energy sources in Armenia, the results of which, together with other measures, will contribute to the use of advanced technologies and realization of the GHG emissions reduction potential. The process of establishing private energy supply companies (ESCO) has also started in the country, which will also contribute to energy saving.

1.2. Determining technological needs of Armenia’s economic sectors

Armenia’s economy on the whole and also the technologies used in the country are characterized by high energy consumption, which is significantly higher than the similar indicators in developed countries. This situation is the result of the low energy efficiency in energy and industrial sectors due to the worn-out production facilities and limited use of energy saving technologies, as well as the absence of the necessary recording and control of the use of energy carriers. One of the main constraints in introducing energy efficient technologies is inadequate funds and difficulties in obtaining credits.

The use of renewable sources of energy continues to be very limited, despite their existing significant potential; biogas from agricultural and municipal wastes is not exploited.

Large changes took place throughout the last decade in the forestry sector, which is the main absorbent of carbon dioxide in Armenia. Mass cuttings for heating purposes in the last ten years resulted in a significant reduction in forest areas and their potential for sequestration.

Assessment of the energy saving potential revealed the technological needs and directions of actions for increasing energy efficiency and reducing GHG emissions in the priority economic sectors of Armenia.

1.2.1. Electricity production

Electricity is produced in Armenia in thermal power plants (TPP), hydroelectric-power plants (HPP) and the nuclear power plant (NPP).

The main indicators of power plants are presented in Table 1.2.

Table 1.2. Main indicators of power plants in Armenia

Title of plant	Design capacity		Energy production				Start date of operation
	Elec-tricity MWh	Heat Gcal/h	Electricity, GWh		Heat, thousand Gcal		
			1990	2000	1990	2000	
Thermal power plants total	**1746**	**1588**	**8500**	**2692**	**3700**	**612**	**1963-1974**
Hrazdan TPP	*1100*	*560*	*6000*	*2278*	*950*	*72*	*1966-1974*
Yerevan TPP	*550*	*622*	*2232*	*414*	*2000*	*540*	*1963-1968*
Vanadzor TPP[1]	*96*	*406*	*268*	*0*	*750*	*0*	*1965-1968*
Hydroelectric power plants total	**1006**	**-**	**1870**	**1260.3**	**-**	**-**	**1913-1989**
Sevan-Hrazdan HPP	*550*	*-*	*585*	*372.6*	*-*	*-*	*1936-1950*
Vorotan HPP	*400*	*-*	*1103*	*780.7*	*-*	*-*	*1970-1989*
Small HPPs	*56*	*-*	*82*	*107*	*-*	*-*	*1913-2000*
Nuclear power plant[2]	**815**	**-**	**0**	**2005.4**	**-**	**-**	**1976-1980**
Total	**3567**	**1588**	**10370**	**5957.7**	**3700**	**499**	**1913-2000**

[1] is not operational since 1996.
[2] including the non-operational energy block 1. The NPP did not operate in 1989-95.

Due to reduced demand and sharp increase in fuel prices, electricity production in Armenia reduced by 43 percent compared to 1990 (71 percent compared to 1987). In 2000, the total energy produced amounted to 5957.6 GWh, including 2692 GWh in TPPs (45.2 percent), 2005.4 GWh in NPP (33.7 percent), 1260.3 GWh in HPPs (21.2 percent).

Energy consumption in 2000 amounted to 3565.67 GWh, including 1234.14 by the population (35.17 percent), 689.45 by industry (19.5 percent), 474.4 by agriculture (13.31 percent), 323.44 for water supply (9.1 percent), 101.13 by budgetary organizations (5.4 percent) and 522.65 for other purposes (17.52 percent).

Thermal power plants The largest share of the design capacity for electricity production in Armenia belongs to thermal power plants (49 percent). Compared to 1990, electricity production in TPPs has reduced by 68 percent and heat production by 77 percent. Design capacities of TPPs are used by less than 33 percent.

The fuel used in TPPs is imported natural gas. In 2000, fuel consumption amounted to 1023 thousand ton equivalent fuel. As a result of the sharp drop in heat load, electricity in TPPs is mainly produced in condensation regime. Fuel consumption amounts to 380 g eq. fuel/kWh, CO_2 emissions coefficient is 623 g/kWh, efficiency of power output in plants is 32.3 percent, the general energy efficiency of power supply from TPP (taking into account losses during transmission and distribution) is 26.5 percent.

Consumption of electrical energy by power plant itself is 7.87 percent.

Currently, electricity production in TPPs accounts for 43 percent of carbon dioxide emissions in the category of "Energy" and around 30 percent of total greenhouse gas emissions.

Armenian nuclear power plant (ANPP). There are two energy blocks in the plant with nuclear reactors of type VVER-440 with a total capacity of 815 MW (28.2 percent of the total electricity production capacity in Armenia). In 1989, after Spitak earthquake,

operation of ANPP was halted for safety reasons, although the plant itself was not damaged. In 1995, in order to overcome the deep energy crisis, the second energy block of the plant with 408 MW capacity was re-operated. Currently, 33 percent of the total electricity in the country is produced by ANPP.

According to EU recommendations, the ANPP should close down in 2004, although it has resources for 15 years of operation and its safety is ensured at a fairly high level. Closure of the plant will reduce the level of energy security in the country from 51 percent at present to 21 percent in 2005 and 11 percent in 2006, and the energy independence will reduce from 20 percent to 9 percent.

As it is known, nuclear plants do not have GHG emissions, however they are associated with serious problems of operation safety and radioactive wastes. Liquid radioactive wastes are accumulated in large volumes and their processing, mainly vaporization, is a highly energy consuming process and does not solve the problem entirely. The closure of the nuclear power plant would not solve the problems of radioactive wastes either. Consequently, the use of effective innovative technologies in the utilization of these wastes is an urgent issue, and application of these technologies will allow for the revision of the future prospects of nuclear energy in Armenia.

Hydro-electric power plants. Presently, the only sources of energy for industrial purposes in Armenia are hydro-resources, and half of their economic potential is already being utilized (1500-1600 GWh). The share of HPPs is 28.2 percent of the total capacity of electricity production in Armenia. In the period of energy crisis and halt in operations of the nuclear power plant, HPPs accounted for up to 64 percent of the total electricity production in the country.

Hydro-energy development plans envisage the full utilization of Armenia’s hydro-potential amounting to 3200-3500 GWh. According to “Small HPP scheme of Armenia”, it is planned to construct 325 small HPPs with a total capacity of 270 MW and production of 833 GWh electricity, which is equivalent to annual saving of around 286 thousand t eq. fuel and reduction of carbon dioxide emissions of 470 thousand t by substituting TPP which operates on natural gas. Trough the planned priority projects for the next 15-20 years large, medium sized and small HPPs with a total capacity of 300 MW and electricity production of 1234 GWh will be built. Implementation of these projects will result in annual saving of fossil fuel of 422 thousand t eq. fuel and reduction of carbon dioxide emissions by 692 thousand t.

Utilization of hydro-electric resources becomes an important factor in the light of compensation for the capacity of the nuclear power plant in case of its closure, as well as reduction of carbon dioxide emissions.

Wind energy is a renewable source of energy with real possibilities of application in Armenia. Currently, there are some activities under way for organizing the construction of two wind-electric power plants (WPS) with 40 MW capacity and design electricity production capacity of around 120 GWh (annul saving of fossil fuel by 35 thousand t eq. fuel, CO_2 emissions reduction by 57 thousand t).

Transmission and distribution of electricity Electricity is transmitted by high voltage air transmission lines with 220 kV (1323 km) and 110 kV (3169 km). The grid has 14 substations of 220 kV and 119 substations of 110 kV. High voltage grid of Armenia

was designed as a component of the Trans-Caucasus energy system with inter-system links in all neighboring countries and its transmission capacity is adequate for large loads.

The distribution grid encompasses the entire territory of the country and includes cable and air transmission lines: 35 kV (2747 km), 6 (10) kV (10967 km) and 0.4 kV (20082 km), 278 substations 35 kV and 10625 substations 10 (6)/0.4 kV. 4 distribution grids are under operation under the management of “Power distribution grids of Armenia” private company.

As a result of the poor technical conditions of power grid facilities, significant losses of energy take place during transmission and distribution, reducing the overall energy efficiency of power grids. The current energy losses in the grid amount to 18 percent, including high voltage- 6 percent, distribution (technological)- 12 percent. The reconstruction of power grid facilities, given the current electricity production processes in TPP, will allow for a saving of 58 thousand t eq. fuel and reduction of CO_2 emissions by 95 thousand t annually.

“Distributed generating” can play a huge role in saving electrical energy. This is s unified system for optimal management of electricity provision and consumption, including centralized and non-centralized (local) distribution stations. This is a computerized grid of the entire power system, including also alternative sources (wind, photoelectric, biogas), which regulates electrical energy at peak loads and during smaller loads by connecting and disconnecting electric power system depending on demand.

Technical condition of electric power system is characterized by the highly worn-out main equipment throughout the system - production (with the exception of NPP), transmission, as well as distribution. In thermal power plants, 35 percent of design capacities are being used for more than 30 years and have used up their technical resources, which causes over-consumption of fuel and the corresponding increase in CO_2 emissions. The operation period of the design capacities of hydro-electric plants is more than 30 years, including 50 percent more than 40 years and 14 percent more than 50 years. Electric power grid facilities are highly worn-out, do not have modern protection, communication and regulation systems and have significance losses of energy in the grid.

Technological needs. Starting in 1994, with assistance from international organizations, seven projects for development of electrical energy sector were developed in Armenia with end dates of 2010, 2015 and 2020. Together with advantages, which will be used, the mentioned projects did not take into account a number of conditions and factors: lack of funds, energy security and independence conditions, impact of capital investments on tariffs, etc. The document "Basic provisions for the sustainable development of energy sector in Armenia" has been prepared, which determines the directions for state energy sector policy and forms the basis for the development of the strategy and long-term development of energy sector. Ensuring an adequate level of energy security and independence for the country is the main priority for state energy sector policy.

The main provisions for sustainable development of energy sector in Armenia include: (1) develop strategy for diversification of production capacities (hydro-energy, thermal energy, nuclear energy), energy carriers (natural gas, diesel fuel, nuclear fuel, energy interconnection between systems), supply methods for energy carriers (transportation of gas in two directions, railroad and road transportation of oil products); (2) create potential for own renewable and fuel-energy resources; (3) take measures for energy saving, in cases considered as national energy resources.

According to “Basic provisions" the long-term investment and energy program will focus on resolving the following issues: (1) hydro-energy – modernization of existing HPP, construction of new medium and small sized HPP through private investments; (2) thermal energy- use of the existing energy production equipment in TPPs until the total expiration of their technical resources and at the same time construct and operate highly effective steam-gas equipment; (3) nuclear energy – continuous improvements in the safety of the existing NPP with consideration for peaceful trends in development of nuclear energy; (4) heat supply- use with introduction of modern effective technologies for combined heat and electricity production, as well as solar and geothermal energy; (5) rehabilitation and modernization of electric power transmission and distribution grids. Technological needs and key technologies for Armenia’s electrical energy sector are determined based on the analysis of current situation and in accordance with the strategy for development of energy sector.

According to projections for the development of Armenia’s electrical energy sector until 2015-2020, electrical energy production will increase by 57-60 percent, and emission of greenhouse gases by 60-72 percent.

Technological needs and technologies

Electrical energy

- Modernization of generation capacities, introduction of new highly effective technologies for producing energy using steam-gas turbines in TPPs
- Introduction of highly effective micro-turbines (1-100 kW)
- Utilization of new hydro-energy resources and widespread use of small HPP
- Utilization of the potential of wind energy and construction of wind electric power plants
- Reconstruction of transmission and distribution grids, reduction of energy losses and introduction of the system of distributional energy supply.
- Modernization of safety system in NPP and introduction of modern innovative technologies for use of radioactive waste.

The main indicators of projects, the implementation of which will contribute to the reduction of greenhouse gas emissions in electrical energy sector, are presented in Table 1.3.

Table 1.3. Characteristics of proposed projects in electrical energy sector

Project title	Capital invest-ments	Annual reduction of GHG emissions	Expiration period of the technology	Reduction of GHG for the expiration period	Cost per unit of GHG reduction
	million $	thousand t	years	thousand t	$/t
Reconstruction of Yerevan TPP with installation of steam-gas block with electrical capacity of 206.3 MW and heat generation of 111 Gcal/h	165.0	352.0	30	10560	15.6
Construction of hydro-electric power plants:					
Meghri HPP, 79.8 MW	100.0*/	254.3	40	10174	9.83
Shnogh HPP, 75 MW	95.0*/	146.1	40	5844	16.2
Loriberd HPP, 59.2 MW	130.0*/	107.1	40	4286	30.3
Small HPPs with total capacity of 70 MW	62.2	121.2	40	4848	12.8
Construction of wind electric power plants with total capacity of 50 MW	45.0	64.9	25	1622	21.5

*/ Preliminary evaluation excluding VAT

The evaluated reduction in GHG emissions of electrical energy sector as a result of the implementation of the above mentioned projects (project line) and without their implementation (baseline) are presented in Figure 1.5. The total reduction of emissions in electrical energy sector over a 20 year period will amount to 9.27 Mt.

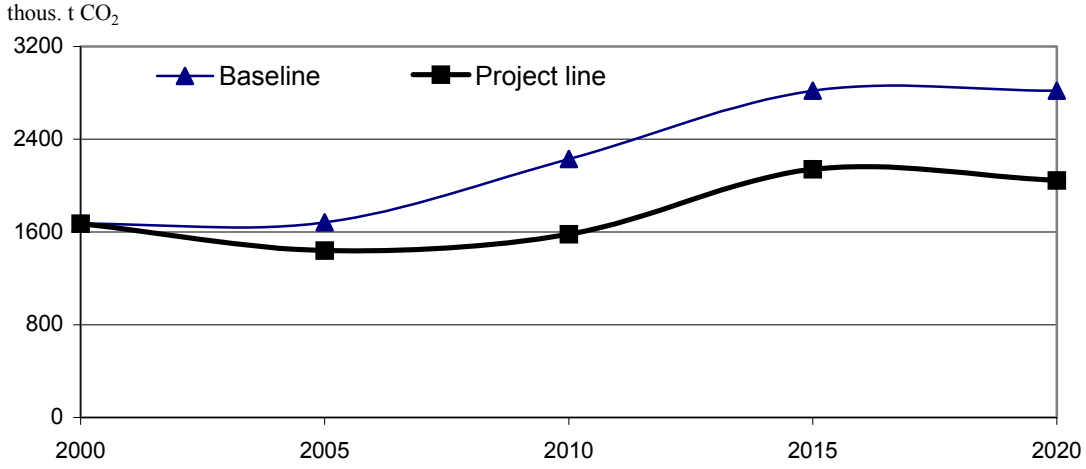


Figure 1.5. Projection of CO_2 emissions in Armenia electrical energy sector

1.2.2. Heat supply

Centralized heat supply in Armenia is provided by thermal power plants, boiler houses of the municipal sector and industrial boiler houses.

Economic and fuel-energy crises in 1990s, sharp increase in fuel prices had an extremely negative impact on the central heating system. In 2000, thermal energy produced

constituted only 5 percent of the level in 1990, including by thermal power plants -15 percent, boiler houses -4 percent. Funding for industrial boiler houses, which accounted for 29 percent of the total heat production, was practically halted.

Presently, within the composition of heat production, 66 percent is the share of thermal power plans and 34 percent the share of boiler houses (in 1990, 21 percent and 50 percent correspondingly).

Comparative indicators of thermal energy production are presented in Table 1.4.

Table 1.4. Central heat production in Armenia, 1990 and 2000

Heat source	Design heat production capacity Gcal/h	Actual heat production thousand Gcal	
		1990	2000
Thermal power plants	1706	4000	612.5
Boiler houses	7506	9400	314.7
Industrial boiler houses	1630	5700	-
Total	**9212**	**19100**	**927.2**

In 2000, the consumption of thermal energy in industry amounted to 406.2 thousand Gcal, with another 316.2 thousand Gcal in central heating system (in 1990, correspondingly 7391 and 9800 thousand Gcal).

In 1990, around 3500 thousand t eq. fuel was used for central heat production, or around 31 percent of the total fuel consumption in the country. In 2000, these indicators dropped to 166 thousand t eq. fuel and 7.8 percent, and the share of central heat production in the total GHG emissions amounted to 6.1 percent (in 1990 – 27.5 percent).

Heat supply to housing-municipal sector is among the main sources of GHG emissions and at the same time has a large potential for energy saving and emission reduction. GEF/UNDP project "Removing barriers to energy efficiency of district heating and hot water supply" allowed for comprehensive analysis of the current situation and identification of the main problems in district heat supply in the country.

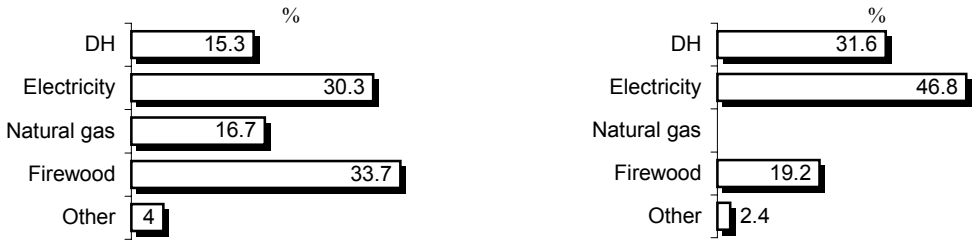
Currently the district heat supply system in Armenia has declined. Compared to 1990, heat loads have shrunk by 87 percent, heated living areas by 74 percent, number of heated public buildings by 80 percent. The system of hot water supply is not operating anymore. The number of settlements with centralized heating has reduced from 55 to 8. The duration of heating season in the country has reduced on average by 30 percent.

Conditions of the current heat supply system are poor at all levels: production, distribution and consumption. There are continued unfavorable trends in heat supply companies, due to their difficult financial situation conditioned by low payment collection rates for the heat supplied and accumulation of debt on the debit side. Conditions of main assets are deteriorated continuously, outdated technologies and equipment are not replaced, and system utilization levels remain low. As a result of the inadequate technical conditions, the energy efficiency of operational systems is not more than 60-65 percent.

Presently, in conditions of sharp decline of central heat production and gas consumption (until 1992 a large part of the population used individual gas boilers for hot water needs), heat supply from partially operational central heating systems, electricity,

natural gas, coal, firewood, etc. are used for heating and hot water in the housing-municipal sector. The types and volumes of energy carriers used are primarily determined by the type of consumer (apartment buildings, single-family houses, public buildings).

Energy consumption for covering heating and hot water needs, studied within the framework of the mentioned project, are presented in Figure 1.6.



a b

Figure 1.6 Structure of energy consumption for heating and hot water in housing-municipal sector of Armenia (a- total for the sector, b- for apartment buildings)

Currently, in Armenia’s housing-municipal sector, the largest share of energy consumption falls on firewood (33.7 percent) and electricity (30.2 percent), and for Yerevan - electricity (50.1 percent) and centralized heat supply (27.5 percent). The share of electricity in apartment buildings in 46.8 percent, centralized heating 31.6 percent, firewood 19.2 percent; in Yerevan correspondingly 55.8 percent, 30.7 percent and 11.1 percent.

The structure of energy consumption formed ensures only 27 percent of the normative needs for heating (34 percent of heating and 15 percent of hot water) and is characterized by low energy-economic effectiveness.

Per unit consumption of fuel within the current pattern of energy consumption is 0.4 t eq. fuel/Gcal, energy efficiency 30-32 percent, which is 2.5 times lower than in efficient heat supply systems.

The use of electricity for heating and hot water purposes is not efficient and economically is not justified. Per unit cost of thermal energy received from the use of electricity is 54.3 US$/Gcal, which is 2.7 times higher than the cost of thermal energy produced in heating supply systems (US$20.0/Gcal).

The low energy efficiency of the existing patterns of energy consumption results in high per unit emissions of CO_2 (0.64 t/Gcal) and polluting substances. The use of electricity, produced by TPPs operating in condensation or under-loaded thermal regimes, for heating purposes results in almost 3 times more consumption of fuel and CO_2 emissions, compared to direct thermal energy production. The use of firewood, the coefficient of carbon dioxide emission of which is 2 times higher than that of the natural gas, also results in increased CO_2 emissions.

In the current energy consumption pattern, 52.4 percent of CO_2 emissions come from the burning of firewood, 43.5 percent from natural gas, 4.1 percent from liquid and solid fuel.

In 2000, CO_2 emissions from housing-municipal sector, where only 27 percent of heat demand was met, constituted 1072 thousand t or 18.7 percent of the total GHG emissions.

Crisis in heat supply resulted in extremely unfavorable consequences for forestry due to mass tree-cuttings in forests for heating purposes, in particular the loss of carbon sequestration function of forests. These problems are discussed in “Forestry” section.

The alternative to energy consumption pattern formed is the gradual rehabilitation of the district heating system with the use of energy efficient technologies, continuation of gas supply extension in the housing-municipal sector, as well as utilization of biological and organic wastes (firewood, plastic, etc.) for obtaining heat, biogas and useful products (fertilizer, chemicals, activated coal).

In order to select the optimal strategy, a financial-economic analysis of alternatives for heat supply rehabilitation was conducted within the framework of the mentioned project for one district in Yerevan, where a 174 MW district heating system was operational until 1991 (Figure 1.7). The comparative analysis revealed that the most preferable alternative, with regard to energy-economy and ecology, is the combined heat and electricity production. Presently, however, possibilities for its application instead of district boiler houses with 100 MW and more capacities are limited by the large volume of needed investments and low level of affordability among the population.

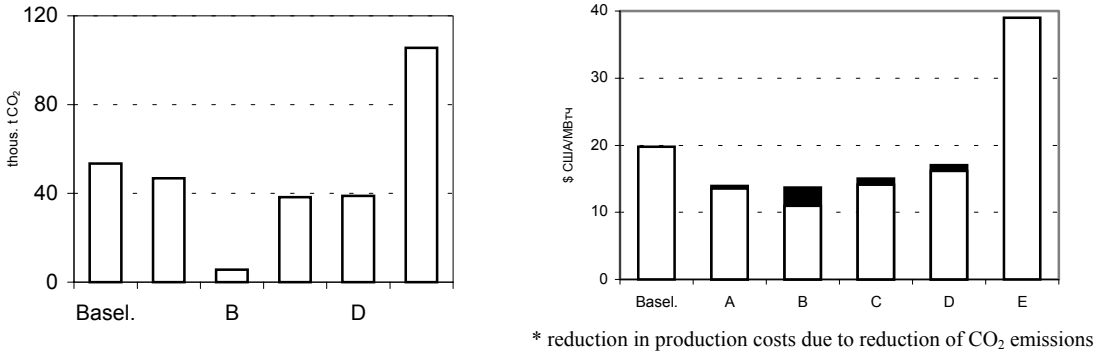


Figure 1.7. Annual CO_2 emissions (a) and energy production cost (b) for various alternatives of heat supply

Baseline – current DH system with 65 percent energy efficiency
A- rehabilitation of DH systems with higher energy efficiency achieved through the reconstruction of boilers, heat supply networks and DH substations
B- centralized system with combined heat and electricity production
C- decentralized system with 18 boilers of up to 10 MW capacity
D- decentralized system with 150 individual small capacity boilers
E- heating by using electricity

Through the implementation of the project “Removing barriers to energy efficiency of district heating and hot water supply” the following problems in Armenia’s heating sector were identified:

- low energy efficiency of the formed pattern of energy consumption, where the share of centralized sources of heat supply is 25-27 percent;
- poor conditions of DH systems, absence of funding sources for their reconstruction, difficult financial situation in heat supply companies;
- absence of heat metering and regulating possibilities at consumer level, as well as tariffs and billing systems based on the actual consumption, and as a result lack of incentives for energy saving;

- low collection rate of payments for the heat energy used;
- slow application of market mechanisms;
- shortcomings in the legal framework regulating heat consumption;
- low level of self-organization and awareness among home owners, limiting energy saving measures at home owner level.

In order to solve a number of technical, financial and organizational problems relating to better energy efficiency in district heating, pilot projects in two apartment buildings in Yerevan and one in Gyumri are being implemented, which will allow for recording the consumed heat by using heat meters installed on buildings' heat intake pipes and regulation of heat consumption in apartments with thermostats on radiators. Projects also address organizational issues related to relationships between heat suppliers and condominiums, as authorized representatives of home-owners. Results of pilot projects will be the basis for recommendations proposed for implementation during the rehabilitation of and efficient DH system in the country.

In 2001-2002, within the framework of the project financed by international financial organizations, the Urban Heating Strategy for Armenia was developed. The strategy is based on the principle of economic affordability of heat supply services for the population and is planned for the period ending in 2025. The strategy envisages that the current DH systems will be maintained and their efficiency will be increased by phases through renovation-rehabilitation and reconstruction activities. In residential areas disconnected from DH system, the strategy plans the use of individual systems (for 1-4 buildings) with small boiler houses, installation of combined heat and electricity production with small capacities, as well as solar heaters in combination with water heating boilers and individual (for individual apartments) gas heating. The main investments will be made in the "growth" phase (6-25 years) taking into account the expected increase in affordable demand on the population's side.

Technological needs and technologies

Housing-municipal sector (heating)

- Introduction of devices for heat consumption metering and regulation.
- Reconstruction of existing DH systems with application of automatic regulation systems, pre-insulated pipes, individual heating stations, etc.
- Introduction of local (individual) heating systems with highly efficient boilers of small capacities using natural gas as fuel, installation of small capacity combined heat and electricity production, solar heaters in combination with water heating boilers.
- Introduction of heat-pumping systems utilizing low-potential heat of the ground, sewerage and other heat sources.

Rehabilitation of efficient DH systems in Armenia will reduce the consumption of primary energy by 60 percent and annual CO_2 emissions by 38-40 percent and in a 20-year period to 9.6 Mt (Figure 1.8).

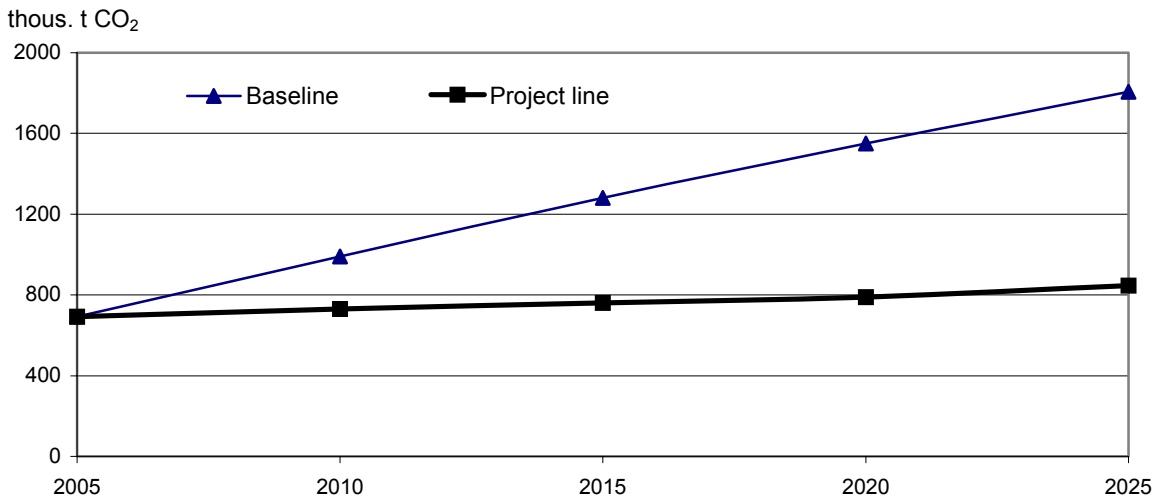


Figure 1.8. Projection of CO_2 emissions from the heating system of Armenia’s housing-municipal sector

Reconstruction and phase by phase improvement of the energy efficiency of Yerevan heating system, which accounts for more than 50 percent of the heat consumption in the entire housing-municipal sector of the country, allows for the reduction of CO_2 emissions in a 20-year period by 6.5 Mt (Figure 1.9).

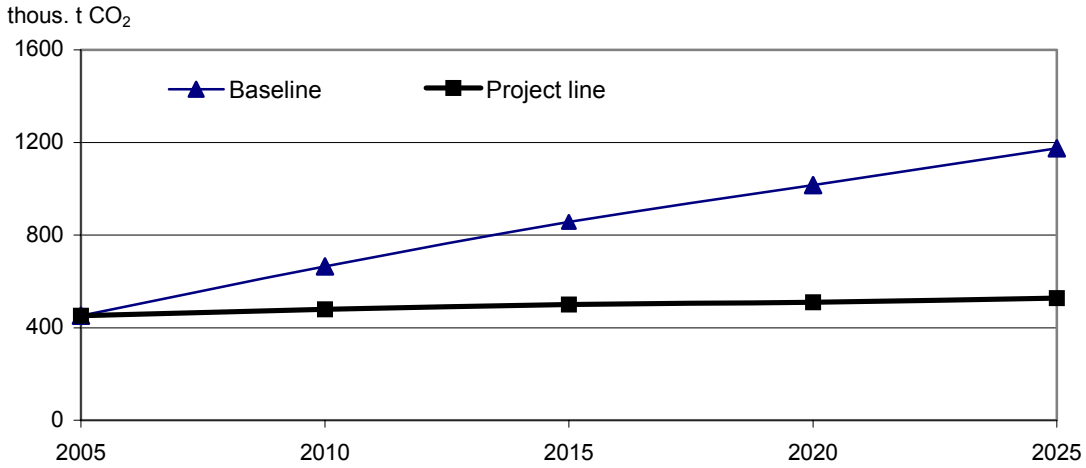


Figure 1.9. Projection of CO_2 emissions from the heating system of Yerevan’s housing-municipal sector

Capital investments in the reconstruction of Yerevan heating system are evaluated at US$45 million (excluding the costs of restoration of gas supply to boiler houses), which is equal to US$6.9/t CO_2 expenditure for emission reduction.

1.2.3. Gas supply

Armenia’s gas supply system started to take shape and became operational in 1960s. In the initial period natural gas came to Armenia through the gas pipeline from Azerbaijan, and from 1972 from the unified gas transportation system of the USSR, through three gas pipelines crossing the territory of Azerbaijan, which are not operational since 1991. Currently, gas is supplied to Armenia from Russia through the territory of Georgia by North Caucasus-Trans Caucasus gas pipeline.

Armenia’s gas supply system is a network of main and distributional gas pipelines with the corresponding installations for regulation, distribution, protection, etc. The central gas supply system consists of main gas pipelines and one-pipeline branches with a total length of 1918 km. Up to 1991, the total length of the distribution network was around 10000km. The flow capacity of systems was designed at 10 billion cubic m of gas. System reserves included also underground gas reservoirs in

Abovyan town, with a volume of 220-240 million cubic m. Presently, the operational volume of underground gas reservoirs is 90-100 million cubic m.

Until the collapse of the USSR, Armenia had a high level of gas supply provision at 83 percent. Gas was supplied to 480 thousand subscribers of in the housing sector of 42 towns and 356 rural settlements, more than 2000 industrial enterprises and municipal facilities.

The economic and energy crises of 1991-94 and the sharp rise in gas prices had an extremely negative impact on Armenia’s gas supply system. Compared to 1988-90, the volume of gas coming into the country in 2000-2001 reduced by more than 4 times and amounted to 1.4 billion cubic m. The use of gas in industries reduced by 7 times, in electric-power production by 1.89 times, in housing-municipal sector by 13 times.

The long and simple systems and the lack of electro-chemical protection resulted in damages and 35 percent of underground and 15 percent of above-ground networks became non-operational.

In 1997, work for restoration of the gas supply system started. As of 2000, 45 percent of distributional networks and gas supply to 20 percent of subscribers were restored.

Currently, natural gas is the main fuel used in Armenia accounting for 88-90 percent of fuel consumption (with the exception of colored oil products) and 45-50 percent of primary energy consumption in the country.

The main gas consumers in Armenia (2001) are electrical energy producers (56.5 percent), industries (20.4 percent), population (10 percent) and heating boiler houses (5.7 percent).

The efficiency of gas burning, and consequently its heat-generating capacity, is highly dependent on the mixtures in the gas, such as moist, SO_2 and CO_2. Thus, it would be appropriate to refine the natural gas using the corresponding technologies. One of these possible technologies might be the use of filters made of natural absorbents, abundant in Armenia, which selectively absorb the mentioned gases.

The gas supply system is managed by Russian-Armenian “ArmRusgasprom" CJSC, conducting transportation and storage of gas in 8 territorial sub-divisions, as well as 16 territorial branches in charge of operating distributional networks and sale of the gas.

Armenia’s gas supply system is a significant source of GHG emissions. Practically the entire methane emissions during the transportation, storage and distribution of gas are is determined by the volume of natural gas emitted during technological operations in

enterprises, as well as technological losses due to poor insulation of equipment and accidents.

Technological (operational) losses of gas in gas supply pipelines occur due to holes, micro-cracks and rust in pipes and poor pipe connection joints, poor insulation of pipe covers, equipment in gas distribution stations and gas distribution sub-stations, underground gas reservoirs and compressor stations. A part of technological losses of gas are linked to technological normative rules for operation of distribution stations, substations and underground gas reservoirs, which require gas releases into the atmosphere and consequently no emission reductions are planned in this area.

Gas losses occur also due to treatment of repaired pipeline sections and cleaning devices with gas, as well as losses during accidents.

In 2000, the total loss (leaks) of gas amounted to 55.09 million cubic m or 3.92 percent of the total volume of gas, including:

- technological losses in gas transportation system at 25.62 million cubic m
- technological losses in gas transportation system at 22.42 million cubic m
- losses during the treatment of gas pipelines and equipment at 3.93 million cubic m
- losses due to accidents at 3.12 million cubic m.

Emissions of methane (constituting 95.4 percent of the gas, weight density 0.72) amounted to 794.7 thousand t or 13.9 percent of the total emissions of greenhouse gases.

Reduction of gas losses, and consequently methane emissions is component part of the activities currently under way for restoration and reconstruction of gas supply systems with the use of modern technologies.

Technological needs and technologies

Gas supply

- use of modern technologies and equipment for reconstruction of the linear par of gas pipelines;
- introduce automatic information-computer systems with tele-control and calculators of gas consumption for timely identification of sources of losses and their prompt repair;
- use of quality sealing grease in gas distribution and compressor stations in order to stop leaks from not very tightly sealed joints;
- impalement regularly the entire set of prophylactic and organizational measures for reduction of accidents and emissions from gas treatment of cleaning equipment, gas pipelines and during elimination of accident consequences and formation of hydrates.

Due to the expected rise in demand for gas, it is projected that the volume of natural gas coming into the country in 2002 will increase by 1.9 times in case of the energy sector development scenario with NPP and 2.3 times in case of the scenario without NPP compensated by TPP using natural gas.

Meeting the above-mentioned technological needs will allow for a reduction of methane emission (expressed in CO_2 equivalent) for the 20-year period by 4.6 Mt (Figure 1.10).

1.2.4. Production processes

Sources of carbon dioxide emissions in Armenia, as a byproduct of the transformation of materials from one condition to another in technological processes not related to energy sector, are chemical industries: ammonium and calcium carbide in the chemical factory of Vanadzor town, production of synthetic rubber in "Nairit" in Yerevan (the synthesis-gas forming as a result of acetyl pyrolysis is sent to Yerevan TPP as fuel), as well as construction material factories (cement production, construction gypsum, concrete, perlite, dolomite).

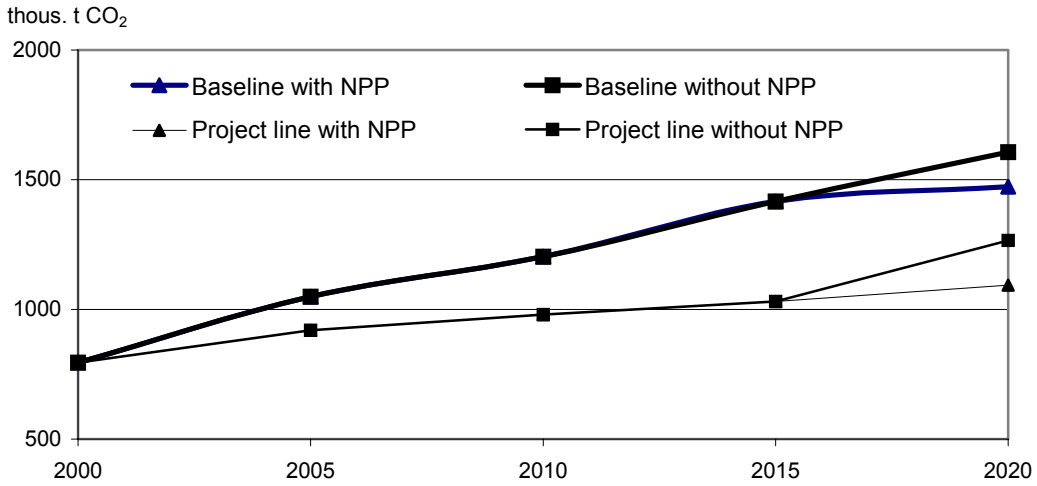


Figure 1.10 Projection of CH_4 emissions form Armenia's gas supply system

In the national GHG cadastre prepared for the baseline year (1990), the mentioned sources of CO_2 emissions, with the exception of emissions during cement production, were not taken into account due to the limited reliable information and absence of data on emission coefficients. In the following years emissions from the mentioned productions were not evaluated due to the fact that many of them were non-operational or operated irregularly at significantly lower capacities. Evaluation of emissions and technological needs for their reduction will be conducted later, after the development issues of the mentioned productions are solved.

The analysis and technological needs of the most significant source of CO_2 emissions in the category of "Production processes", i.e. cement production is presented below.

Cement production. In Armenia, cement is produced in two factories, Hrazdan (wet method for clinker production) and Ararat (with dry method for clinker production). Design capacity of each factory is 1200 thousand t of cement per year. Currently, both factories are privatized and belong to private companies.

In the last decade, due to the decline in volumes of construction, cement production and consequently CO_2 emissions reduced drastically (Figure 1.11). In 2000, cement production and CO_2 emissions amounted to 17.3 percent of the level in 1990.

In 2000, CO_2 emissions from cement industry (excluding emissions from fuel burning, which are included in the energy sector) amounted to 109 Gg (thousand t) or 1.9 percent of the total GHG emissions.

In 2000, Armenia's cement industry accounted for 7 percent of industrial energy consumption and 21.8 percent of fuel consumption (1.5 percent and 4.7 percent of the total electricity and fuel consumption in the country).

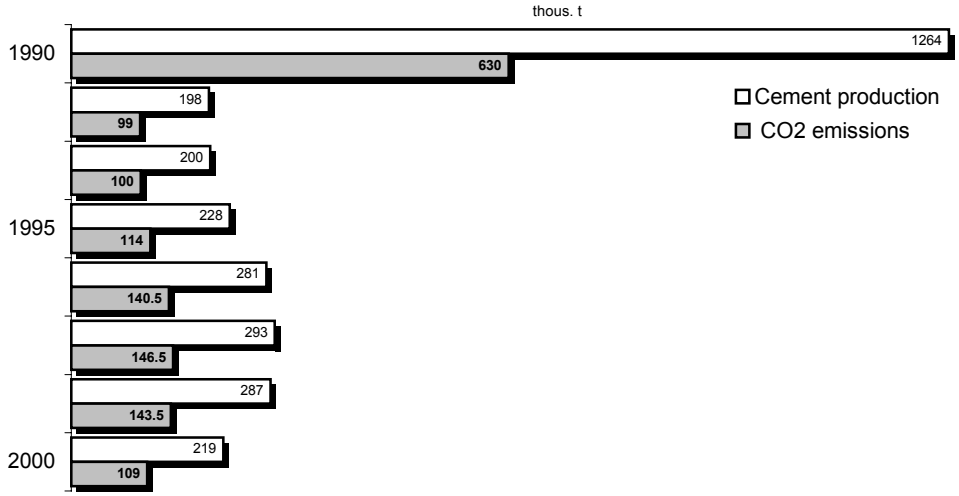


Figure 1.11. Cement manufacturing and CO_2 emissions, 1990-2000

Cement manufacturing in Armenia is characterized by high level of energy consumption. Per unit consumption of thermal and electric energy is 2 times higher than in developed industrial countries. This is a result of the conditions of technological equipment, as well as operations of factories at sharply downgraded capacities.

Technological needs and technologies

Production processes (cement manufacturing)

- increase the energy efficiency of production by application of modern energy and resource saving technologies and equipment (transition from direct to indirect burning, improvement of preliminary heating up of furnaces, use of highly efficient mills and separators, introduction of automated regulation systems and control of the burning regime, improvement of heat-insulation of furnaces, etc.);
- cement production with small proportionality of clinker-cement;
- convert Hrazdan cement factory into using dry technology in cement production.

Introduction of the mentioned technologies will result in the reduction of energy consumption in cement production and CO_2 emissions by 40-45 percent.

At the same time, it must be noted that the conversion from wet method of cement production to the dry one needs large capital investments (around US$50-60 million).

1.2.5. Transportation

Transportation system in Armenia includes motor vehicle, railroad, air and pipeline transportation. Railroad transportation in the country is entirely electricity based, internal air transportation in currently non-operational, and thus carbon dioxide emissions from air transportation are not applicable.

Carbon dioxide emissions from the transportation sector are almost entirely from motor vehicles, the share of which in carbon dioxide emissions in 2000 amounted to 19.4 percent (757 thousand t) and 13.2 percent of the total GHG emissions.

Due to difficult socio-economic conditions and emigration of a large part of the population, significant changes have taken place in the numbers and composition of motor vehicles in Armenia. Compared to 1990, the number of motor vehicles has reduced by 43 percent, and the share of personal motor vehicles has increased by 72 to 87 percent. More than 40 percent of motor vehicles in the country are concentrated in Yerevan.

Data on motor vehicles are presented in Table 1.5.

Table 1.5 Motor vehicles in Armenia, 2000

Motor vehicle category	Quantity	Share %
Automobiles	153655	76
Trucks	38526	19
Buses	9409	5
Total	**202231**	**100**

The majority of motor vehicles currently used in Armenia were manufactured in the former USSR in 1980s. In recent years, the number of foreign made used cars imported into the country has increased (5.2 percent of the total number of automobiles for personal use). Motor vehicles in the country, on the whole, have become old, and they have poor technical conditions and ecological characteristics. Old motor vehicles do not have exhaust gas cleaning systems, such as catalytic neutralizers widely used in developed countries. This results in atmospheric air pollution with gases such as SO_2 and NO_x, which although not considered greenhouse gases, nevertheless have an impact on climate change as precursors of GHG.

Automobiles in Armenia have the following distribution by age: 10-20 years 60 percent, more than 20 years 30 percent, up to 10 years 10 percent.

There are 50 technical examination points for motor vehicles in the country. Mandatory technical examination is conducted once a year, which includes the examination of carbon dioxide emissions.

The overall quantities of fuels used for motor vehicles by type of fuel are presented in Table 1.6. As presented in the Table, 6.5 percent of motor vehicles use gas and 20.7 percent use diesel fuel.

Table 1.6 Use of fuel by motor vehicles in Armenia, 2000

Type of fuel	Quantity		Share	CO_2 emissions	
	t	t eq. fuel	%	thous. t	%
Petrol	178500	265965	72.8	538.5	71.1
Diesel fuel	52200	75690	20.7	165.36	21.8
Compressed natural gas	20416	23682	6.5	53.3	7.1
Total	**251116**	**365337**	**100**	**757.16**	**100**

The distribution of motor vehicles by types of fuel used is presented in Table 1.7.

Table 1.7 Distribution of motor vehicles by types of fuel used, 2000

Category of motor vehicle	Share, %		
	Petrol	Diesel	Gas
Automobiles	93.9	-	6.1
Small trucks	29.7	61.4	8.9
Large trucks	0	90.2	9.8
Small buses	36.1	0	63.9
Large buses	34.7	65.3	0

In recent years, an underlined trend has been recorded in Armenia regarding the use of compressed natural gas as fuel for motor vehicles and development of the network of compressed gas refueling stations.

Gas fuel has a number of advantages compared to the traditional types of motor fuel: low price and 25-35 percent lower emissions of carbon dioxide and polluting substances. The use of gas fuel increases the life of engine by 1.4 to 1.8 times and the period between engine repairs by 1.5-2.0 times. Compared to 2000, it is planned to increase the use of compressed natural gas 1.8 times by 2010, 2.3 times by 2015 and 3 times by 2020. According to projections of the development of gas-compressor refueling stations network, the share of compressed natural gas as fuel for motor vehicles will increase up to 20 percent by 2020.

Over the last decade, the energy efficiency of urban public transportation has reduced significantly. According to expert evaluations, the per unit consumption of fuel in passenger transportation has increased by 4 times. This is a result of large busses and transportation operating on electricity (trams, trolley buses, metro) being gradually substituted by microbuses, which currently account for 90 percent of passenger transportation. This structure of passenger transportation has resulted in overuse of motor fuel, and correspondingly an increase in CO_2 emissions and level of atmospheric air pollution.

Currently, within the framework of a loan from the WB, a joint project between the Swedish company "Sweca" and Yerevan city for improving the management of public transportation in Yerevan, where 34 percent of country's population and the majority of motor vehicles are concentrated, is being developed. The problem of optimization of

transportation flows is also being addressed within the framework of the new master plan for the city. Implementation of the mentioned programs will contribute to the mitigation of the impact of emissions from motor vehicle transportation on the environment.

Improvement of normative-legal framework, as well as implementation of tax, customs and ecological policies promoting the use of better fuel and limiting the import of used cars will have an important impact on the reduction of emissions from motor vehicles.

Technological needs and technologies

Transportation

- Increase in number of motor vehicles using natural gas and diesel fuel;
- Improve the quality of motor fuel;
- Optimize passenger transportation and diversify the urban public transportation means; Use of large buses and transportation means using electricity;
- Improve streets-roads network and optimize transportation flows;
- Provide modern devices to points conducting technical and ecological examination;
- Introduce financial incentive mechanisms for limiting and reducing emissions of polluting and greenhouse gases.

Projected evaluation of carbon dioxide emissions from motor vehicles for two scenarios, one with continuation of the existing pattern of motor fuel use (baseline) and the other one with increased use of natural gas and diesel fuel (projected line) are presented in Figure 1.12.

The expected reduction in carbon dioxide emissions for the projection period is 1 million t.

1.2.6. Agriculture

Agriculture accounts for 23.1 percent of Armenia's GDP. 64.7 percent of gross agricultural production comes from crops production and 33.3 percent from livestock production. Farming in Armenia is mostly irrigated (22 percent to total agricultural land and 65.5 percent of arable land are irrigated).

In 2000, agriculture accounted for 8.8 percent of the total GHG emissions (in 1990 - 5.7%). The share of agriculture in total methane emissions is currently 29 percent.

Sources of greenhouse gas emissions in agriculture are: agricultural machinery (CO_2), intestine fermentation of livestock and manure (CH_4) and use of nitrogen fertilizers (NO_2).

Significant changes have taken place in the agricultural sector within the last decade: fragmentation of farms and large livestock production farms, reduction in cultivated areas, number of livestock and agricultural machinery. As a result of these changes, greenhouse gas emissions in the agricultural sector in 2000 constituted 39.4 percent of the level of 1990 (Table 1.8).

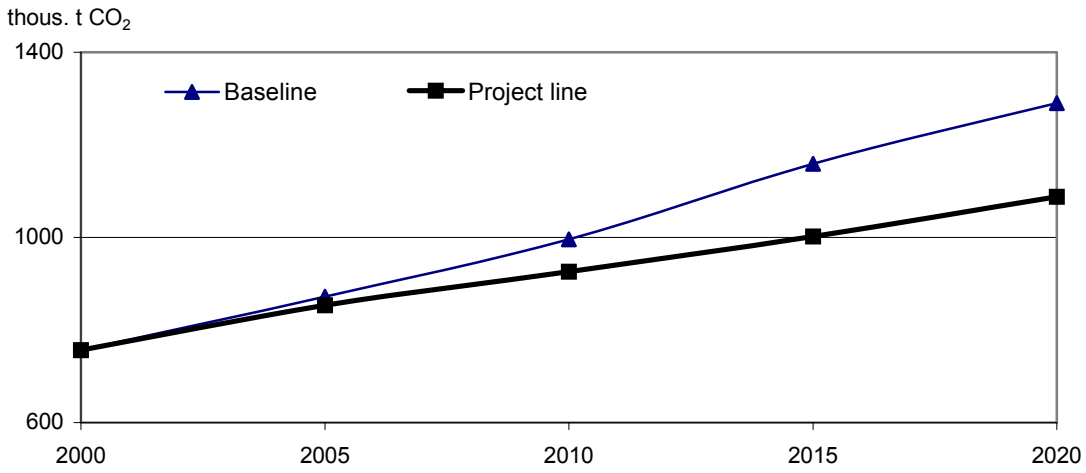


Figure 1.12. Projection of CO_2 emissions from motor vehicles in Armenia

Table 1.8 Greenhouse gas emissions in Armenia's agricultural sector, Gg (thousand t)

Sources	CO_2		CH_4		N_2O		CO_2	
	1990*	2000*	1990	2000	1990	2000	1990	2000
Agricultural machinery	427.7	71.6					427.70	71.6
Intestine fermentation			44.07	22.21			925.47	466.4
Manure			2.7	1.17			56.70	24.6
Agricultural lands					0.16	0.04	49.60	12.4
Total	**427.7**	**71.6**	**46.77**	**23.38**	**0.16**	**0.04**	**1459.47**	**575.0**

* For 1990 cadastre data, for 2000 evaluated data.

The largest share of greenhouse gas emissions in agriculture belongs to emissions resulting from intestine fermentation of livestock at 81 percent of total emissions and 95 percent of methane emissions.

Reduction in emissions from intestine fermentation can be achieved by a better balance of nitrogen and carbon in animal feed through application of technologies for ammoniation of hay, which is successfully used in a number of countries. Evaluation of the effectiveness of the use of this technology and the corresponding potential for reduction of methane emissions in Armenia’s conditions can be done after additional analysis based on the specifics of local conditions.

The technology using zeolites and other adsorbents as supplements to animal feed is very promising. At the same time, these supplements absorb methane in animals’ stomachs, contributing to digestion and reducing the number of losses. This technology is successfully used in other countries, and preliminary experiments with good results have been conducted in Armenia.

The quantity of methane emitted from livestock production waste constitutes around 5 percent of total emissions of this gas. In Armenia, livestock animals are confined for 6-7 months per year, and in the rest of the year they are in pastures, and quantity of manure which can be collected and processes amounts to almost half of its total quantity. Thus the potential for reducing methane emissions through application of technologies for manure processing is evaluated at 600 thousand t or 850 thousand cubic m of methane annually.

In recent years, due to the sharp decline in gas supply and the rise in fuel prices, the rural population in northern mountainous areas of the country use around 30 percent of the manure formed during confinement of livestock, as fuel, the annual quantity of which, according to experts, amounts to 126 thousand cubic m (37.8 thousand t).

The introduction of modern technologies for using the methane of livestock production waste is hindered by small sizes of farms (from among 340 thousand farms, only 100 have more than 50 heads of cattle), lack of financing and information among farmers, etc. The trend in recent years for consolidating livestock farms and improving their financial situation is a precondition for introducing modern waste processing technologies contributing to reduction of greenhouse gases.

In recent years, small biogas production facilities are being installed in farms, in particular in Aparan (together with a solar collector, reactor volume 6 cubic m), Yeghvard (reactor volume 13 cubic m) and Baghramyan (reactor volume 30 cubic m).

Widespread use of these facilities will allow for obtaining gas for further use in electricity and heat production, as well as quality organic fertilizers. In addition, there are modern facilities for producing gas not only from manure, but also from wastes of agricultural crops, stems and leaves, hay, etc. In some countries, crops with large volumes of green mass, such as amaranth and sorghum, are specially cultivated for this purpose.

There is a huge potential for energy saving in the agricultural sector related to the irrigation system. Irrigation needs account for 13-14 percent of the total energy consumption in the country. At the same time the efficiency of irrigation systems on average is 54 percent, which results in overuse of water and electricity. The reconstruction work currently conducted in the irrigation system will increase its efficiency to 72-74 percent, which will result in the corresponding reductions in irrigation water loss, energy consumption and carbon dioxide emissions.

Irrigation can be made much more efficient through the use of sprinkler and drip irrigation methods. Also artesian waters are not effectively used for irrigation purposes.

Technological needs and technologies

Agriculture

- optimize livestock feed through technologies of silage and ammoniation of hay.
- use of natural adsorbents available in Armenia as feed supplement for livestock.
- use of crops cultivation and livestock production wastes for energy production based on biogas.

1.2.7. Forestry

The forest area in Armenia is currently 459.9 thousand ha, of which 334.1 thousand ha of forest covered areas (11.2 percent of country’s territory). The forest covered areas per capita is around 0.1 ha. 62 percent of forests are situated in north-east, 36 percent in south-east. Central regions have only 2 percent of the total forest area. More than 250 types of tree-shrub plants grow in forests. The main forest forming species are oak, beech and

birch, which cover 81.3 percent of the forest covered area, including: oak 120 thousand ha (35.9 percent), beech 96 thousand ha (28.7 percent) and birch 56 thousand ha (16.7 percent). The remaining area is covered by pine, maple, lime and other tree-shrub species.

According to forest management data from 1993, the timber reserve in Armenia’s forests amounted to 41.47 million cubic m, with total annual growth rats of 0.435 million cubic m, average growth rate of 1.3 cubic m/ha, average reserve of 125 cubic m per 1 ha, average density of forest 0.53, average age 99 years. In the overall timber reserve the largest shares are those of beech at 20.68 million cubic m (49.5 percent), oak 12.5 million cubic m (29.8 percent) and birch 6.0 million cubic m (6.4 percent).

These data need to be adjusted, since they do not take into account the mass illegal tree-cuttings of the recent years and timber growth during that period.

The data presented show the ineffective management of the forestry sector. Growth indicators and consequently timber reserves in Armenia’s conditions could have been 50-60 percent higher. Absence of cuttings to the necessary volume in the past, due to, in particular, the fact that up to the collapse of the USSR country’s needs for timber were covered by imports, resulted in increase in areas of aged and extremely aged forests amounting to 26.3 percent of the total forest area. Around 47 percent of forests are classified as middle-aged, young forests of first and second age categories amount to 10 percent.

After 1990, Armenia’s forest being the only natural long-term absorbents of carbon dioxide, as well as having important protection functions, such as water protection, erosion protection, etc., were affected by extremely negative impacts as a result of the heat supply crisis and sharp drop in population's gas consumption. According to expert evaluations, for the period of 1992-2000, around 7 million cubic m of timber, or more than 16 percent of the total volume, was cut for heating purposes. Currently, the population uses almost 40 times more timber for energy purposes, compared to pre-crisis years.

As a result of mass illegal tree-cuttings in forests, 7.0 thousand ha are totally destroyed and another 100 thousand ha are damaged by 41 percent, where forests have become thin. The average density of forests has reduced to 0.32. At the same time healthy young forests near settlements with the highest capacity of carbon dioxide sequestration have been damaged the most, while aged forests remained almost untouched because of their remoteness.

In Armenia, characterized by its small forest area, such large-scale cuttings of forests resulted in the disruption of the ecological balance, and caused a number of negative ecological consequences through a chain reaction: reduction of biodiversity in forest ecosystems, activation of erosion, flood and landslide processes, worsened water protection functions of forests.

Such non-sustainable use of forests with significantly higher cutting rates than natural regeneration rates resulted in worsened functions of forests, as absorbents and accumulators of carbon and transformed them into sources of CO_2 emissions through the use of timber as fire wood.

In 1990, sequestration of CO_2 in forest ecosystems amounted to 697 Gg, and emissions constituted 80 Gg or 11.4 percent, and in 2000 the corresponding figures were 523 Gg and 960 Gg, i.e. emissions exceeded sequestration by about 2 times (Figure 1.13).

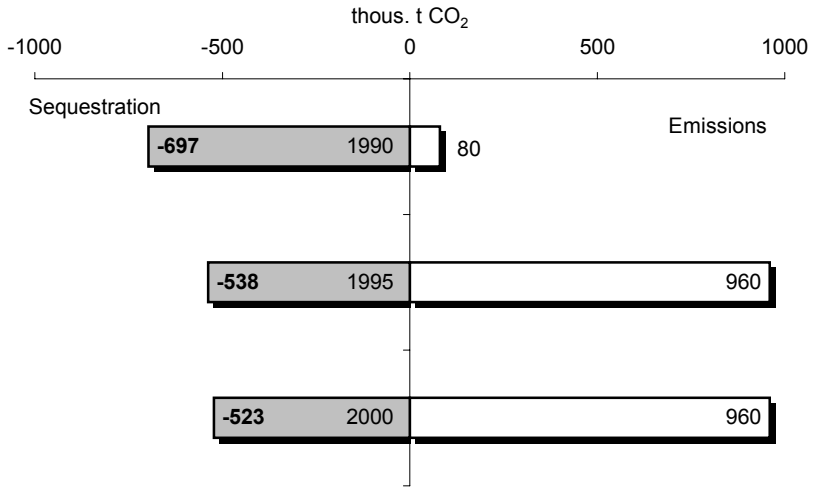


Figure 1.13. Balance of sequestration and emission of carbon dioxide in Armenia’s forestry sector, 1990-2000

Continuation of the current practices of forest use is inherent with irreversible ecological consequences. Based on projection calculation, it is determined that the restoration of forest to their initial situation (1990) will be achieved only after the year 2020, in conditions of gradual restoration of heat and gas supply to the population and improvements in their living conditions, reduction of annual cuttings to 350 thousand cubic m by 2010, to 200 thousand cubic m by 2015, to 100 thousand cubic m by 2020, as well as annual forest restoration activities on 1.0 thousand ha.

Reduction of sequestration capacity in Armenia’s forests is also caused by large-scale (on more than 20 thousand ha of territory) increase in populations of leaf-eating insects-pests, defoliation of trees, and consequently hindering the growth of timber. Absence of pest control measures has resulted in desiccation of large areas of oak forests in southern areas of the country (according to expert evaluations the total area of desiccated forests amounts to 2-3 thousand ha). Such volume of damage done by insects-pests is unprecedented in the country. At southern borders of forests in various areas of the country group desiccation of trees not caused by leaf-eating pests has been recorded. In the last three years, climatic conditions in the country formed a natural model of scenarios expected as a result of climate change, and the mentioned factors both confirmed the projected forest vulnerability (increase in number of insects-pests and higher lower borders of forests).

An important precondition for restoration and sustainable development of Armenia’s forestry sector is institutional reforms, by which management structures and their status should be adapted to the existing conditions, which in its turn will contribute to the development and implementation of large-scale state projects on restoration of forest ecosystems on the verge of disappearance.

Currently, the forestry sector is managed by the Ministry of Environment through "Hayantar" state CJSC, which basically finances its own operations. The state commissions some activities and allocated the corresponding funds from the state budget, however the amount of these allocations does not exceed 10-15 percent of the necessary funds for given activities and is not adequate even for conducting the minimum volume of the most urgent measures.

The current annual volume of forest regeneration activities is 300-500 ha, which is 10 times lower compared to pre-1990 years. At the same time, the quality of activities is low, there is a large share of desiccated seedling, all operations of forest regeneration are done manually, which makes them labor-intensive and not very effective.

International commitments of Armenia under environmental conventions establish the necessity for changing the status of “Hayantar” state CJSC and returning the status of state enterprise to forest management, increasing state funding, strengthening protection of forests, sharply reducing the volumes of illegal cuttings, increasing volumes of forest regeneration and restoration. The necessity of state funding for forestry activities is also mentioned as one of the main directions for development of Armenia’s forestry sector elaborated in 1996 jointly by State Forestry Service of Armenia and FAO experts.

The priority issue for Armenia's forestry is the development of a national program for development of forestry sector and implementation of the state program “Rehabilitation of forest ecosystems of Armenia” as soon as possible.

Technological needs and technologies

Forestry

- Technological development of seed and seedling production.
- Forest restoration, forest generation and cultivation of dry-resistant species.
- Technology for sustainable forest use.
- Technology for protection of forests from pests and diseases.
- Water saving technologies for watering.
- Management and staff training technologies.

1.2.8. Wastes

Solid municipal waste. Currently, about 3580 thousand cubic m of solid municipal waste (garbage) is generated in Armenia, which is a combination of domestic, commercial, construction and other wastes. The share of solid domestic waste in the garbage is 60 percent, its weight density 0.2-0.3 t/cubic m. The total quantity of solid domestic waste in 2000 was around 495 thousand t, from which 430 thousand t were transported to landfills near settlements, and 13-15 percent, mainly in rural areas, was dumped in small volumes wherever possible.

Accumulation of solid domestic waste for the entire population of the country in 2000 amounted to 0.5 kg/person-day, for the urban population 0.59 kg/person-day.

Currently, there are 58 landfills for solid domestic waste in the country, form which 57 are managed by local authorities and one by Yerevan city.

The total area of landfills is 250 ha. The largest landfills are in Yerevan (60 ha), Vanadzor (18 ha), Gyumri (10 ha), Armavir (8 ha), Ejmiatzin (7 ha), Hrazdan (6 ha).

In all landfills solid domestic waste is accumulated without sorting and is partially neutralized by being buried under the earth layer. Technical conditions of landfills are

extremely poor; vehicles and machinery for burying waste under a layer of earth are not adequate.

Accumulation of large amount of waste in landfills results in anaerobic decomposition of their organic parts and emission of methane. It must be noted that sometimes fires occur in landfills which results in CO_2 emissions.

Due to reduction in population of the country as a result of emigration in 1990-2000, the volumes of solid municipal waste and methane emissions have decreased. According to GHG cadastre, emission of methane from landfills in 1990 amounted to 23.7 Gg (thousand t) or 2 percent of the sum of GHG emissions, in 2000 (estimation)- 18.0 (thousand t) and 6.6 percent correspondingly.

For effective processing of wastes, it is necessary to introduce a system of sorted removal of domestic waste by the population (glass, metal, paper, food wastes), and on a wider scale a comprehensive system of waste processing with their classification, separation and utilization.

Cleaning of wastewaters with large content of organic substances, including domestic, commercial and part of industrial waters streams, cause emissions of a large quantity of methane. By 1990, there were 35 large and small operational wastewater treatment plants in Armenia with a total capacity of 974.3 thousand cubic m per day.

The wastewater treatment system at all stations includes equipment for mechanical and biological cleaning, processing of sediments and discharging of cleaned water. Depending of the magnitude and level of pollution of wastewaters, plants have different technological methods for cleaning, including different technologies for decontaminating sedimentary wastes. In 10 largest treatment plants sediments are processed through methane extraction in digesters anaerobic conditions, and in small capacity plants in aerobic conditions in mineralization tanks or in tow-shelved clarifiers, which have insignificant methane emissions.

The largest wastewater treatment plant, i.e. Yerevan aeration plant started operations in 1981. Although the initial design included digesters and gas-holders for accumulation of methane, these did not operate from the beginning of plant exploitation.

Presently, wastewater treatment plants are in extremely poor technical conditions and need radical reconstruction. Decontamination of sedimentary wastes is practically not done, and sediments accumulate in huge plants equipment, and part of the methane from discharged water enters the atmosphere without any control. Methane emissions resulting from the treatment of wastewaters in 2000 are estimated at 1.25 Gg (thousand t).

A large amount of sediments is accumulated in treatment plants every year, which, given the corresponding technologies would be made available, would require large quantities of energy for decontamination. Considering that wastewater treatment plants need radical reconstruction, it is appropriate to install modern technologies for high-temperature treatment of sedimentations, which produced a mixture of flammable gases (mainly methane) and organic fertilizers. At the same time, methane can be used as fuel for producing electricity and heat for internal use in the treatment plant, and the residual product in the form of compost can be used as quality fertilizer. The largest quantity of sedimentary waste is generated in Yerevan aeration plant, thus it is appropriate to use the mentioned technology first of all in treatment plants of Yerevan.

Technological needs and technologies

Municipal waste

- Modern technologies for processing solid domestic waste with obtaining alternative energy.
- Modern technologies with collection and utilization of methane from sedimentary waste formed in treatment plants of wastewaters for obtaining energy and organic compost.
- Construct waste processing plants for producing electricity and heat.

Considering that 66 percent of the total methane emissions from landfills in the country and 61 percent of the total methane emissions from municipal waster, including the wastewater treatment plant, come from Yerevan, it would be appropriate to implement a project for processing of solid municipal waste in Yerevan (Table 1.9).

Table 1.9 Characteristics of the proposed project for waste treatment

Project title	Investment	Annual reduction of GHG	Expiration period of technology	Reduction in GHG emissions for the expiration period	Per unit cost of reduction of GHG emissions	Quantity of alternative energy
	million US$	thous. t	years	thous. t	US$/t	GWh/year
Utilization of solid domestic waste and its methane for obtaining electricity and heat (construction of waste processing plant in Yerevan)	51.0	212.0	25	5300	9.62	148.8

1.2.9. Renewable sources of energy

Armenia does not have almost any fuel-energy resources of its own. The only local sources of energy of industrial use are hydro-resources, the potential of which has been already exploited by half. Need for fuel is fully met through imports. At the same time, Armenia has a significant potential for solar, wind and geothermal energy, which practically are not currently used.

Maximum possible utilization of renewable sources of energy has a huge significance for Armenia for ensuring its sustainable development and energy security, as well as substituting imported fuel and avoiding additional emissions of greenhouse gases.

The total theoretical potential of renewable sources of energy in Armenia amounts to 6924 million t eq. fuel. The technical potential of renewable sources of energy is estimated at 31.1 million t eq. fuel, from which 0.2 million t eq. fuel or 0.64 percent is currently utilized (Table 1.10).

Table 1.10 Potential of renewable energy sources in Armenia

Type of potential	Total	Energy			
		Hydro	Solar	Wind	Geothermal
Theoretical potential, million t eq. fuel	6923.9	2.7	6900	1.3	19.9
Technical potential, million t eq. fuel	31.12	0.92	30.0	0.2	N/A
Utilized technical potential					
million t eq. fuel	0.2	0.2	0	0	0
%	0.64	21.7	0	0	0

Hydro-resources. Armenia's rivers are not abundant with water, but have significant energy potential due to sharp drops in altitude. Quantity of water in rivers is characterized by underlined variability of water flow depending of the season, which created additional difficulties in the use of hydro-energy; it is necessary to construct reservoirs for seasonal or daily regulation, install additional hydro-blocks in HPP, which add to the costs of the project.

The theoretical hydro-potential of Armenia is estimated at 21.8 Twh per year, including 18.6 Twh for average sized rivers and 3.2 Twh for small rivers. The technically exploitable hydro-potential is 7-8 Twh, of which 3.2-3.5 Twh is economically viable (part of technical potential which is economically viable).

Hrazdan, Vorotan, Debed, Dzoraget and Arax have the largest economic hydro-potential. Currently around half of the economic potential is being utilized (1.6 Twh), including Hrazdan and Vorotan rivers completely, Pambak-Dzoraget-Debed rivers by 15 percent, Arax border river is not utilized. Hydro-potential of small HPPs is utilized by 10 percent.

Development of small capacity hydro-energy, which has a significant potential and possibilities for involving private capital, should be an area of focus. By the "Scheme of small HPPs in Armenia" developed by Armhydroenergoproject institute, which includes the entire territory of the country with 11 river basins, it is planned to construct 325 small HPPs with a total capacity of 274 MW and annual production of electricity at 833 kWh (Table 1.11).

Capital investments for implementation of development schemes for small capacity hydro-energy sector is estimated at US$250 million, with average per unit capital investment of US$900/Kw and US$0.3/Kwh.

A state policy is being implemented for promoting the development of small capacity hydro-energy in the country; the main directions of this policy are: (1) privatization of all existing small HPPs; (2) issuing licenses for construction and operation of new HPPs; (3) creating favorable conditions for attracting investments for construction of small HPPs. As a result of the policy 14 small HPPs with a total capacity of 30 MW are privatized and 11 new HPPs were constructed in the last 5 years.

Development plans for Armenia's energy sector envisage the utilization of the entire economic hydro-potential of Armenia. The priority list of HPP construction has been prepared and submitted to EU for possible investments. In the next 15-20 years, it is planned to construct HPPs with a total capacity of 300 MW in Armenia, including 38 small HPPs of 70 MW capacity (Table 1.12).

Table 1.11 Energy indictors of small HPPs in Armenia

River basin	Quantity of small HPPs	Installed capacity	Annual electrical energy production
		MW	million kWh
Debed	79	35.5	123.5
Aghstev	67	58.3	159.3
Akhuryan	14	25.0	79.8
Kasakh	26	21.0	54.5
Hrazdan	13	9.1	27.4
Sevan	20	23.0	66.0
Azat-Vedi	20	18.2	56.1
Arpa	26	35.0	88.7
Meghri	12	17.6	59.8
Vokhchi	40	21.2	72.6
Vorotan	8	9.8	45.0
Total	**325**	**273.7**	**832.7**

Table 1.12 Indicators of hydro-energy development in Armenia for the next 15-20 years

Hydro-electric power plants	Installed capacity	Annual electrical energy production
	MW	GWh
Large	210	950
Average sized	20	60
Small	70	224
Total	**300**	**1234**

It must be noted that during the elaboration of the program for utilization of hydro-potential, the factor relating to the reduction in country’s water resources due to the expected climatic changes and increase in demand for irrigation water is not taken into account. The mentioned factor can have a notable impact on the estimated economic hydro-potential of the country.

Solar energy. The geographic location of Armenia predetermines the availability of a considerable potential of solar energy. The average annual radiation balance is 1720 kWh/sq m, duration of sunshine from 2000 to 2800 hours per year.

The territorial distribution of sun radiation in Armenia is presented in Figure 1.14, which shows that 25 percent of country’s territory has annual solar energy resources amounting to no less than 1850 kWh/sq m.

The main direction for use of solar energy is its direct transformation into electricity through photoelectric transformers and transformation of solar energy into heat for heating, hot water and air conditioning purposes.

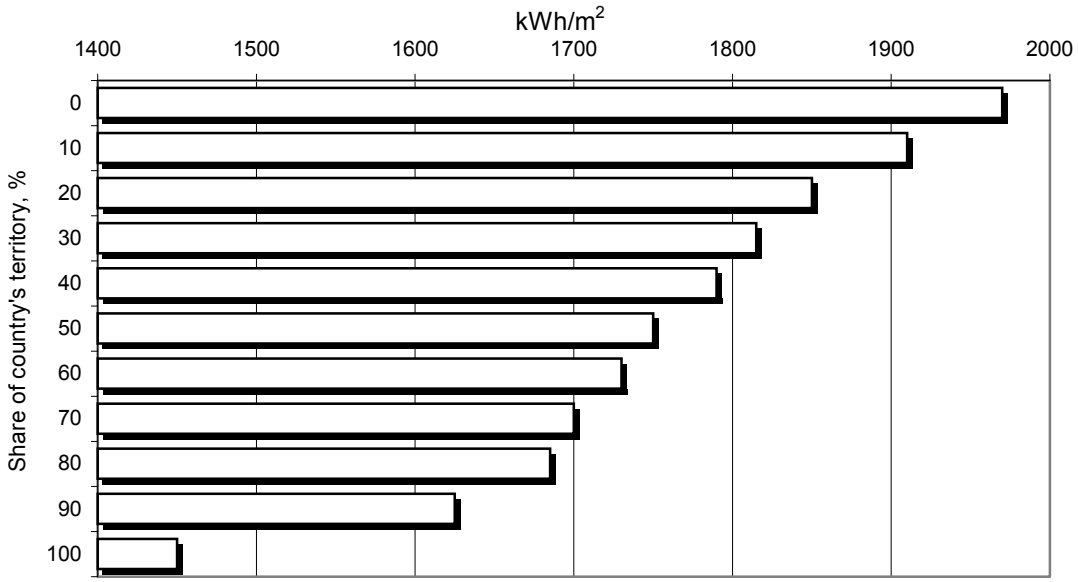


Figure 1.14 Distribution of solar energy in Armenia’s territory

Currently, only the second direction has been practically applied in Armenia. From 2000, with financial and technical support from the Dutch Government, the ArmNedsun project is being implemented in the country, within the framework of which the SunEnergy joint enterprise has been established for local production and sale of solar water heaters, which can be used for hot water supply, as well as in combination with additional heaters for heating purposes. Presently, 15 heaters with a total collector surface of 50 sq m have been installed. In the next 10-20 years, with gradual improvement of economic conditions, an increase in the demand for solar heaters is forecasted in housing, commercial and municipal sectors.

A fairly promising direction for utilization of solar energy in Armenia is the use of spherical and parabolic antennas, used in radio-physics research. Due to reduced volume of radio-physics research, some of these antennas are not used in recent years. With some modifications, the reflectors of non-operational antennas can be used as mirror concentrator for solar energy, at the focus point of which a capacitor is warmed up to high temperatures and converts that energy to electricity and heat. Currently, the project “Arev-100” for establishing an experimental solar electric power station is being implemented using reflectors of radio-antennas.

Wind energy. Based on the analysis of long-term meteorological information, the theoretical potential of wind energy in Armenia is 10.7 Twh. The technical potential is estimated at 1.6 Twh.

In order to determine the potential of wind energy and identify the more promising sites for its use in the country, within the framework of the inter-governmental agreement between the Netherlands and Armenia, wind energy is being monitored from 1999. Monitoring stations are installed in different regions, and on the basis of the information collected and with financial support from USAID and NREL a project for preparing the map of wind energy is being implemented, which will be finalized in 2003.

The potential of wind energy in the most promising sites is presented in Table 1.13.

Table 1.13 Wind energy potential in Armenia

Site	Capacity	Electricity production	Use of capacity
	MW	million kWh/year	%
Sisyan mountain pass	12	38.5	37
Kochbek	32	32	11
Zangeszur and Vayotsdzor mountain ranges	14	42	34
Pushkin mountain pass	11.2	24	24
Karakhach mountain pass	10	21.5	25
Bazum mountain pass	14	30.1	25
Yeratmber	20	21.6	12
Geghama mountain range	40	43.3	12
Hayotsdzor mountain pass	20	15.5	9
Lake Sevan	20	15.5	9
Mount Aragatz	2	2.16	12

Currently, Solaren and ArmNedWind companies are implementing projects for organizing the construction of two wind electric power stations in Pushkin mountain pass and in Zod region with a total capacity of 40 MW and annual electrical energy production of 120 million kWh, which will bring savings of 39.6 thousand t eq. fuel and reduction of 65 thousand t of CO_2 emissions.

Geothermal energy. Armenia has a significant potential of geothermal resources, both petro-thermal (heat of "dry" hot rocks) and hydro-thermal. Areas with high petro-thermal regimes are identified and studied: south-west of Lake Sevan and north-eat of Syunik highlands (Jermaghbyur and Angeghakot regions). In particular, the potential of Jermaghbyur area was confirmed, where according to data collected at a depth of 920m the temperature is 99^{o}C and at the depth of 2-2.5km 250-300^{o}C. Through artificial circulation of water between the rocks, it is possible to obtain steam for a geo TPP with 200 MW capacity.

The most significant geothermal resources with water temperatures of 80^{o}C are in the zone of high temperature flows, stretching from north-west to south-west of the country. The potential of geothermal energy in Armenia is estimated at 584 PJ.

Currently, geothermal resources (mineral hot waters) are used for medical purposes. The use of petro-thermal energy for producing electricity needs large investments. The most practical perspective for the near future is the use of hydro-thermal waters for heating and agricultural purposes. It is also possible to use thermal pumps in conjunction with thermal waters as one of the effective alternatives for heat supply.

Use of renewable sources of energy in the near future. With the necessary financial and technical support, it is fully practical in the next 10-20 years to produce 1795 million kWh energy per year using renewable sources of energy, which will substitute fuel at a volume of 518 thousand t eq. fuel and reduce CO_2 emissions by 850 thousand t (Table 1.14).

Table 1.14 Indicators of the use of renewable energy sources in the near future

RES	Energy production	Fuel substituted	Reduction of CO_2 emissions
	million kWh/year	thousand t eq. fuel	thousand t
Hydro-energy	1275	420.8	690.0
Wind energy	120	39.6	64.9
Solar energy	200	28.9	47.4
Geothermal energy	200	28.9	47.4
Total	**1795**	**518.2**	**849.7**

1.3 Summary characteristics of projects for reduction of greenhouse gas emissions

The selection of priority projects for reducing GHG emissions was done based on the analysis of the distribution of emissions by economic sectors and the effectiveness of technologies applied. As a result of the analysis investment proposals meeting the following criteria were selected:

- project is in line with national economic development goals;
- proven GHG reduction capacity of the project;
- inclusion of necessary technical and economic information;
- implementation of the project does not redistribute emissions to other sectors of economy;
- project is in line with conditions of technology transfer by clean development mechanism.

The main characteristics of proposed projects are presented in Table 1.15.

Table 1.15. Main indicators of projects for technology transfer

Project title	Capital investments	Annual reduction of GHG emissions	Expiration period of technology	Reduction in GHG emissions during operations	Per unit cost of reduction in GHG emissions*
	million $	thous. t	years	thous. t	$/t
Combined electricity and heat production, total	**165.0**	**352.0**	**30**	**10560**	**15.6**
Reconstruction of Yerevan TPP with steam-gas block with electrical capacity of 206.3 MW and heat production of 111 Gcal/h	165.0	352.0	30	10560	15.6
Renewable sources of energy, total	**432.2**	**693.7**	**-**	**26674**	**16.2**
Construction of HPPs:					
Meghri HPP, 79.8 MW	100.0	254.3	40	10174	9.83
Shnogh HPP, 75 MW	95.0	146.1	40	5844	16.2
Loriberd HPP, 59.2 MW	130.0	107.1	40	4286	30.3
Small HPPs with a total capacity of 70 MW	62.2	121.2	40	4848	12.8
Construction of wind electric power stations with total capacity of 50 MW	45.0	64.9	25	1622	21.5
Enhancing efficiency, total	**45.0**	**325,0**	**20**	**6500**	**6.92**
Reconstruction of heat supply system of Yerevan	45.0	325.0	20	6500	6.92
Reduction in gas leaks from the linear part of gas pipelines	**21.0**	**230**	**30**	**6900**	**3.04**
Use of wastes, total	**51.0**	**212.0**	**25**	**5300**	**9.62**
Utilization of solid domestic waste and its methane for obtaining electricity and heat (construction of waste processing plant in Yerevan)	51.0	212.0	25	5300	9.62
Total indicators for all projects	***714.2***	***1812.7***		***55934***	***12.76***

* Ration of capital investments to the volume of emission reduction for the entire period of the project.

The structure of the reduction in annual GHG emissions by categories of proposed projects is presented in Figure 1.15.

The total investment for the proposed projects amounts to US$714.2 million, the structure of which is presented in Figure 1.16.

The most preferable from the viewpoint of GHG emissions reduction are investments in projects for reduction of gas leaks, enhancing energy efficiency of heat supply and use of wastes, since with a small share of total investments (correspondingly 2.9 percent, 6.4 percent and 7.1 percent) the results would ensure 33.4 percent of the total reduction of GHG emission in all projects (Figure 1.17).

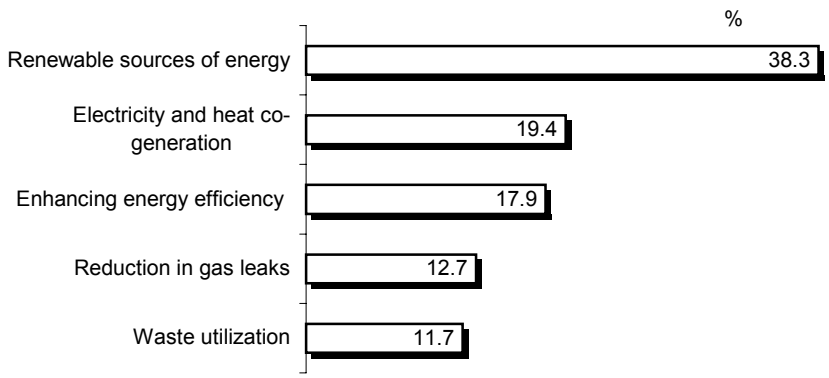


Figure 1.15 The structure of annual potential for reduction of GHG emissions

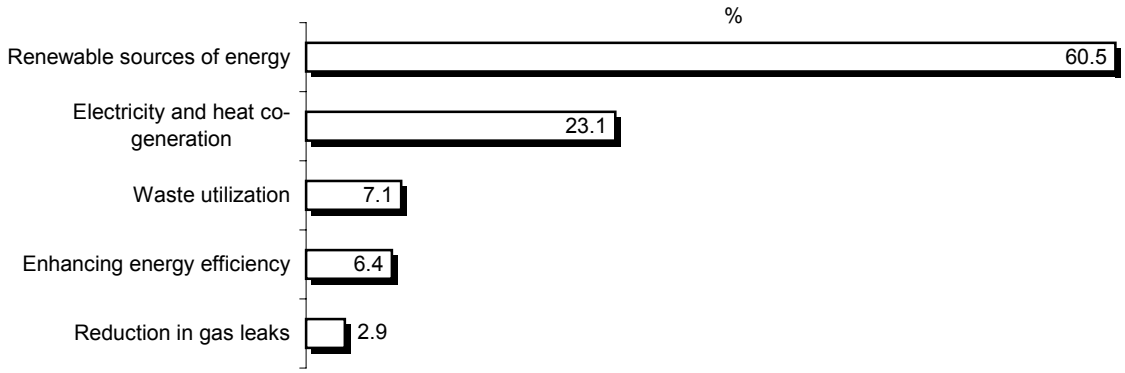


Figure 1.16 The structure of investments in proposed projects

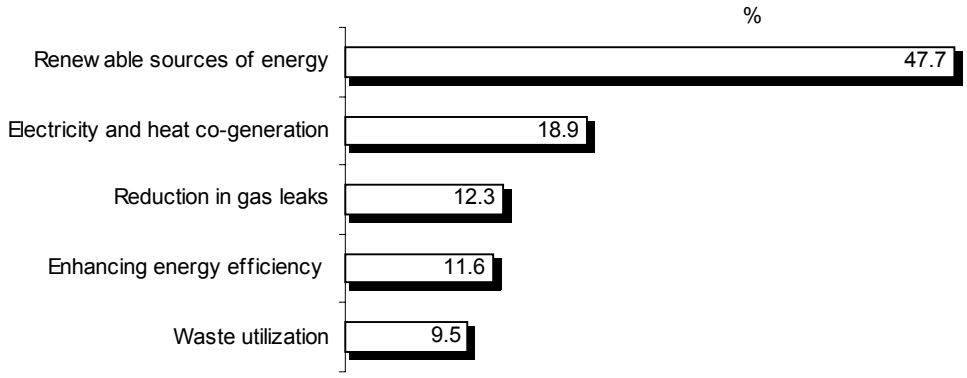


Figure 1.17 The structure of potential reduction of GHG emissions for the entire period of project operations

CHAPTER 2.

TECHNOLOGICAL NEEDS AND ADAPTATION TECHNOLOGIES FOR MITIGATION OF CLIMATE CHANGE IMPACTS

2.1. Water resources

Water resources in Armenia are mainly formed on its territory and their annual average quantity is 6250 million cubic m. There are 9500 small and average sized rivers with a total length of 25 thousand km. The density of river network is on average 0.8 km/d\sq km and rivers are distributed very unevenly. Around half of water resources flow out of the borders of the country. There are around 100 small lakes (excluding Lake Sevan) in the territory of Armenia with a total volume of 0.8 billion cubic m. Groundwater resources in Armenia are estimated at 4017 million cubic m, approved reserves available for exploitation amount to 1200 million cubic m.

75 water reservoirs with a total volume of around 1 billion cubic m have been built in Armenia in order to accumulate spring flows of rivers for their further use in irrigation.

Water resources in Armenia are used as sources of hydro-energy, irrigation and water supply, thus assessment of their vulnerability in case of climate change and implementation of the necessary adaptation measures are extremely important.

The uneven distribution of flow during the year and throughout years in Armenia’s rivers is a result of the primarily mixed intake (snow-rain-groundwater).

In many watersheds of the country flows are very sensitive to even small changes and variations in climate. Studies using empirical-statistical methods have revealed that annual and seasonal flows are more sensitive to changes in precipitation than changes in air temperature. However for basins, where the main water reserves are formed by snowmelt, the distribution of flow by months is more sensitive to air temperature, compared to precipitation.

In mountainous countries like Armenia precipitations in the form of snow have a special role in forming river flows. The intake of many rivers in Armenia comes mainly from melted snow. On Armenia’s territory the depth of snow cover depends on orographical conditions and varies between 10-15 cm at altitudes of 900-1200 m and 2.5 m at altitudes above 3000m.

In case of climate warming, it is expected that the area of snow cover and the duration of their preservation will shrink, especially in middle latitudes. Studies of the dynamics of the formation and disappearance of stable snow cover for the period of 1961-1990 revealed time shifts. The formation of snow cover shifted to later periods, and its duration shrank by a week, compared to the norm. The overall water reserves in snow on the territory of the country reduced by 5-10 percent in the studied period.

The quantitative assessment of changes in characteristics (vulnerability) of river flows in case of expected climate changes, for individual watersheds, situated in different physical-geographical conditions and encompassing almost all major rivers in Armenia (75 percent of all river flows) revealed that in case of the scenario projecting 1.5-2^{o}C increase

in temperature and reduction in precipitation by 10-15 percent, the total annual flow can reduce by 15-20 percent.

However, for some river basins there is certain incongruence between data on quantity of precipitations, characteristics of snow cover and changes observed in the river flow, thus there is a need for additional studies in order to have more specific projections for the vulnerability of water resources.

The main consumer of water resources in Armenia is irrigated farming, and their reduction related to possible warming of the climate is a serious threat to agriculture.

Together with irrigation, water resources are also important for supply of drinking water to the population and technical water to industrial-energy sectors.

The demand for water on the side of irrigated farming varies widely based on the seasons and quantity of water in rivers. Thus, in conditions of meeting the irrigation demand by 75-95 percent, reduction of flow in dry years by 21 percent to 42 percent compared to an average year can increase the need for irrigation water by 20-51 percent. The largest imbalance between river flows and water demand by irrigation farming occurs in summers, when surface flows amount to 19 percent of the annual flow and demand for irrigation water reaches 66 percent, and in the hottest months with 5 percent of the flow the demand for irrigation water constitutes 30 percent of the annual demand. In case of climate change this imbalance might become more tangible with the corresponding consequences for irrigated farming. Water systems in Armenia are created based on the basin principle. Projected assessment of the irrigated farming demand for water, considering the increase efficiency of irrigation systems, is presented in Table 2.1. Projected indicators of the demand for irrigation water can be used as reference during the development of adaptation measures aimed at mitigation of climate change impacts.

Climate change poses a serious threat to Lake Sevan which has a unique role in the natural environment and water system of Armenia. The current water level in the Lake is 1896.46 m, the mirror surface is 1238 sq km, volume 33.4 cubic km. During the period starting in 1930s when water from the Lake has been used for irrigation and energy purposes, its level has dropped by 19.3 m, mirror surface has shrunk by 178 sq km (12.5 percent), water volume by 25.4 cubic km (43.4 percent). The large-scale use of water reserves in the Lake for industrial purposes resulted in changes in the structure of its water balance and serious disruption of its ecological balance.

Preservation of Lake Sevan is one of the priority environmental problems in Armenia. Measures for improving ecological conditions of the Lake are included in the “Program for restoring ecological balance in Lake Sevan” developed with financial assistance from the WB, as well as the “Comprehensive program for restoration, preservation, regeneration and use of Lake Sevan ecosystems” developed in accordance with Sevan Act passed in 2001. One of the important measures in the program is to finish the construction of a 23 km long tunnel for diversion of a part of Vorotan river flow (165 million cubic m) to the Lake, which together with the currently operational Arpa-Sevan, will divert more than 400 million cubic m of water annually and gradually increase the water level of the Lake.

Table 2.1. Projection of water demand by irrigated farming in Armenia

River basins	1998				2050				
	Area of irrigated land	Efficiency coefficient of irrigation systems	Water demand	Per unit water consumption	Area of irrigated lands	Efficiency coefficient of irrigation systems	Water demand, efficiency coefficient constant	Water demand, higher efficiency coefficient	Per unit water consumption
	ha		million cubic m	cubic m/ha	ha		million cubic m	million cubic m	cubic m/ha
Debed	23600	0.57	185	7845	52473	0.80	412	295	5622
Aghstev	3883	0.55	41	10677	13048	0.78	139	98	7493
Joghaz	5219	0.55	60	11548	5719	0.69	66	53	9255
Kura	5279	0.55	45	8583	9142	0.58	78	74	8084
Akhuryan	45615	0.48	534	11702	84151	0.68	985	696	8275
Kasakh	13115	0.51	137	10444	16565	0.67	173	131	7905
Arax	21502	0.56	365	16957	29796	0.73	505	385	12925
Sevjur	30967	0.51	542	17505	40926	0.76	716	481	11752
Hrazdan	74543	0.51	1225	16433	143597	0.84	2360	1441	10035
L. Sevan	18863	0.60	107	5688	34307	0.77	195	152	4422
Azat	4159	0.51	66	15985	6680	0.70	107	78	11696
Vedi	1049	0.51	14	13051	4000	0.60	52	45	11158
Arpa	9348	0.60	100	10711	21782	0.77	233	183	8384
Vorotan	13339	0.55	132	9870	48214	0.77	476	339	7026
Voghji	1726	0.55	19	11211	6300	0.60	71	65	10349
Meghri	1323	0.55	17	12993	3557	0.66	46	38	10759
Total	**273530**		**3590**	**13126**	**520257**		**6615**	**4553**	**8752**

The expected climate changes can have a crucial impact on the water balance of the Lake. The most vulnerable element of the Lake's water balance is evaporation from its surface. Assessments conducted within the framework of the first phase of the project "Armenia-country study on climate change" revealed that for the given scenarios of climate change (increase in air temperature by 1.5-2^{o}C and reduction in precipitation by 10-15 percent) the volume of water in the lake will decrease by 250 million cubic m annually, including 150 million cubic m due to additional evaporation, and 100 million cubic m due to reduction in precipitations, in which case compensation measures are necessary for substituting these losses. Climate change can also result in the reduction of donor-river flows, in particular Arpa, Yeghegis, Vorotan rivers, which in its turn is reflected in the water balance of the Lake.

For more accurate assessment of the vulnerability of water resources in Armenia to climate change, it is necessary to conduct detailed studies of the expected changes in various elements of the water balance in both individual hydrological regions and the country as a whole, including Lake Sevan. This is also true for artesian and ground waters. It is appropriate to conduct these studies together with the countries bordering Armenia, since the reach of these waters is not limited to the territory of Armenia.

In order to mitigate the consequences of climate change for water resources of Armenia, it is necessary to apply the corresponding adaptation measures and technologies:

Technological needs and technologies

Water resources

- increase the volume of accumulation of winter-spring river flows through construction of new water reservoirs with a total volume of 1.0 billion cubic m (apply new technologies for managing water reservoirs in order to reduce was losses due to vaporization and filtration);
- divert part of the flows from water-abundant basins to those with water shortage;
- use of non-traditional methods for replenishing water resources (artificial precipitation through active manipulation of clouds);
- reconstruct irrigation systems for reducing water losses and apply modern water-saving irrigation technologies (sprinkler, drip irrigation);
- replenish water reserves of Lake Sevan through diversion of part of the Vorotan river flow, reduction of water withdrawals from the Lake for irrigation purposes through improvements in Yeghvard water reservoir and banning the use of water from the Lake for energy purposes during the irrigation period;
- use of modern technologies for treatment of polluted water, as well as treatment of saline waters in Ararat valley through, for example, electrolysis method;
- balance the use of artesian and ground waters for drinking and irrigation;
- savings and rational use of waters in all sectors of economy by using semi-closed cycle and closed-cycle systems of water supply;
- improve the monitoring of water resources;
- develop national program for use of water resources taking into account the future needs of economy and possible changes in the climate.

2.2. Agriculture

The total area of agricultural land in Armenia is 1394.4 thousand ha, including: arable 494.3 thousand ha (35.5 percent); perennial plantations 63.8 thousand ha (4.6 percent); grassland 138.9 thousand ha (10 percent); pastures 694 thousand ha (49.9 percent); virgin lands 0.8 thousand ha (0.1 percent). The lower border of crops cultivation starts at 400 m above sea level and the upper limit reaches 2300 m. Around 40 percent of country's territory is not usable for agricultural purposes. Due to sharply underlined vertical zoning and fragmented mountainous terrain, Armenia is in the last place among CIS countries as regards the area of agricultural land per capita.

Difficulties in the agricultural sector are further aggravated by the dry climate, as a result of which in the majority of agricultural zones in the country the profitability is very low in rainfed conditions. Comparatively higher yields are ensured in irrigation conditions; around 70 percent of gross agricultural product.

Currently, lands suitable for agricultural activities, including perennial plantations (except grasslands and pastures), are privatized and highly fragmented. Large areas of

vineyards and fruit crops are destroyed and transformed for cultivation of cereals. This situation resulted from the deep economic crisis in recent years. The area under cereal crops, compared to 1990, has increased by 30 percent, but due to low yields the gross production has increased only by 10 percent. The average yield of cereals in 1990 was 2.06 t/ha, in 1999 it was reduced to 1.75 t/ha and in 2000, as a result of the drought, to 1.37 t/ha.

In the firs national communication, as expected scenarios of climate change, a drop of 8-14 percent in the productivity of crops farming was projected, including cereal yields by 9-13 percent, vegetables by 7-14 percent, potato by 8-10 percent and fruits by 5-8 percent. Climatic indicators, which corresponded to projections for the next 50-100 years (increase in temperature by $2^{o}C$ and reduction in precipitation by 10 percent), were recorded in the country in the last 5-6 years. This allowed for observation and practical assessment of the projected and real vulnerability of agriculture, which exceeded all the negative expectations.

According to data from meteorological service, air temperature in Armenia in June-August 2000 was higher than average by $5^{o}C$. The quantity of precipitations reduced sharply. Relative air humidity in this period decreased by 17-18 percent. Volume of water in water reservoirs decreased by 30 percent. According to data from the Ministry of Agriculture, only crops farming suffered damages amounting to US$40 million. Losses of cereal crops amounted to 105 thousand t (35 percent), potato 90 thousand t (22 percent), vegetables 70 thousand t (17 percent), forage 130 thousand t. Area of mountainous grasslands damaged by the drought amounted to around 54 thousand ha. More damages were caused to pastures, the productivity of which, according to expert evaluations, decreased by 48 percent.

As a result of feed shortage in 1998-2000, huge losses were recorded in livestock production: the number of livestock animals decreased by 20 thousand heads in 2000, losses of meat production amounted to 1.8 thousand t, milk 20 thousand t. Consequences of the devastating drought were somewhat mitigated thanks to material-technical and financial support of a number of international organizations, governments, benefactors, etc.

Besides the drought, other extreme phenomena, such as frost, hale, heavy rainfall, etc. also caused serious damage to country’s agricultural sector in recent years. High yields of agricultural crops were achieved in Armenia in 1980s due to the widespread introduction of the time’s modern technologies. Large volumes of high quality fertilizers, chemical and biological means of plant protection and advanced agro-technical practices were used in agriculture. Melioration measures were widely used. Forest protective zones were planted around agricultural lands. Latest achievements of agricultural science were introduced into production, sectoral research institutes for farming, grape production and fruit production, agro-chemistry, plant protection, etc. were operating actively. The agricultural institute prepared the necessary number of qualified specialists each year. Armenia’s technological needs were almost fully met in those years. Advanced technologies of international scale were introduced in individual farms.

Presently, the country is in a different socio-economic situation. The deep economic and energy crisis, the blockade, hurried privatization of land regressed agriculture back to 1950s, when the use of advanced technologies in agriculture had just started in the country. The only difference with the mentioned period is the availability of scientific-academic potential, which is capable of functioning effectively in case of material-technical and financial support and certain institutional-legal changes.

Currently, even if material-technical and financial support is made available, the introduction of modern technologies in country’s agricultural sector on large territories would be impossible, since lands are highly fragmented due to land privatization. The owner cultivates one or another crop depending of his individual needs. For example former collective-soviet farms with 150-250 ha of land currently belong to 30 and more owners, and 5-6 types of crop are cultivated in one areas, and part of the land is not used at all. Thus, the application of comprehensive agro-technical and other measures becomes impossible due to the fragmentation of formerly large land areas. Previously, one type of crop was cultivated each year on agricultural lands of 150-250 ha, i.e. an effective system of crops rotation was applied. It was possible to conduct plant protection measures form pests, diseases and weeds at the same time. Currently, these measures are difficult to conduct due to fragmentation of farms and low material-technical and financial capabilities of farmers.

This situation has serious consequences for the development of fruit production and grape production, since the fate of harvested fruits and grape is largely dependent on the characteristics of their varieties and quality of planted seedlings, as well as the size of agricultural land and simultaneous implementation of the set of agro-technical and other measures.

For grasslands and pastures owned by the state and rented out for use, it is more appropriate to have a unified sustainable development policy. The entire set of long-term measures, contributing to the rational use and restoration of degraded grasslands and pastures and provisions for encouraging their implementation can be included in the conditions of rental contracts.

Thus, the analysis of the current situation in the agricultural sector of the country, calls for, first of all, the necessary institutional-legal changes.

The state strategy for agricultural development should take into account the factor of global climate change and correspondingly the projected vulnerability of the sector.

During elaboration of adaptation technologies, it is necessary, first of all, to take into account and consider possibilities for their implementation by all land users, regardless of the right to ownership.

As already mentioned, the majority of necessary technologies have already been developed, and there is a need to create possibilities for their introduction through removing institutional, as well as material-technical and financial barriers. It is also appropriate to develop and implement pilot projects on adaptation models by using advanced technologies, which will contribute to the sustainable practice in various sectors of agriculture also taking into account the projected vulnerabilities.

Each of the proposed agricultural projects envisages the use of already tested effective local technologies and modern international experience adapted to Armenia’s conditions.

Considering the high vulnerability of agriculture to the projected climate changes, there is a need for a fundamental review of the structure of agriculture (crops farming and livestock production) in the long-term.

Technological needs and technologies

Agriculture

- Restoration and sustainable use of degraded grasslands and pastures.
- Restoration and sustainable development of fruit and grape production.
- Adaptation of farming to climate change, including cultivation of new climate change resistant crop varieties.
- Restoration of collector-drainage network on agricultural and saline lands in Ararat valley.
- Application of water saving technologies in crop production.

2.3. Natural ecosystems

During the preparation of Armenia's First National Communication on climate change, it was shown that Armenia's natural ecosystems can undergo serious transformations in case the projected scenarios of climate change for the next 50-100 years come true (rise in average temperature by $2^{o}C$ and reduction in precipitation by 10 percent). It was proven that in this case the borders of landscape zones will shift on mountain slopes by 200-400 m, which will result in drastic changes in areas occupied by various ecosystems, changes in their flora and fauna composition, reshaping of structures, which will have consequences for country's biodiversity as a whole.

In the years following the preparation of the first national communication, climatic conditions in Armenia have come closer to the projected values. Against the background of increased temperature and reduction in precipitation, numerous climatic phenomena, such as severe droughts, heavy rainfalls, floods, etc., were recorded.

In 1998-2000, climatic conditions corresponding to the projected scenarios of climate change for the next 50-100 years were naturally formed in the country.

Presently, conducting a detailed comparison of changes in ecosystems between the last few years and the projections is not possible. First of all due to the fact that there in no monitoring system for natural ecosystems in place. Comparison methods using indicators of ecosystem changes are not applicable either, since the corresponding indicator system is not developed and their potential possibilities and level of representativeness are not determined.

It is only possible to provide general expert evaluation based on observations of individual ecosystems in individual regions in the country.

Over the last 5 years, changes in the range of a number of representatives of semi-desert plant species, for example, on the south-eastern slope of mount Aragatz individual *Artemisia fragrans* plants were found on altitudes 200 m higher than previously recorded; in Kotayk, on the slopes of Voghjaberd mountain range, populations of a number of plant species characteristic to semi-desert or even more arid deserts were recorded (*Kochia proctrata*, species of *Salsola*, etc.).

Increase in ranges of invading weed species in steppe and meadow zones has been recorded. At the same time, increase in their ranges is coincided with increase of their numbers in existing territories. Among these species, first of all, *Euphorbia seguieriana,*

Lepidium), *Cirsium,*etc. can be mentioned. These species are also indicators of aridity of conditions.

Reduction in numbers in populations of some relatively mezophyle plant species in sub-alpine and alpine zones has been recorded (for example, *Taraxacum stevenii, Campanula tridentate*, etc.).

In protected natural areas of Armenia some changes in phenology of some animals (mainly insects) have taken place, with shifts of flying periods to earlier times. The limited number of examination of soils in Sevan revealed that the quantitative indicators of soil fauna have decreases, which is a testimony to desertification processes. In Khosrove reserve, drying of springs and earlier than usual drying of temporary water flows have been recorded, which have resulted in, particularly, earlier departure of some elements of water band entomo-fauna.

In case of projected changed in climate, the vulnerability of the network of protected areas can be manifested in the redistribution of ecosystems with possible disappearance of some protected areas as such. Changes in hydrographic regime can cause the extinction of many components of natural cenozes. Habitat of Ararat valley Porphyrophora hammeli Brandt might be especially threatened, including the corresponding reserve area.

According to projections presented in the first national communications, the total annual water flow in Armenia can decrease by 15-20 percent. Today some proof of the reduction of water flow is already noticed. Thus, for example, in lake-water reservoir Arpi, during the last 5 years, the minimum volume of water has reduced from 30 to 6 million cubic m, at the same time, constantly moist territories around the lake have dried up in the last two years. In the last three years, the level of water in the small (10 ha) mountainous lake Ardenis, due to shortage of snow, has diminished by 45 cm, which has affected the entire ecosystem near the lake.

Currently, the most important measure for ensuring long-term objectives is the *establishment of a monitoring system for natural ecosystems,* which should be unified and take into account, based on indicators, changes in ecosystems, as well as changes in biodiversity, intensity and direction of desertification processes, etc. The main analytical mechanism for ecosystem monitoring should be the use of GIS.

Technological needs and technologies

Natural ecosystems

- Develop nature use concept taking into account the global climate change;
- Optimize the system of protected natural areas;
- Optimize the management of water ecosystem and swamped habitats;
- Restore degraded forest ecosystems.

2.4. Population’s health

In the first national communication, it was revealed that if the projected scenario of climate change (increase in temperature by $2^{o}C$, reduction of precipitations by 10 percent) for Armenia comes true, it is expected that the epidemiological situation of the population related to especially dangerous and other infectious diseases and parasitic diseases will worsen. High temperatures of the last 3 years, as if provided a model for climate change scenarios, within the framework of which these projections were made.

Assumptions on the consolidation and circulation of cholera vibriones in Armenia and the possible sporadic cases and outbreaks of infection in conditions of high temperatures were approved in 1998, when against the background of the highest temperatures recorded in 70 years in August and September, a cholera outbreak was recorded in Zartonk village of Armavir marz. Until the localization of the outbreak, 288 people contracted the disease, two of whom died. Measures taken by the Ministry of Health, Center for Prevention of Especially Dangerous Infections and local authorities liquidated the outbreak, but cholera vibriones in this and other areas of the country were not totally eliminated and their numbers increased in the following years, whereas the discovered cases of vibrones of group 01 (El Tor vibriones) increased from 1.4 percent to 2.4 percent of samples in 1999-2001.

In recent years, the number of malaria morbidities has also increased. In 1998, the number of people contracting the three-day malaria reached 1156, after which, as a result of more active prevention and treatment measures taken within the framework of "National program for combating and preventing malaria” which is a part of the WHO "Turn back malaria” program, the morbidity rate dropped sharply. Despite measures for reducing morbidity, due to high malaria potential of the majority of regions in the country, the geography of the disease became more widespread in 1999-2001, as predicted by the first national communication.

Similar results, confirming projections made earlier, were obtained by analysis of the directions of the spread of intestine and parasitic diseases, which also play an important role in pathology. Intestine typhoid, paratyphoid and other salmonelloses, dysentery, coelenterates, viral hepatitis A, amebiasis, liambliosis and from soil parasites ascariasis, trichocephallis , etc. have been recorded in Armenia. Having fecal-oral and water-food mechanisms, as well as transmission through water, food (through domestic items) and soil, all of them are characterized by strongly underlined seasonal manifestations, since the biology of infections and mechanical carriers of these infections significantly depend on the impact of climatic factors, especially temperature.

Based on the above-mentioned, it can be stated that projections made in the first national communication have been confirmed in practice.

Technologies necessary for mitigation of the vulnerability of population’s health in case of expected climate change, taking into account the national capacities, should have two directions: mitigation of health vulnerability in normal conditions and in emergency situations.

For the first direction, taking into account the high epizootic activeness of the mountainous area of Trans-Caucasus and high virulence of plague, circulating in near-Arax area, as well as the continuation of the geographic expansion of malaria and higher morbidity rates of intestine and parasitic infection in recent years, the main technologies are:

- prognosis;
- monitoring (including natural-epicenter territories);
- early diagnosis;
- strengthening preventive measures in potentially dangerous areas;
- modern methods of combating with carriers and transmitters of especially dangerous and other infectious diseases;
- sanitary control over the quality and drinking water and irrigation water, quality of food products.

Enhancing the accuracy of prognosis and optimization of the monitoring process itself will contribute to the formation of a data base of infections and invasive diseases and development of modern medical-geographic maps of Armenia through retrospective analysis, introduction of computer technologies and cartographic methods, in particular GIS.

It is also necessary to transfer tested and effective adaptation models, using intra- and inter-sectoral links for protection of population's health in emergency situations.

Technological needs and technologies

Population’s health

- Combating transmitters and carriers of especially dangerous and other infectious diseases with biological methods using if possible the local fauna.
- Ensuring modern methods for disease prevention among the population.
- Develop local preparations for biological control of carriers and transmitters of communicable infectious diseases.
- Develop and introduce technologies contributing to the optimization of the monitoring process of natural-epicenter infections, quality of water, soil, food products.
- Develop informational-educational programs for the wide public, including models for actions during epidemiological and other emergency situations, methods of individual prevention and medical first aid.
- Prepare an up-to-date medical-geographical map of Armenia, taking into account the on-going changes in climate.
- Create the optimal model for multi-sectoral links ensuring population’s health in case of changes in environmental conditions.

CHAPTER 3.

TECHNOLOGICAL NEEDS FOR DEVELOPMENT OF THE NETWORK OF CLIMATIC OBSERVATIONS, MONITORING OF ENVIRONMENT AND CAPACITY BUILDING FOR CLIMATE CHANGE STUDIES

3.1. Activities of national hydro- meteorological service and conditions of observation network

Hydro-meteorological observations in Armenia are conducted for more than hundred years, from 1881. Currently the observation network includes 45 meteorological stations (until the beginning of 1990s there were 80 stations), 3 climatic station, 60 meteorological, 98 river and 7 lake observation posts. In 1948-90, route observations of snow cover and snow flow were also conducted.

Hydro-meteorological observations and their analysis, as well as monitoring of climate change in Armenia is conducted by National Hydro-meteorological Service or ArmHydroMet (from 2002 Hydro-meteorological and Environmental Monitoring Agency of the Ministry of Environment). Based on data from ArmHydroMet, the “Reference on Climate in Armenia” bulletin and climate in largest towns of Armenia were published. Information provided by the Service is widely used in planning and in various sectors of economy in Armenia.

In conditions of economic crisis of the transition period and absence of the necessary financing, observation network ended up in an extremely difficult situation. Observations are conducted irregularly and not to the full extent, the system for collection, processing and provision of observation data has become outdated and is worn out.

There is a need for modernization using contemporary information technologies with a data base adequate representative ness: meteorological, hydrological, actinometrical, radiation, ozonometrical, which are currently filed as paper sheets and are in extremely poor conditions.

Significant support is provided to National Hydro-meteorological Service within the framework of cooperation with WMO and other bilateral cooperation. Within the framework of cooperation with WMO, Meteo-France provided Armenia with RETIM-AEROMET system, which allows for receiving meteorological data and maps through a geo-stationary satellite, as well as KLICOM system for receiving and processing climatic data, which is used for managing meteorological data. Currently, by using this system data on many years received from Obninsk town (Russia) have been processed and filed, and current data is also being processed.

From 1992, Armenia is a member of World Meteorological Organization and CIS Inter-Governmental Council on hydro-meteorology and has committed itself to cooperate with global and regional centers and national hydro-meteorological services regarding exchange of information. Part of data from observations is provided to WMO and global climate information centers (Germany, USA) for publication.

34 stations of Armenia's hydro-meteorological network are included in the regional network of global telecommunication network, including 3 stations (in Yerevan, Gyumri

and Sevan) included in the global information exchange network. Based on the data from these stations the monthly telegram “CLIMATE” is prepared, which is sent to the International Center for Climatic Data in USA and daily-synoptic telegrams for global information exchange.

Telegrams based on data from 17 stations, as well as annual reports on climatic specificities of Armenia are prepared for inter-regional exchange, which are sent to Germany and published in annual climate bulletin.

Research activities of ArmHydroMet are conducted in Center for Climate Studies, which has departments for climatology, digital modeling of hydro-meteorological processes, study of global and regional climate changes, applied climatology and atmosphere pollution.

In ***climatology department*** data for different periods from 180 stations and observation posts located on the territory of Armenia are processed, annual climate bulletins are prepared, which present the details of climatic resources in Armenia.

In ***digital modeling of hydro-meteorological processes department*** dynamic-static models are developed and elaborated for short-term prognoses hydro-meteorological processes. The developed algorithms are use for prognosis and evaluation of precipitation, river flows, floods, yields of agricultural crops and droughts, atmosphere pollution.

In ***study of global and regional climate changes department*** models are developed which are used for devising scenarios of climate change on the territory of Armenia, taking into account global climate changes. Currently, methods for long-term prognosis are developed (monthly, seasonal, annual), which are used in solving various issues.

Applied climatology department develops methodologies for prognosis in the area of hydrology and water resources, agro-meteorology, bio-meteorology, alternative energy, frequency and intensity of droughts.

Atmospheric pollution study department is involved in issues relating to diagnosis and prognosis of atmospheric pollution on the territory of Armenia.

3.2. Observed and expected climate changes in Armenia

Within the framework of the first phase of “Armenia-country study on climate change" trends of average annual, seasonal and monthly deviations of air temperature and precipitation compared to the standards period (1961-1990) were determined. According to studies conducted in the observation period the air temperature on the territory of Armenia increased by 0.4^{o}C and quantity of precipitations reduced by 3.6 percent. Within the second phase of the project studies were completed by reviews of the time series until 2001.

Figure 3.1 presents the air temperature trends on the territory of Armenia, balanced by the 11-year binomial filter.

Until 1998, the precipitation norm in Armenia was set at 630 mm, however according to calculations done at the Center for Climate Studies in 2001, for 1961-1990 the norm was 592 mm, and for 1935-2000, compared to this norm, a reduction of 7 percent was recorded (Figure 3.2).

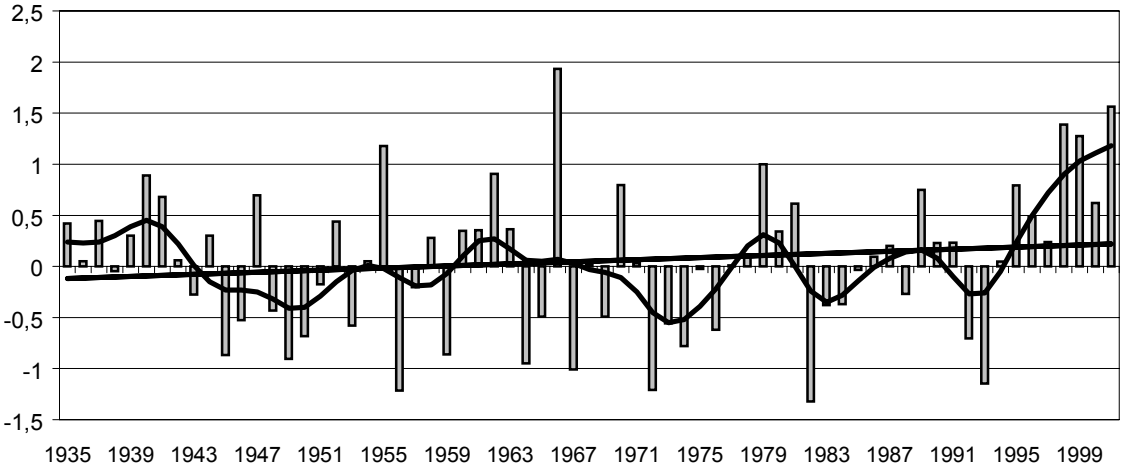


Figure 3.1 Deviation of average annual temperature on the territory of Armenia compared to the standard period (1961-1990)

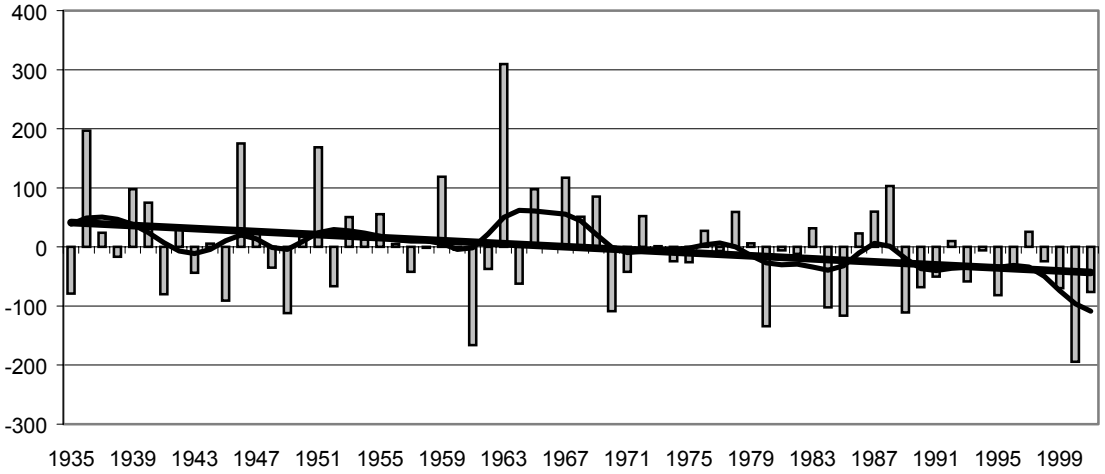


Figure 3.2. Deviation of average annual quantity of precipitation of the territory of Armenia compared to the average data from 1961-1990

Tables 3.1 and 3.2 present deviations from the air temperature and precipitation norms on the territory of Armenia in 1998-2001. In these years the temperature was higher than the norm by 1-1.5^{o}C and precipitations decreased by 15-20 percent.

Table 3.1 Seasonal and annual changes in air temperature on the territory of Armenia in 1998-2001 compared to the norms

Season	T_{actual} °C				T_{actual} °C	ΔT °C			
	1998	**1999**	**2000**	**2001**		**1998**	**1999**	**2000**	**2001**
Winter	-4.1	-2.2	-2.4	-3.3	-5.5	0.5	3.3	3.1	2.2
Spring	7.3	5.2	4.8	6.5	4.4	1.6	0.8	0.4	2.1
Summer	19	17.2	18.1	17.2	15.7	2	1.5	2.4	1.5
Autumn	10.6	7.4	7.6	7.5	7.2	2.2	0.2	0.4	0.3
Year	8.2	6.8	6.4	6.9	5.5	1.6	1.3	0.9	1.4

Table 3.2 Seasonal and annual changes in precipitation on the territory of Armenia in 1998-2001 compared to the norms

Season	R_{actual} (mm)				R_{actual} (mm)	R_{actual}/R_{norm} %			
	1998	**1999**	**2000**	**2001**		**1998**	**1999**	**2000**	**2001**
Winter	75	57	99	66	114	77	50	87	58
Spring	190	167	139	183	211	96	79	66	87
Summer	127	147	42	101	148	88	99	28	67
Autumn	67	125	78	76	119	61	105	66	64
Year	459	487	382	424	592	81	82	65	72

T_{actual} R_{actual} – actual value of air temperature and precipitation
ΔT – actual deviation of temperature from the norm of 1961-1990
R_{actual}/R_{norm} – ratio of actual value of precipitation quantity to the norm for 1961-1990

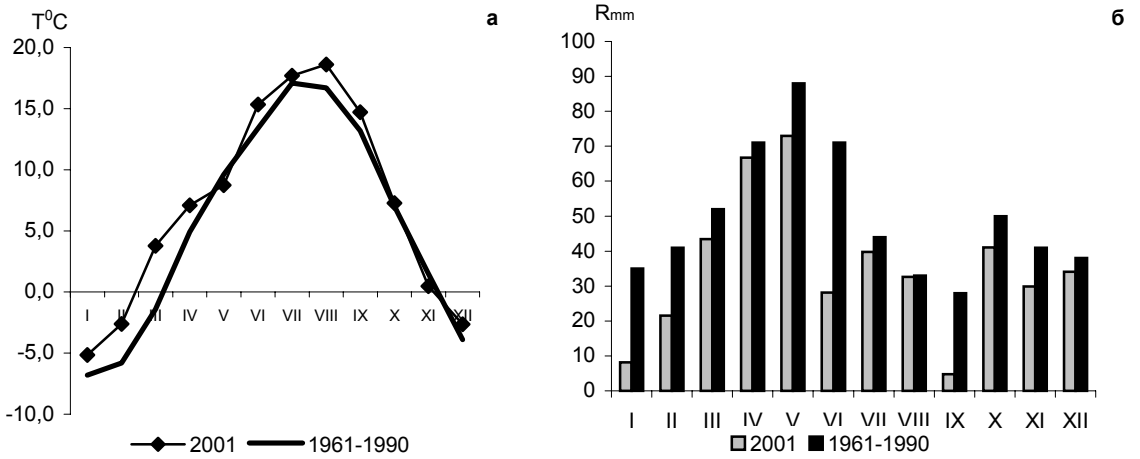


Figure 3.3 Average monthly air temperature (a) and quantity of monthly precipitation (b) on the territory of Armenia

According to the results of studies in first phase of "Armenia- country study on climate change" an increase of 2°C in air temperature and decrease of 10 percent in precipitations are expected in this century in Armenia. According to this scenario the reserves of effective moist in soils will reduce by 15-20 percent, vaporization will increase

by 7-8 percent, natural moist in plants will reduce by 15-20 percent, water resources will diminish by 15-20 percent.

A large volume of work was conducted within the framework of the first and second phase of the project, the results of which were compared to the results presented in the Third Assessment Report of IPCC and the climate change section of Kiev report. Evaluations of temperature and precipitation changes, as well as frequency of extreme hydro-meteorological phenomena are well in line with regional climate prognoses presented in these reports.

Activities of the Center for Climate Studies of ArmHydroMet regarding climate change problems have a continuous and long-term character. Assessment of climate change trends on the territory of Armenia continues and their link with global climate change has been established, the work on development of empiric-statistical methods for assessing expected climate changes and development of models for long-term prognosis, etc. continues as well.

3.3. Analysis of trends of climatic anomalies and assessment of their impact on economy

Due to the specificities of geographic location, geological structure and soil-plant cover of Armenia, natural disasters of various magnitude, frequency and spread occur on its territory: earthquakes, landslides, floods, etc. which create emergency situations with various levels of threat.

Average annual damage caused to the country by natural disasters, according to data from Emergency Situations Department, is AMD10.1 billion or 10 percent of GDP.

The study of damages caused by natural disasters of hydro-meteorological character reveals that the largest damages to the country are caused by droughts, hale and frosts. Some damages are caused also by heavy rainfall, snow storms, blizzards, floods and spring inundations. The economic damage caused by these phenomena, according to data from Emergency Situations Department, is estimated at AMD1 billion annually, which is around 10 percent of the damage caused by all types of natural disasters.

During development of measures for prevention and mitigation of consequences of natural disasters and identification of their development trends, data on their numbers, distribution within one year and across years, frequency aspects and damages caused play an important role.

The corresponding services of ArmHydroMet play a certain role in reducing damages caused by natural disasters of weather-climatic nature, warn about the possibility of their occurrence, which in case of effective preventive measures allows for a significant reduction in the volume of economic losses, ensuring risk assessment, determining frequency and intensity of extreme phenomena, and patterns of their changes. These activities are very important for long-term planning during the design of buildings, bridges, water reservoirs, transportation routes and other facilities.

Floods and spring inundations. More than half of Armenia’s territory is under the threat of floods. The washing of the fertile layer of soil by floods and flood sediments cause great damage to agriculture and cause damages to 200 settlements. For quantitative assessment of floods, a data bank is established in the Emergency Situations Department, which includes the publication of ArmHydroMet “Catalog of flood-prone rivers of

Armenia" from 1969, data from annual reports of ArmHydroMet on floods, and data from the Institute of water problems and hydro-technology. The data base includes flood parameters and damages caused in 1946-2001.

Results of studies show that activation of floods and inundations, depending on the snow cover, is mainly recorded in low-water years.

The maximum quantity of spring inundations is usually recorded in April. Floods in 1990-2001 were mainly recorded in July and August, while in 1946-1990 maximum numbers of floods were recorded in June and July. In order to determine the causes for increase in the number of floods in dry summer conditions, integral curves of flood activity and modules of river flows on the territory of Armenia were compared. Results of the comparison are presented in Table 3.3.

Table 3.3 Numbers of floods in water-abundant and dry years

River basins	Dry years	Water-abundant years	Average year
Akhuryan	14	11	7
Kasakh	1	6	-
Lake Sevan	11	14	6
Hrazdan	-	8	7
Azat	2	7	-
Vedi	10	3	3
Arpa	27	20	-
Meghri	12	10	-
Voghchi	29	1	-
Vorotan	6	17	4
Pambak	26	14	-
Dzoraget	5	5	1
Debed	27	3	-
Aghstev	2	8	-

Floods of water-abundant years, have less sediments (80-320 kg/cubic m), occur in Hrazdan, Azat, Vorotan, Aghstev river basins with high water permeating capacity.

Quantity of water in Armenia’s rivers depends mainly on the quantity of precipitations. Based on the fact that in the next 50 years a decrease in the quantity of precipitations is expected, low-water volumes recorded in the last decade of the XX century will continue. In this case, the number of floods with lower quantities of sediments will decrease, and the number of floods with higher quantities of sediments will increase. Consequently, floods in the next 50 years will become more prevalent.

Drought. Armenia is country with dry climate and in the UN Convention for Combating Desertification the country is included in the region at risk of desertification and drought.

Studies of recent years revealed that Armenia’s climate is changing. These changes have different intensities in different regions of the country. In 2000, the territory of the country was impacted by a long drought. Air temperature was higher than the norm by 3-5^{o}C everywhere in the country. The maximum temperature in Ararat valley reached 42^{o}C. Quantity of precipitations was lower than the norm by 55-80 percent. In summer months

water flow in rivers decreased by 40-50 percent. Up to 2000 m altitudes the reserves of effective moist in soils were practically equal to zero. According to estimations of the Ministry of Agriculture, the damage caused by the drought to agriculture amounted to US$40 million.

An important factor in combating droughts is the prognosis of their duration and intensity, which allows for proper planning of preventive measures, such as preservation of effective moist in soils, accumulation and rational use of irrigation waters, determining the optimal periods for implementation of agricultural and agro-technical measures. Timely implementation of these measures will allow for prevention or mitigation of negative impacts of droughts in conditions of changing climate.

For timely assessment of drought conditions and prognosis of its intensity in conditions of expected climate changes, it is necessary to have reliable and prompt data from hydro-meteorological stations on factors characterizing drought conditions.

At the current conditions of stations and their equipments it is not possible to solve the above-mentioned issues. In order to measure soil moisture, temperature, perception, wind and other necessary elements, stations should have the needed telemetric automatic devices and recorders, which will provide prompt data for ensuring accurate and reliable seasonal, monthly and territorial prognoses of meteorological characteristics forming the growth, development and yields of agricultural crops. These prognoses, in their turn, will allow for timely and reliable assessment of elements, intensity and duration of droughts and developing measures for combating negative impacts, such as forest fires.

The Center for Climate Studies of ArmHydroMet has developed a program for prognosis of droughts. However, its effective implementation is hindered by the absence of necessary data due to the poorly equipped observation network.

3.4. Technological needs for developing observation, information provision and monitoring networks

For ensuring sustainable and ample operation of the national hydro-meteorological service and it further development, it is necessary to implement the following measures:

- technical re-equipping of observation networks with measurement devices, automatic and semi-automatic meteorological stations in accordance with international standards;
- modernization of means of communication and telecommunication in the system of collection, processing, accumulation and exchange of meteorological information;
- development of data base management systems with use of modern information technologies;
- improvement of meteorological prognoses with application of modern digital methods and computerized models;
- training and on-the-job training of service’s specialists;
- enhance the level of meteorological services.

Implementation of these measures is planned for 2000-2005, if the corresponding funding is provided by the government, within the framework of WMO assistance programs and through own incomes of ArmHydroMet.

In conditions of market relationships the main strategic objectives of Armenia’s hydro-meteorological service are:

- ensuring sustainable operations;
- preservation of resource potential;
- formation of effective economic mechanisms and additional sources of financing for covering the budget deficit.

The mentioned objective can be achieved by implementing the following measures:

- **organizational –** introduction of new forms, means and methods for climatic service provision; development and improvement of hydro-meteorological structures through the use of new effective forms of business contacts with partner organizations;
- **operational-productional –** preservation of scientific-technical basis of hydro-meteorological information, reducing costs of producing the information;
- **marketing –** expand the volumes of the sale of hydro-meteorological information;
- **Financial –** targeted development of specialized hydro-meteorological services, provision of paid information and services to consumers, expand spheres of specialized hydro-meteorological services.

Significant saving of funds can be achieved by ensuring reduction in costs of transmission of data measured by the observation network, which amounts to AND30 million (US$53 thousand) annually.

In order to equip the network with modern devices and modernize the system of information transmission, investments of US$37 thousand are necessary, which will result in annual cost reduction of information transmission by 4 times (US$16 thousand) and annual saving of US$40 thousand.

CHAPTER 4.
CONDITIONS IN ARMENIA FOR TECHNOLOGY TRANSFER

4.1. Macroeconomic situation and investment environment

After the sharp economic decline in 1991-94 in Armenia, by overcoming the difficulties of the transition period, it became possible in recent years to ensure economic stabilization and fairly sustainable economic growth based on market economy.

Political and economic stabilization, consistent implementation of market reforms and structural transformations, formation and development of the legal framework became important preconditions for the subsequent positive trends in the economy.

In recent years, Armenia's economy is developing at relatively high rates with a low inflation rate and relatively stable monetary regime.

In 1997-2001, the average annual growth of GDP amounted to 5.9 percent. Due to financial stabilization, price levels and inflation became more predictable. The average annual inflation rate in recent years does not exceed 3 percent. In recent years, the national currency exchange rate is fairly stable, which had a positive impact on external trade.

The dynamics of main indicators, characterizing the macroeconomic situation in Armenia, is presented in Table 4.1.

Table 4.1 Main macroeconomic indictors in Armenia, 1997-2001

Indicators	1997	1998	1999	2000	2001
Real GDP million US$	1638.9	1892.4	1845.5	1915.2	2120.0
GDP growth rate %	3.3	7.3	3.3	6.0	9.6
Inflation %	14.0	8.7	2.0	-3.8	2.9
Exchange rate AMD/US$	490.7	504.9	535.1	552.2	564.3
GDP per capita US$/person	432.4	498.7	485.6	503.6	557.7
GDP per capita by PPP US$/person	1638.4	1892.4	1845.5	1915.2	2120.0

As of 2001, 1572 medium sized and large enterprises and 6855 small enterprises had been privatized. It is planned to include 900 companies in the privatization program for 2001-2003, including hydro-electric power plants, thermal electric power plants, electricity distribution networks, mining and chemical enterprises, etc. Currently, around 85 percent of the GDP is generated in the private sector.

A liberal trade regime is in place in Armenia with a simplified two level tariff on imports (0 percent and 10 percent) and absence of tariffs on exports and barriers on

volumes of trade, there are no limits on imports of foreign currencies. In 2002, Armenia was admitted to World Trade Organization.

Systemic market transformations, development of market mechanisms and liberalization of economy contributed to the creation of a favorable environment for entrepreneurship in Armenia. According to assessments made by American research center Heritage Foundation and The Wall Street Journal in 2002, by the composite index of economic freedom, Armenia is in the 44th place among 161 nations and in the first place in CIS countries and is classified in the category of “mainly free” countries.

The banking sector in Armenia includes 31 commercial banks, including 13 resident-banks. Five banks are owned by foreign citizens. 42.6 percent of shares in the entire banking sector are owned by foreign citizens.

In 2000, the total bank funds amounted to US$428 million (24 percent of GDP), deposits US$367 million, total bank capital US$60.9 million.

The financial market in Armenia on the whole is under-developed. The total bank capital is insignificant; the majority of loans financed by local deposits are short-term. Interest rates on loans are high (16-40 percent in 2000). In recent years, a trend toward reduction of interest rates and increase in the share of medium-term loans is recorded.

Non-banking financial institutions (stock exchange, investment funds) are on the way to becoming fully operational. In order to increase the effectiveness of the stock exchange and volumes of its trades the Stock Market Act is passed by the parliament and a program for development of stock markets is being developed.

Attracting foreign investments is the necessary precondition for ensuring the needed volumes and rates of economic development in Armenia.

Consistent reforms and economic stability made it possible for Armenia to receive cooperation from international financial organizations, bilateral donors and direct foreign investments.

Investment and trade policies in Armenia are among the most open policies in CIS countries. The commitment and efforts of the government in attracting direct foreign investments, political and economic stability, favorable investment legislation and investment guarantees and the capable labor force are important incentives for investment in Armenia’s economy. Wide-scale privatization also adds to investment possibilities in Armenia.

The total sum of direct foreign investments in Armenia in 1997-2002 amounted to US$806 million (Figure 4.1). As of 2001, 1072 enterprises had foreign capitals, 20 of which have investments of more than US$1 million each and 6 have investments of more than US$10 million each. Around 65 percent of foreign investments are made in already existing companies. In 1997-2001, the share of foreign investments in the main capital amounted to 27-34 percent.

In 1998-2000, the main investments were made by Greek (27 percent), Russian (27 percent), Canadian (11 percent), American (10 percent) and French (9 percent) investors. In the mentioned period, investments were mainly directed toward energy (27 percent), communications and telecommunications (26 percent), trade (14 percent), food industry (13 percent).

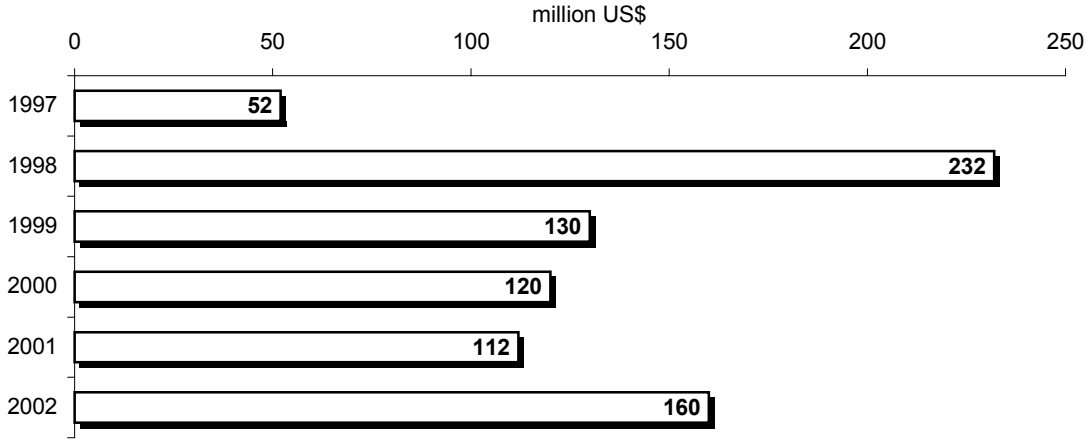


Figure 4.1. Dynamics of direct foreign investments in Armenia’s economy

Legislative regulation of investments In order to create favorable investment environment, Armenia has passed a number of laws providing privileges and guarantees to foreign investors. Foreign Investments Act (1994) defines a number of privileges for foreign investors, such as compensation for VAT on export, absence of duties for exports, exemption from profit tax for two years for companies with foreign investments exceeding US$0.9 million. There are no limitations for conversion or repatriation of capital and incomes. Foreign companies have the same legal rights as local companies. Foreign investments in Armenian cannot be nationalized or confiscated. Confiscation is allowed only in extraordinary situations and with full compensation.

All types of ownership and rights of citizens to ownership are protected by the Constitutions and regulated by Property Registration Act.

From January 1999, commercial disputes can be solved through the courts or alternative mechanisms of conflict resolution. In addition, Armenian joined the international convention on investment disputes and is a member of the international center for resolution of investment related conflicts, multi-lateral CIS convention on protecting the rights of foreigners and multi-lateral investments guarantee agency of CIS.

Measures taken in recent years, significantly simplified the process of company registration: Legal Persons State Registration Act (2001) and Licensing Act (2001). For ensuring a favorable environment for competition the Economic Competition Protection Act was passed.

Insurance Act (1996) regulated the activities of the insurance sector, and in particular offers compensation for financial risk, deposits, credits, stock market transactions, etc.

Despite the economic stability achieved and favorable investment environment created, the volume of foreign investments is very inadequate for ensuring a sustainable economic development for Armenia. Attracting the inflow of foreign investments is linked to the overcoming of a number of barriers, such as increased risk levels relating to the conflict situation in Trans-Caucasus, inadequately formed infrastructures contributing to investment attraction, weak data base on priority investment programs, inadequate system of insurance for reducing risk levels for investors, administrative violations and red-tape, corruption, etc.

Overcoming the mentioned barriers will contribute to a wider attraction of foreign investments and realization of not only short-term, but also long-term investment projects, wider opportunities for transfer of modern technologies in priority sectors of Armenia's economy. An important role in technological collaboration and financial support for technology transfer can be played by international organizations USAID, UNIDO, TACIS, Know-How Fund, GEF, etc.

4.2. Technology transfer barriers and recommendations for their removal

There are a number of barriers of economic, financial, institutional, personnel, organizational, legal and information nature hindering technology transfer and implementation of priority projects. In Armenia’s conditions the principle barriers are: a weak financial sector and absence of the necessary capital, high costs of operations, difficult financial situation of potential consumers and low level of demand for ecologically clean technologies, inadequate institutional framework, low level of awareness among stakeholders, etc.

The identified barriers of general nature are grouped in Table 4.2.

Table 4.2 Barriers of technology transfer and measures for their removal

Barriers	Possible solutions
Economic, financial:	
Limited state resources	State cooperation in provision of grants and concessional loans and attraction of foreign investments
Lack of participation of national banks in technology transfer activities, high interest rates	Lowering interest rates, involvement of banks' main capitals as the economic situation improves
Low solvency of enterprises and affordability of population	Organizational and technical measures for metering and regulating energy consumption; increase population’s incomes by the planned high rates of economic growth Job creation with introduction of new technologies
Organizational-legal:	
Absence of national standards for energy consumption	Develop standards and norms for energy consumption and enhance efficiency of technologies
Absence of incentives for development of renewable sources of energy due to small profit compared to invested capital	Include the cost reduction due to prevention of GHG emissions and polluting substances in the production cost. Implementation of a promoting policy for renewable sources of energy by Commission for Regulating Energy Issues.
Absence of laws on energy saving and renewable energy sector.	Pass laws on energy saving and renewable energy sector.
Absence of coordination in activities for assessment of technological needs and technology transfer.	Establish a national inter-agency consulting center; coordination and manage activities for transfer of ecologically safe technologies within the framework of UN FCCC and Kyoto protocol.

Informational:	
Shortage of information on energy efficiency and ecological safety of technological equipment used.	Strengthen sectoral structures and control over sectoral information.
Difficulties for stakeholders in obtaining information on modern technologies.	Develop systems of specialized information services. Establish a data base on technologies by all sectors.
Lack on information among investors on potential technology market of the country.	Develop activities on assessment of technological needs and projects selected for specific investors and organize cooperation with them.
Shortage of information in governmental structures, companies and the public on energy efficiency and climate change problems.	Strengthen informational and educational activities related to problems of climate change, and measures for mitigation of consequences and adaptation.
Personnel:	
Inadequate personnel for preparing projects to be implemented within the framework of mechanisms stimulating the introduction of ecologically appropriate technologies, including within the framework of clean development mechanisms.	Organize activities for preparing qualified specialists for introduction of technologies and preparation of projects for technology transfers.
Inadequate personnel for introduction and operation of new ecologically clean technologies.	Improve the quality of personnel preparation and strengthen the scientific-technological potential of specialists. Introduce special courses in university curricula on innovative technologies in ecology.

CHAPTER 5.

CAPACITY BUILDING FOR ASSESSMENT OF TECHNOLOGICAL NEEDS AND TECHNOLOGY TRANSFER

The objective of UNDP-GEF project “Armenia-country study on climate change. Phase II” is to ensure continuation of activities and further develop and strengthen the national capacity in Armenia for solution of problems related to climate change.

National capacity building for implementation of Armenia’s commitments within the framework of the UN FCC in accordance with provisions of Articles 4 (points 1.7, 8), 5 and 6 of the Convention.

The main focus of the second phase of the project is national capacity building for assessment of technological needs for reduction of greenhouse gas emissions and mitigation of the consequences of climate change, strengthening the national observation networks and monitoring systems, as well as identification of mechanisms and conditions for transfer of ecologically safe technologies.

Within the framework of the implementation of the second phase of the project, the work already conducted for the preparation of the first national communication regarding the strengthening the informational potential and further development of the potential for training and enhancing public and stakeholder awareness on climate change problems continued.

5.1. Development of organizational, informational and personnel potential

The institutional structure of the national system for implementation of the UN FCCC was formed in the period of the implementation of “Armenia-country study on climate change” and “Removing barriers to energy efficiency of district heating and hot water supply” projects.

In order to implement national commitments of the Republic of Armenia under the UN FCCC, the Government of Armenia (Order N 115 dated 25 February 1998) approved the program of actions and the list of responsible ministries and agencies. The function of executing agency for the implementation of the Convention was assigned to the Ministry of Environment, where coordination and working groups were formed with the participation of representatives from the corresponding ministries and agencies, scientific and public organizations. The implementation of the mentioned program of action is presented in the first national communication of Armenia, in the project Removing barriers to energy efficiency of district heating and hot water supply” and in this project.

UNDP Armenia is the GEF implementing agency for the implementation of the project.

For the implementation of the project “Armenia-country study on climate change. Phase II” expert groups consisting of national experts were formed in the following main fields:

- identification of technological needs in Armenia’s economic sectors for reduction of GHG emissions, including the use of renewable sources of energy;
- identification of technological needs in climate dependent economic sectors, environment and population's health, contributing to mitigation of negative impacts of climate change and better adaptation possibilities on the basis of the analysis of their climatic vulnerabilities;
- identification of technological needs and measures for strengthening the national network of systematic observations and environmental monitoring systems.

During project implementation, the information center established during the preparations for the first national communication of Armenian on climate change developed further. The stock of specialized literature, IPCC, materials of Conference of the Parties to UN FCCC, Internet information on international experience of using ecologically safe technologies, etc. were further enriched in the center.

The expert groups consisting of national experts included the leading specialists in the country in electrical energy sector, heat supply, renewable energy, industry, transportation, forestry and agriculture, health, climatology, hydrology and agro-climatology. Implementation of the second phase of the project contributed to human capacity building and enhancing of qualifications of national experts looking for solutions to sectoral problems, taking into account the need for minimization of GHG emissions and mitigation of consequences of climate change. Enhanced qualifications of experts and information exchange contributed also to their participation in the reporting period in 12 international conferences and seminars (ANNEX 3).

Taking into account the multi-sectoral character of the identification of technological needs and technology transfer, a great deal of attention during the implementation of the project was paid to organizing interagency cooperation and creating a data base on technological needs and technologies.

The data base on technological needs includes:

- national programs for development of economic sectors;
- works of specialized scientific, design institutes and universities;
- projects implemented in the country with the cooperation of international organizations;
- local technologies and technological equipment;
- information on international experience with consideration for its adaptation to local conditions.

The scheme of cooperation and creation of the data base on technological needs and technologies is presented in Figure 5.1.

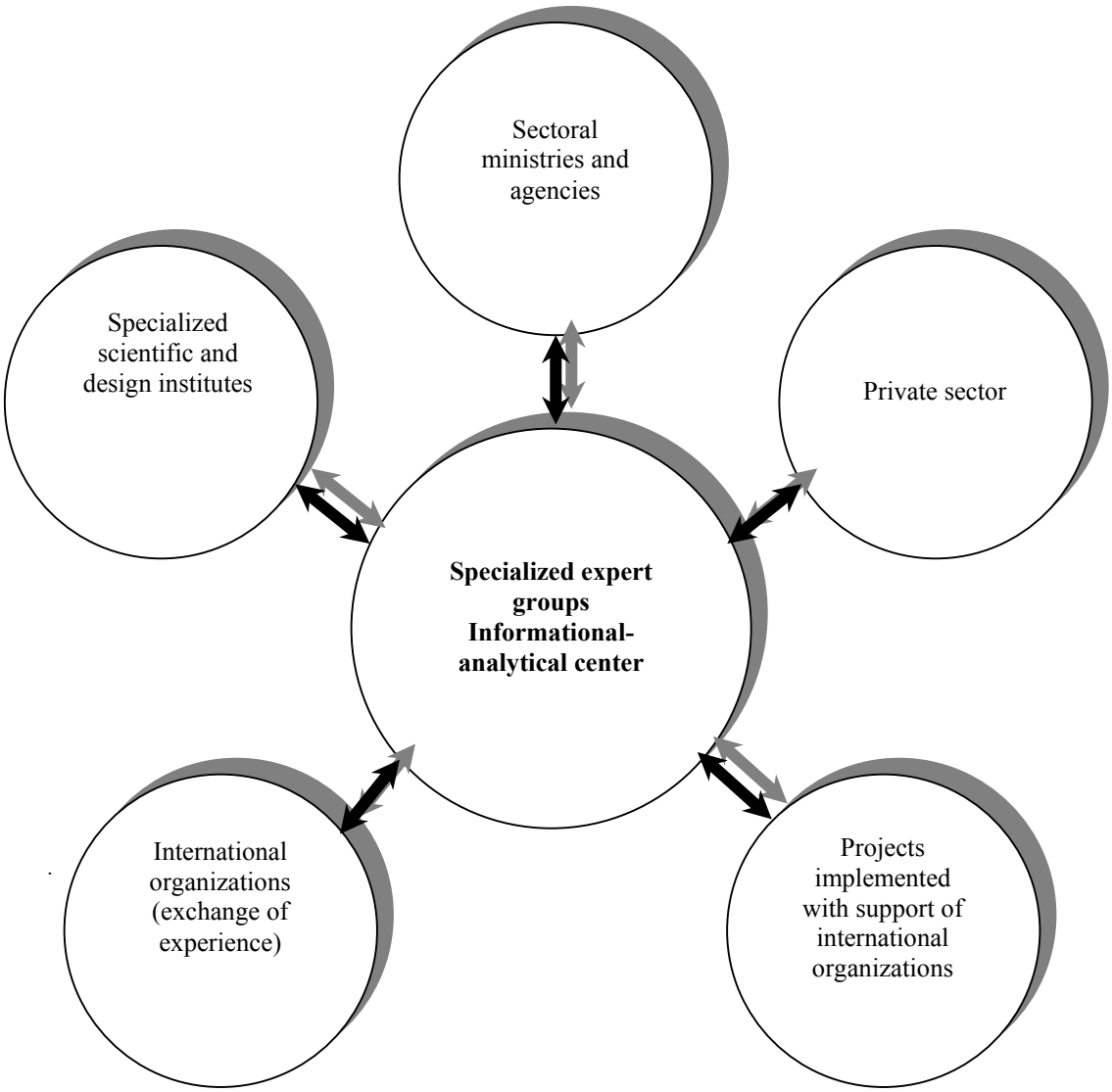


Figure 5.1 Scheme of cooperation and creation of the data base on technological needs and technologies

In order to enhance the level of interagency coordination a number of joint seminars with stakeholder organizations were held (Annex 3).

Activities within the framework of the second phase of the project contributed greatly to the development of institutional structures, organizational and personnel potential. However, it must be noted that after the end of projects national expert groups usually break up and collaborations formed with governmental, scientific and technical organizations become weaker.

In order to implement commitments under UN FCCC, solve issues related to transfer and introduction on modern technologies, including those within the framework of Kyoto protocol, Armenia has an urgent need to establish a professional center for promoting activities related to transfer and introduction of technologies corresponding to climate change problems.

5.2. Capacity building for education and enhancing awareness on climate change problems

During the implementation of the project “Armenia-country study on climate change. Phase II” activities for education and public and stakeholder awareness on climate change problems continued and expanded.

In the reporting period, the following activities were conducted in the mentioned direction (Annex 3):

- 22 joint seminars and workshops devoted to the identification of technological needs and technology transfer were conducted with the participation of stakeholders form sectoral organizations;
- 11 thematic lectures and training seminars were conducted in schools, universities and public organizations;
- a thematic plan for teaching a course on "Problems of climate change" in formal basic education schools was developed, in a number of universities the course has been included in curricula as a voluntary course;
- articles of national experts were published among materials of international conferences and seminars;
- the second issue of the journal "Armenia. Problems of climate change” was prepared and published;
- educational materials, brochures, informational booklets (9 titles) on problems of climate change were published and distributed;
- an Internet portal was created in Armenia, English and Russian languages.

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ANNEXES

ANNEX 1

PROPOSAL ON ESTABLISHMENT OF "CENTER FOR CLIMATE TECHNOLOGIES"

Center for Climate Technologies coordinates and promotes the transfer and introduction of modern technologies contributing to the solution of problems related to climate change (climate technologies).

The main barriers for the transfer and introduction of modern climate technologies were presented and classified in section 4.2.

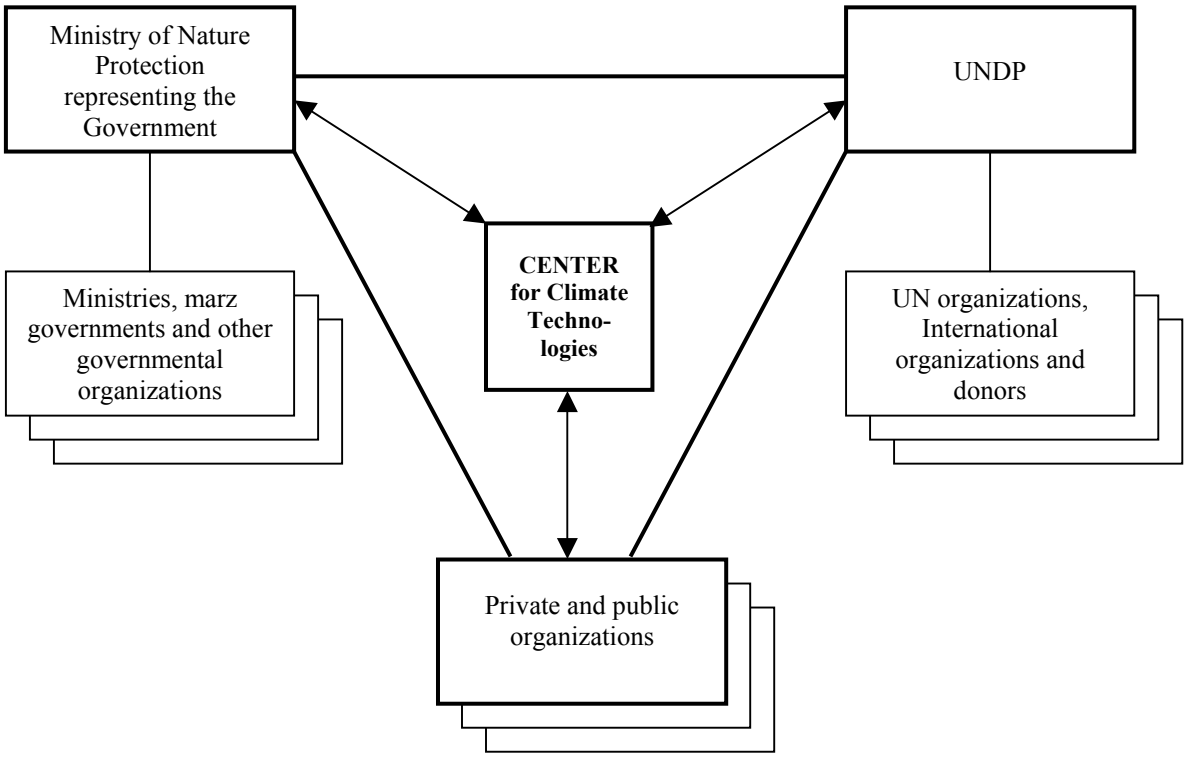
According to the work plan of the second phase of "Armenia – country study on climate change" UNDP/GEF/ARM/95/G31/A/1G/99, one of the immediate objectives of the project is the establishment of a sustainable basis for technology transfer aimed at the reduction of GHG emissions and adaptation to climate change, as well as strengthening the national capacity for identifying technological needs, their assessment and creation of conditions for their transfer and introduction, also through clean development mechanism foreseen by Kyoto protocol.

The following measures should be taken in order to organize the process of technology transfer:

- Enhance awareness among private, public and governmental sectors, ensuring access to information and its dissemination, demonstration of promising technologies, equipment, materials, dissemination of best practices and pilot projects.
- Systematically and regularly inform all governmental agencies and decision makers on opportunities provided by the Convention and Kyoto protocol for technology transfer contributing to integrated development in economic, ecological and social spheres.
- Develop, elaborate and implement projects as concrete measures for reducing GHG emissions and improving GHG sequestration, as well as adaptation to climate change, which will be based on ecosystem restoration (including natural resources) simultaneously ensuring sustainable development through rational and economical use of natural resources.
- Attach special importance to regional initiatives. Create an environment promoting regional initiatives through the implementation and demonstration of successful pilot projects. Introduce "decentralization" of technology transfer carefully and step by step.
- Shift from mandatory principles of management to incentive measures, including privileged taxation and lower duties on the import of modern technologies and formation of a cooperative environment among stakeholders. For the transfer of modern technologies, especially in energy sector, widely use ecological credits with low interest rates and conduct a stimulating tariff policy.
- Establish a stable financial mechanism through legislative reforms and management measures. Improve systems of nature use and environmental impact payments and compensations for ecological damages, develop and introduce "ecological insurance". Establish a revolving ecological fund using the mentioned as well as other sources. Use the fund for financing projects and measures, which cannot be otherwise funded through typical credits (for example, forest restoration, plantation, restoration of wetlands and other ecosystems).

- In order to address the above-mentioned issues it is proposed to form an institution for partnership among private, public (governmental) and international sectors (Public/Private Partnership).

The following scheme which aims at coordination and stimulation of cooperation is proposed as one of the options for developing partnerships.



It is proposed that

- **The Ministry of Nature Protection,** as the responsible agency for implementation of the Climate Change Convention in the country and the Designated National Authority for CDM projects, ensures inter-agency coordination of activities among ministries of RA, marz governments and other governmental structures;
- **The UNDP,** ensures collaboration and coordination among UN organizations, other international organizations and donors, contributes to the mobilization of financial resources;
- **The private and public sectors,** organized into a consortium of various public and private stakeholder organizations, as well as research and applied sciences institutes, implement technology transfer and introduction. It lobbies the interests of producers and users of ecologically clean technologies during the adoption of laws and regulations, conducts technology transfer and introduction.
- **The Center for Climate Technologies** is the operational body of the consortium and partnership, provides technology transfer services, implements the corresponding functions and contributes to the mentioned activities. This body will be funded by stakeholder organizations, including member organizations of the consortium.

Preferably, an Armenian scientific-industrial organization with experience in the development and introduction of ecologically clean technologies should be involved in the

formation of the Center. The Center should have highly qualified specialists from a wide range of specialties and qualifications, as well as the necessary technical and professional resources to handle and introduce technologies. It is planned to establish a technological park, where achievements of the most advanced ecologically clean technologies will be demonstrated. Innovative technologies of Armenian and foreign specialists can also be demonstrated and tested in the Park.

As the first step for the formation of partnerships it is proposed to establish the Center for Climate Technologies using the human and institutional capacity formed within the framework of the project "Armenia-country study on climate change".

The Center will contribute to and actively participate in the transfer of ecologically clean technologies. Technology transfer involves a wide range of processes of technical, economic, juridical, legal and political nature. It is possible to introduce locally developed advanced innovative technologies, as well as those form developed and developing countries, and ensure the reverse mechanism, i.e. transfer of local technologies to other countries. The selected technologies should be relevant to sustainable development objectives of the country and need to be adapted to local conditions. They should encompass various economic sectors, such as energy, industry, transportation, construction, agriculture, forestry, waste management, healthcare, etc. The Center will seek the cooperation of highly qualified specialists and experts in the mentioned fields.

Other than the mentioned activities the Center will:

- Analyze technological needs in the country on a continuous and flexible basis taking into account the relevant changes in conditions;
- Monitor and assess innovative technologies, analyze them comprehensively and provide expert evaluations, form a data base of modern technologies;
- Disseminate information among policy makers, investors, the public, private sector industrial enterprises, place a website on the Internet;
- Collaborate in scientific-research and testing-construction activities for developing climate technologies, support and take technologies to the level of commercialization, their marketing, patenting, assessment of barriers to their transfer, implement measures for their removal and formation of an environment conducive to their introduction;
- Search and find funding sources, grants, ecological funds, concessional credits, contribute to the formation of joint enterprises with partners abroad, bring in investments from the Armenian Diaspora.
- Train specialists in climate change issues, nature use economics, entrepreneurship and legislation; organize special training courses on the mentioned subjects in order to contribute to climate technology transfer and introduction.

ANNEX 2

PROPOSED PROJECTS

Project title	**Steam-gas block of 206.3 MW capacity in Yerevan TPP**
Project category	Enhancing energy efficiency Reduction in CO_2 emissions
Project partners	Government of Armenia (Ministry of Energy) “Yerevan TPP” CJSC
Investment site	City: Yerevan Country: Republic of Armenia
Project description	The project is developed by «Tokyo Electric Power Services Co, LTD» jointly with Kawasaki Heavy Industries LTD, Mitsui &Co., LTD (Japan) and “Yerevan TPP” CJSC. The project objective is to replace the outdated equipment in Yerevan TPP with a new energy block operating on steam-gas combined cycle with nominal electric power capacity of 206.3 MW and heat production of 111 Gcal/h. The energy block includes a modern gas turbine of type GT13EA with a capacity of 165 MW, heat separating steam condensation turbine with capacity 57MW and boiler-utilizer. Annual energy production will be 1567.8 GWh, fuel consumption in average regime 170 g/Kwh, energy efficiency 44.87 percent, annual fuel saving 276 thousand t eq. fuel. The project is aimed at sustainable development of energy sector in Armenia, reduction in fuel imports, energy saving and reduction of GHG emissions.
Project status	Preparation phase
Investments	Total investments - $165 million Financing organizations: Government of Japan (loan) - $140 million (85 percent) Government of Armenia (loan) - $25 million (15 percent) Investment reimbursement period – 4.5 years Investment realization: year 1 – 8 percent, year 2- 58 percent, year 3 – 34 percent.
Timetables	Start of construction: January-March 2005 End of construction and energy production- December 2005 Duration of project functioning - 30 years
Reduction in CO_2 emissions	Annually – 352 thousand t of CO_2 During project functioning – 10.56 Mt CO_2 Per unit cost of emission reduction - $15.6/t CO_2
Agreements on problems of climate change	Armenia is a non-Annex I party of UN FCCC. The Convention was ratified by Armenia in May 1993, Kyoto protocol in December 2002.

Project title	**Reconstruction of heat supply system in Yerevan**
Project category	Enhancing energy efficiency Reduction in CO_2 emissions
Project partners	Government of Armenia (Ministry of Finance and Economy) Yerevan Municipality
Investment site	City: Yerevan Country: Republic of Armenia
Project description	Due to the crisis in heat supply, currently only 29 percent of the total living area in apartment buildings of Yerevan have central heating. By energy consumption composition, 55.8 percent of heating needs are covered by central heating, 30.7 percent by electricity and 11.1 percent by firewood. Whereas, heat consumption amounts to 28 percent of the norm and hot water 17.6 percent of the norm. The energy efficiency of the existing system is very low amounting to 34 percent on average (DH systems -50 percent, electricity for heating – 25 percent, firewood for heating -50 percent). The project aims at gradually increasing the energy efficiency of existing systems of DH up to 75 percent through modernization of boiler houses, introduction of devices for metering and regulating heat consumption, as well as restoration of heat supply to homes not connected to DH systems using efficient local (independent) systems. Implementation of the project will save primary energy by 176.64 TJ and reduce per unit emissions of CO_2 to 70-73 kg/GJ.
Project status	Preparation phase
Investments	Total investment needed - $45 million (excluding costs of gas supply to boiler houses)
Timetables	Duration of project functioning – 20 years (by phases) Project start date - 2005 Duration of project functioning - 20 years
Reduction in CO_2 emissions	Average annual – 325 thousand t During project functioning – 6.5 Mt
Agreements on problems of climate change	Armenia is a non-Annex I party of UN FCCC. The Convention was ratified by Armenia in May 1993, Kyoto protocol in December 2002.

Project title	**Meghri HPP with 79.8 MW capacity**
Project category	Renewable energy sources Reduction in CO_2 emissions
Project partners	Government of Armenia (Ministry of Energy)
Investment site	City: Yerevan Country: Republic of Armenia
Project description	Meghri HPP will be built in south of Armenia on Arax River section bordering with Iran. Main facilities of the HPP: • water intake-discharge dam 4 m high • one-way non-pressurized tunnel 7.8m in diameter and 18.2km in length • pressure block with a high-pressure reservoir 11.8m deep and penstock with 4.0m diameter • power house with discharge canal. The main design parameters of the HPP: • pressure 93 m • water flow 100 cubic m/sec • capacity 79.8MW • electricity production 470 GWh annually • turbines PO (“Francis” type) 4 units The project aims at ensuring the sustainable development of Armenia’s energy sector, enhancing the level of the use of own energy resources and energy security, substituting the imported fossil fuel and reducing GHG emissions. The project is developed by HayHydroEnergoDesign Institute.
Project status	Planning phase
Investments	Project cost $100 million
Timetables	Construction duration 5.5 years Construction start after 2007 Duration of project functioning - 40 years
Reduction in CO_2 emissions	Annually 254.3 thousand t During project functioning 10.17Mt Per unit cost of emission reduction - $9.83/t CO_2
Agreements on problems of climate change	Armenia is a non-Annex I party of UN FCCC. The Convention was ratified by Armenia in May 1993, Kyoto protocol in December 2002.

Project title	**Shnogh HPP with 75.0 MW capacity**
Project category	Renewable energy sources Reduction in CO_2 emissions
Project partners	Government of Armenia (Ministry of Energy)
Investment site	City: Yerevan Country: Republic of Armenia
Project description	Shnogh HPP will be built in north Armenia on Debed River. Main facilities of the HPP: • main water collection facilities on Debed river • water collection facilities on Martsiget river with sediment removal reservoirs • 2 derivation non-pressurized tunnels 22km long with 37 cubic m/sec flow • daily regulation reservoir with 470 thousand cubic m capacity • high-pressure reservoir • penstock with a tunnel section 0.35km long and open canal section 0.27km long • power house with discharge canal. Main design parameters of the HPP: • pressure 240 m • water flow 37 cubic m/sec • capacity 75.0MW • electricity production 270 GWh annually • turbines PO-230 2 units The project aims at ensuring the sustainable development of Armenia’s energy sector, enhancing the level of the use of own energy resources and energy security, substituting the imported fossil fuel and reducing GHG emissions. The project is developed by HayHydroEnergoDesign Institute.
Project status	Planning phase
Investments	Project cost $95.0 million Financing organizations: N/A
Timetables	Construction duration 5 years Construction start after 2007 Duration of project functioning - 40 years
Reduction in CO_2 emissions	Average annual – 146 thousand t During project functioning – 5.84 Mt Per unit cost of emission reduction - $16.2/t CO_2
Agreements on problems of climate change	Armenia is a non-Annex I party of UN FCCC. The Convention was ratified by Armenia in May 1993, Kyoto protocol in December 2002.

Project title	**Loriberd HPP with 59.2MW capacity**
Project category	Renewable energy sources Reduction in CO_2 emissions
Project partners	Government of Armenia (Ministry of Energy)
Investment site	City: Yerevan Country: Republic of Armenia
Project description	Loriberd HPP will be built in north Armenia on Dzoraget river as a complex consisting of three derivation type HPPs (HPP-1, HPP-2 and small HPP). All three plants will include: water discharge dams with water intake and discharge facilities, derivation canals and non-pressurized tunnels, daily regulating reservoirs, one-way penstocks, power house with water discharge canals. In HPP-1, water from the water collection facility on Dzoraget river through a tunnel 10.4km long and a canal 1.6km long and penstock 1.5km long and 3m in diameter will come to the power house. HPP-2 will use water discharged from HPP-1 and from the additional reservoir on Her-Her river, which through a covered canal 1.04km long, and then a penstock 1.045km long and 3.0m in diameter will enter the power house. The small HPP will be built on Urut river. Main design parameters of the complex:

	HPP-1	HPP-2	Small HPP
pressure, m	46.3	274.2	70.0
water flow, cubic m/sec	20.0	21.0	3.5
capacity, MW	8.0	49.4	1.8
electricity production, GWh	25.0	105.0	8.1
turbines	PO-230 (2 units)	K-400 (3 units)	PO-230 (3 units)

	The project aims at ensuring the sustainable development of Armenia's energy sector, enhancing the level of the use of own energy resources and energy security, substituting the imported fossil fuel and reducing GHG emissions. The project is developed by HayHydroEnergoDesign Institute.
Project status	Planning phase
Investments	Project cost $130 million Financing organizations: N/A
Timetables	Construction duration 5 years Construction start after 2007 Duration of project functioning - 40 years
Reduction in CO_2 emissions	Average annual – 107.1 thousand t During project functioning – 4.3 Mt Per unit cost of emission reduction - $30.3 /t $CO2_2$
Agreements on problems of climate change	Armenia is a non-Annex I party of UN FCCC. The Convention was ratified by Armenia in May 1993, Kyoto protocol in December 2002.

Project title	**Wind electric power plant of 50mw capacity in Sotk**
Project category	Renewable energy sources Reduction in CO_2 emissions
Project partners	Solaren JSC 375068, Yerevan, Shrjanayin street, 2/2, Armenia www.solaren.am info@solaren.am
Investment site	Town: Sotk Country: Republic of Armenia
Project description	Based on monitoring conducted in Armenia, the most promising areas for wind energy were identified, the total capacity of which is estimated at 200MW. The site selected in Sotk region for the first wind electric power plant is considered the most promising with regard to resource utilization. Main design parameters of the plant: • design capacity 50MW • electricity production 120Gwh annually Equipment include wind electric power modules of 50MW capacity. The project plans to connect the Plant to Armenia power grid. The Energy Regulation Committee has set the tariff for electricity produced by wind power plant at $0.05/Kwh. The project aims at developing the national energy system, enhancing the level of energy security, substituting the imported fossil fuel and reducing GHG emissions. The results achieved can be replicated in other parts of the country. The project will be implemented by Solaren company.
Project status	Planning phase
Investments	The needed investment $45 million Equipment cost 75 percent Construction, installation 25 percent
Timetables	Construction start 2003 Construction duration 2 years Duration of project functioning - 25 years
Reduction in CO_2 emissions	Average annual – 65 thousand t During project functioning – 1.62 Mt Per unit cost of emission reduction - $27.7 /t CO_2
Agreements on problems of climate change	Armenia is a non-Annex I party of UN FCCC. The Convention was ratified by Armenia in May 1993, Kyoto protocol in December 2002.

Project title	**Utilization of methane form Yerevan city landfill for electricity and heat production**
Project category	Waste utilization Reduction in CH_4 emissions
Project partners	Government of Armenia Yerevan Municipality
Investment site	City: Yerevan Country: Republic of Armenia
Project description	The projects is developed by Shimizu Corporation (Japan) based on instruction form NEDO. 102-110 thousand t of solid domestic waste is accumulated annually in Yerevan city landfill, which is disposed of without preliminary processing and sorting. The landfill is a source of methane emissions and environmental pollution. The projects proposes to use the waste and accompanying methane as fuel for combined electricity and heat generation. The project envisages equipment for collecting waste, their separation and preparation for burning, a system for methane collection, incinerators, boiler, energy block (steam turbine, generator), boiler-utilizer for obtaining hot water, cleaning system for discharged gases. The annual electricity production will be 89.3 GWh, heat energy 59.5 GWh. The annual saving of fossil fuel is 15.4 thousand t eq. fuel. The project aims at substituting the imported fuel, reducing GHG emissions, improving sanitary and energy situation.
Project status	Discussion phase
Investments	The needed investment $51.0 million Financing organizations: N/A
Timetables	Construction duration 3 years Construction start 2004 Duration of project functioning - 30 years
Reduction in CO_2 emissions	Annual average 212 thousand t CO_2 equivalent During project functioning – 6.36 Mt Per unit cost of emission reduction - $8.0 /t CO_2 equivalent
Agreements on problems of climate change	Armenia is a non-Annex I party of UN FCCC. The Convention was ratified by Armenia in May 1993, Kyoto protocol in December 2002.

Project title	**Restoration of degraded forest ecosystems in south-eastern Armenia (Kapan-Meghri)**
Project category	Land use, changes in land use and forestry CO_2 sequestration
Project partners	Government of Armenia (Ministry of Environment, Armforest CJSC)
Investment site	Region: Syunik Country: Republic of Armenia
Project description	Illegal mass cuttings during the energy crisis have caused huge damage to Armenia’s forests and have reduced CO_2 sequestration. In1990, the amount of CO_2 sequestered by forests was 697 thousand t and CO_2 emissions from forests amounted to 80 thousand t, in 2000 correspondingly 523 thousand t and 960 thousand t, i.e. emissions were almost 2 times more than sequestrations. The project aims at preventing further degradation of forests in Armenia’s south-east region and increasing their sequestration capacity through integration aviation means of combating pests and diseases and forest restoration activities. The project site selected is a 61.3 thousand ha forest covered area, which has notable degraded forest ecosystems, which is a result of trees losing their leaves due to leaf-eating insects and their subsequent desiccation in groups, resulting in reduction in rates of annual timber growth and carbon dioxide sequestration (by 33 percent compared to 1980-1990).
Project status	Discussion phase
Investments	N/A
Timetables	Project duration 5 years Project start 2003
Reduction in CO_2 emissions	In 10 years the additional sequestered CO_2 will amount to 438136 t Per unit cost of sequestration \$0.43/t of CO_2
Agreements on problems of climate change	Armenia is a non-Annex I party of UN FCCC. The Convention was ratified by Armenia in May 1993, Kyoto protocol in December 2002.

ANNEX 3

THE LIST OF EVENTS ATTENDED BY PROJECT TEAM ORGANIZED DURING THE IMPLEMENTATION OF "ARMENIA- COUNTRY STUDY ON CLIMATE CHANGE. PHASE II"

INTERNATIONAL CONFERENCES AND SEMINARS

	Title, venue and date	Comments
1.	**"Good Practices in Policies and Measures"** *Copenhagen, Denmark, 8-10 October 2001*	Armenia was represented by A. Gabrielyan and R. Stepanyan. The workshops aims to advance the work on sharing experience and exchanging information on "good practices" in policies and measures.
2.	**7th Conference of the Parties to UN FCCC** *Marrakech, Morocco, 29 October- 9 November 2001*	Armenia's delegation A. Gabrielyan and D. Harutyunyan.
3.	**"Energy Systems in Large Cities"** *Moscow, Russian Federation, 14-16 December 2001*	R. Arsenyan "Removing Barriers to Energy Efficiency in Municipal Heat and Hot Water Supply" Project team leader presented the report "Restoration and Modernization of Yerevan City Central Heating Systems", which was published.
4.	**"State Funding of Energy Efficiency as an Environmental Component" seminar of Energy Saving Alliance** *Krakov, Poland, 9-13 December 2001*	Project expert M. Vermishev represented Armenia with the report "Energy Efficiency in Armenia's DH and its Impact on the Environment"
5.	**"Capacity Building for Improving National GHG Cadastre"** *Zagreb, Croatia, 26-28 March 2002*	Armenia was represented by A. Gabrielyan and M. Tsarukyan, "Capacity Building for Improving National GHG Cadastre" Project Expert
6.	**UNFCCC workshop on the IPCC Third Assessment Report (TAR)** *Bonn, Germany, 4-6 April 2002*	The workshop aims to explore the information contained in the TAR and how the content of the TAR can facilitate the work relating to climate change, research and systematic observation, impacts of climate change and its adaptation, innovative technology development and methodological issues. A. Muradyan attended the workshop.
7.	**Workshop of the Consultative Group of Experts (CGE) on National Communications from Non-Annex I Parties**	Armenia was represented by D. Harutyunyan. The draft guidelines for the second national communication of Non-Annex I Parties were

	Bonn, Germany, 10-12 April 2002	discussed.
8.	**Intersessional Workshop on the Revision of the Guidelines for Non-Annex I National Communications** *Bonn, Germany, 15-17 April 2002*	D. Harutyunyan participated in the workshop. The draft-launching event was held. Agreement was reached for presenting guidelines to the 16 session of SBI.
9.	**UNFCCC/UNDP Expert Meeting on "Methodologies for Technology Needs Assessments"** *Seoul, Republic of Korea, 23-25 April 2002*	Ms. Stepanyan attended the meeting and made a report "Different Barriers/Challenges in Conducting Technology Needs Assessments and the Means to Overcome these Barriers in Armenia".
10.	**"Mitigation of Negative Impacts of Climate Change in Transition Countries; advantages and perspective of reduction of GHG emissions" international seminar** *Moscow, Russian Federation, 20-22 May 2002*	M. Vermishev reported on "Strategy and Potential of Reduction in GHG Emissions in Armenia".
11.	**Workshop on the Sixteenth Session of the Subsidiary Body for Scientific and Techno-logical Advice (SBSTA) under the UNFCCC** *Bonn, Germany, 02-14 June 2002*	Armenia was represented by A.Gabrielyan
12.	**"Investments and Climate Change; opportunities for Ukraine" international conference** *Kiev, Ukraine, 10-11 July 2002*	D. Harutyunyan made a report on "Problems of DH Systems in Armenia" (co-authors A. Gabrielyan and M. Vermishev).
13.	**Second International Energy Conference** *Yerevan, Armenia, 24-28 September 2002*	Reports were presented by A. Gabrielyan "Environmental Consequences of the Crisis in Armenia's DH Systems and Directions for Removing Barriers to their Restoration" (co-author D. Harutyunyan) and M. Vermishev "Energy Consumption Efficiency in Heat and Hot Water Supply of Residential and Public Buildings in Armenia". The proceedings of the Conference are published.
14.	**8th Conference of the Parties to UN FCCC** *Delhi, India, 23 October-1 November 2002*	Armenia was represented by A. Gabrielyan
15.	**Seminar for capacity building in climate technology initiatives for South-Eastern European and former USSR countries "Climate Technologies and Energy Efficiency "Best Practices" from Experience to Policy Dissemination"** *Tutzig, Germany, 16-20 November 2002*	Armenia was represented by D. Harutyunyan. The seminar aimed at promoting technology transfer process. Regional projects on clean development mechanisms were discussed with representatives from Georgia and Azerbaijan.
16.	**Workshop on the use of the guidelines for the preparation of national communications from Parties not included in Annex I to the Convention** *Port Louis, Mauritius, 8-11 April 2003*	The workshop was attended by R. Stepanyan. The objectives of the workshop were to inform non-Annex I Parties on the use of the UNFCCC guidelines for the preparation of national communications from NAI Parties.

17.	**"Capacity Building for Improving GHG Inventories" Project start-up workshop** *Szentendre, Hungary, 30 July-1 August 2003*	The workshop was attended by M. Tsarukyan and A. Pasoyan, "Armenia – Country Study on Climate Change" expert on GHG inventory.
18.	**"Climate Technology and Energy Efficiency – Challenges and Chances for Climate Technology"** *Tutzig, Germany, 20-24 September, 2003*	Ms. D. Harutyunyan represented Armenia. The seminar aims to support networking among existing energy saving agencies, energy efficiency centers and other institutions actively promoting the rational use of energy.
19.	**World Climate Change Conference** *Moscow, Russia, 29 September – 3 October 2003*	Armenia was represented by A. Gabrielyan, M. Vermishev and H. Melkonyan. They maded reports: Mr. Gabrielyan "Possible Consequences of Climate Change in Armenia, Vulnerability Assessment and Measures of Adaptation" (co-author D. Harutyunyan) M. Vermishev "Assessment of GHG Emissions Reduction Potential in Armenia". Mr. Melkonyan's report "Assessment of Forthcoming Changes in Air Temperature in Armenia".
20.	**Third Regional and first National Conference on Climate Change** *Isfahan, Iran, 13-16 October 2003*	H. Melkonyan participated in the Conference and made a report "Climate Change Monitoring in the Territory of Armenia".
21.	**Joint Seminar on Technology Diffusion in Eastern Europe and Central Asia organized by Climate Technology Initiative (CTI) and the UN Industrial Development Organization (UNIDO)** *Vienna, Austria, 28-29 October 2003*	Armenia was represented by A. Gabrielyan and UNDP/GEF "National Capacities Self-Assessment" Project Coordinator D. Harutyunyan Mr. Gabrielyan presented "Technology Transfer Issues in Armenia".
22.	**Expert Group Meeting on Industrial Energy Efficiency and Carbon Financing organized by UN Industrial Development Organization (UNIDO) and Austria's Ministry of Agriculature, Forestry, Environment and water Management (MAFE)** *Vienna, Austria, 30-31 October 2003*	D. Harutyunyan and A. Gabrielyan participated in the meeting. Ms. Harutyunyan presented "Armenia – Energy Efficiency and Climate Change Mitigation Policy Perspectives in Industry Sector"
23.	**21st Session of the IPCC** *Geneva, Switzerland, 3-7 November 2003*	M. Tsarukyan and S. Papyan, First Deputy Minister of Nature Protection attended the Session.
24.	**9th Conference of the Parties to UN FCCC** *Milan, Italy, 1 - 12 December 2003*	A. Gabrielyan represented Armenia

JOINT SEMINARS AND WORKSHOPS WITH STAKEHOLDERS

	Title, venue and date	Comments
1.	**Seminar on "Issues of Phase II of the project and presentation of IPCC guidelines for National Communications from Non-Annex I Parties"** *Yerevan, Ministry of Nature Protection, 20 September 2001*	Project coordinator A. Gabrielyan presented the objective and activities of the project and IPCC methodologies for technology transfer. Coordinating experts M. Vermishev, A. Nalbandyan and H. Melkonyan presented priority actions by sectors. 79 experts and representatives from stakeholder organizations participated in the seminar.
2.	**Seminar "Capacity building and strengthening for reduction of GHG emissions and technology transfer in Armenia" jointly held by Energy Institute, Energy Strategy Center, OPET Caucasus project** *Yerevan, Energy Institute, 7 February 2002*	Reports were presented in the seminar by A. Gabrielyan, assistant D. Harutunyan and expert M. Vermishev. The reports discussed issues of joint activities in the energy sector and transfer of ecologically clean technologies contributing to reduction of GHG emissions. The seminar was attended by 29 participants, including representatives from the UNDP, Ministry of Energy, as well as specialists from the Institute of Energy.
3.	**Seminar "Vulnerability of Armenia's mountain ecosystems to climate change and the necessity for adaptation measures"** *Yerevan, UNDP office, 15 February 2002*	Reports were presented by project assistant D. Harutyunyan, experts A. Nalbandyan, N. Khajakyan, M. Kalashyan, H. Sayadyan and V. Gabrielyan. The seminar was attended by the representatives from the Ministry of Nature Protection, UNDP, National Academy of Sciences, project experts and NGO; 44 participants were present.
4.	**"Energy saving and energy efficiency measures in housing sector" seminar held jointly by Energy Saving Alliance and USAID** *Yerevan, American University of Armenia, 13 March 2002*	Reports were presented by A. Gabrielyan and N. Vardanyan "Removing Barriers to Energy Efficiency in Municipal Heat and Hot Water Supply" Project expert. Participants were 74 representatives from Energy Saving Alliance, USAID, Ministry of Urban Development, international projects implemented in Armenia and from condominiums.
5.	**Founding meeting of Armenia's Energy Saving Council** *Yerevan, Tekeyan Center, 23 April 2002*	Project coordinator A. Gabrielyan was elected a member of Armenia's Energy Saving Council
6.	**Working meetings with representatives of Japanese Shimizu corporation** *Yerevan, Ministry of Nature Protection, 22 November 2001* *2 March 2002* *2 March 2002*	The Japanese party proposed 3 CDM project proposals: obtaining methane from processing landfills and producing energy using the methane, Hydro-energy development in Armenia. The Japanese side was interested in those organizations, which could contribute to implementation of projects. Project coordinator A. Gabrielyan, assistants D. Harutyunyan and R. Stepanyan, representatives from ministries of Nature

		Protection and Energy participated in meetings.
7.	**Working meetings with representatives of "Shghta" Ltd.** *Yerevan, Ministry of Nature Protection,* *20 December 2001* *22 February 2002*	Issues of processing domestic waste and manure for biogas production were discussed.
8.	**Working meetings with representatives from Urban Institute and USAID** *Yerevan, Urban Institute* *29 January 2002*	The Urban Institute works with local authorities in 9 towns of the country on heat supply, wastewater treatment and processing of solid wastes and provides services for business plan development. Agreement was reached to develop a project for reducing GHG emissions jointly. Project assistant D. Harutyunyan participated in the meeting.
9.	**Seminar within the framework of TEMPUS (Tacis) project** *Yerevan, Engineering Academy, 1 March 2002*	Project coordinator A. Gabrielyan presented the main objectives of the Convention, characterizing energy saving and energy efficiency as important measures of GHG mitigation and presented Kyoto protocol mechanisms for technology transfer. Project assistant D. Harutyunyan participated in the seminar.
10.	**Seminar of "Youth for Europe" organization on water resources problems for students' organizations** *Yerevan, Nalbandyan 29, 19 March 2002*	Project assistant D. Harutunyan presented assessment of the vulnerability of water resources as a result of climate change and other environmental issues. Representative of "Environmental academy" NGO participated in the seminar.
11.	**Working meeting with director of "Ecoperlit" Ltd. H. Hakopyan** *Yerevan, Ministry of Nature Protection, 25 March 2002*	Organization of a round-table on cooperation and on vulnerability of water resources as a result of climate change was discussed. Project assistant D. Harutyunyan and expert L. Chilingaryan participated in the meeting.
12.	**Working meeting with director of Energy Saving Alliance organization A. Pasoyan** *Yerevan, Ministry of Nature Protection, 1 April 2002*	The mandate and organizational issues of the renewable energy council were discussed. Project coordinator A. Gabrielyan and assistant D. Harutyunyan participated in the meeting.
13.	**Working meeting with FAO financed Agricultural Development Strategy project coordinator Ashot Voskanyan** *Yerevan, Ministry of Agriculture, 2 April 2002*	The climate change factor in assessment of long-term agricultural needs and prospects of cooperation with FAO experts were discussed. Project coordinator A. Gabrielyan and assistant D. Harutyunyan participated in the meeting.
14.	**Working meeting with "Armenia Tree Project" consultant G. Nersisyan** *Yerevan, Ministry of Nature Protection, 2 April 2002*	Implementation of 2 projects were discussed: 1. Biological filters for wastewaters based on the example of a project implemented in Canada (rapid growing trees were used in Vermont, British Columbia for cleaning wastewaters after mechanical treatment); 2. Use of tailing dumps in Kapan for growing

		plantation forests. Agreement was reached on information exchange. Project coordinator A. Gabrielyan and assistant D. Harutyunyan participated in the meeting.
15.	**Joint seminar with the Ministry of Urban Development and earthquake zone donor working group** *Yerevan, American University of Armenia, 14 May 2002*	Discussion of heat supply and energy efficiency in earthquake zone rehabilitation projects. Project coordinator A. Gabrielyan participated in the seminar.
16.	**Discussion of gas supply restoration project considering the heat supply restoration strategy** *Yerevan, National Academy of Sciences, 15 May 2002*	Project coordinator A. Gabrielyan participated in discussions, whose proposal for including the measures for assessing the fugitive emission from gas supply system and its reduction in the project were accepted.
17.	**Round-table by the initiative of the WB** *Yerevan, Ministry of Finance and Economy, 15 May 2002*	Representatives from Ministry of Finance and Economy, the agency implementing heat supply projects, USAID, TACIS and Urban Institute participated in the round-table. Project coordinator A. Gabrielyan and assistant D. Harutyunyan participated in the round-table.
18.	**Working meeting in Tufenkyan foundation Office** *Yerevan, Foundation office, 3 July 2002*	Project coordinator A. Gabreilyan presented studies of Armenia's forests within the framework of the project, objectives of Phase II and problems of heat supply. Mr. Tufenkyan presented the main objectives of their project, including restoration of Armenia's forests, substitution of firewood with other fuel, etc. Agreement was reached on signing a memorandum of understanding.
19.	**Seminar "Energy sector and environmental issues of Yerevan public transportation"** *Yerevan, Energy Institute, 23 July 2002*	Organizers: Energy Institute of the Ministry of Energy, Energy Strategy Center and OPET Caucasus project. 26 experts participated in the seminar from the above-mentioned organizations, Yerevan Municipality, WB, "Yerevan Design" Institute, State Traffic Police and other stakeholders.
20.	**Presentation of "Wind's Map of Armenia" by Solaren company** *Yerevan, SolarEn company office, 10 October 2002*	Project coordinator A. Gabrielyan presented the possibilities for investments in renewable energy sector under the clean development mechanisms.
21.	**Working meeting with USAID representative Marina Vardanyan, Project Management Specialist, Environment &Natural Resources, Economic Restructuring and Energy Office** *Yerevan, Ministry of Nature Protection, 22*	The meeting aims to discuss Proforma Sortware – a tool for assessment of renewable energy and energy efficiency projects. During the meeting it was revealed that the project would have a need in such type of software prior to preparing Armenia's Second National Communication

	October 2002	Report on Climate Change, which requires estimation of the GHG emission reduction potential. Participated A. Gabrielyan, M. Vardanyan and R. Stepanyan
22.	**Seminar “Management of multi-apartment buildings”** *Yerevan, Hotel Armenia, 14 December 2002*	The seminar was organized by Urban Institute within the framework of local administration project. The newly passed law on management of multi-apartment buildings and condominiums was discussed. Project coordinator A. Gabrielyan and assistant D. Harutunyan participated in the seminar.
23.	**Round-table at the Parliament “Information exchange in the Parliament. Energy efficiency in Armenia”** *Yerevan, Parliament, 16 December 2002*	The round-table was organized jointly with USAID financed projects “Energy efficiency and renewable energy” and “Support to Armenia’s legislation". Project coordinator A. Gabrielyan presented the report “Environmental aspects of energy efficiency”. 9 booklets prepared within the framework of the project were presented and delivered to Parliament’s library.
24.	**Working meeting with Victor Zakarian, Senior Industrial Development Officer, Investment and Institutional Capacity Building Division, UNIDO** *Yerevan, UNDP Office, 18 December 2002*	Participants discussed the possibility to prepare a project proposal on technology transfer to be submitted for UNIDO’s funding. The proposal should contain 2 parts: technical assistance component for capacity building for CDM projects in Armenia. Participated: A.Simonyan, A.Gabrielyan, D.Harutyunyan
25.	**Round-table for discussing the draft “Principles of the concept for reduction of motor vehicle emissions”** *Yerevan, Public center for environmental information, 7 March 2003*	The round-table was organized by the Ministry of Nature Protection jointly with Atmosphere Protection Division. The round-table aimed at discussing the draft “Principles of the concept for reduction of motor vehicle emissions” expecting proposals from participants. Representatives of stakeholder organizations participated. Number of participants 25.
26.	**Round-table discussion on environmental aspects of Armenian NPP** *Yerevan, Ministry of Nature Protection, 25 April 2003*	The round-table aim to discuss the use of NPP waste heat energy emitted into the atmosphere and its perspectives. The round-table discussion was attended by the Head of Armenian HPP, Head of Radiation Safety Department, Member of Energy Regulatory Commission, Senior Specialist of Urban Development and Natural Resources Department at the Governments Administration, UNDP Portfolio Manager, etc.
27.	**Round-table discussion on climate change and agricultural issues**	Topics discussed: 1. Coordination and cooperation between UNDP implemented projects

	Yerevan, Ministry of Agriculature, 14 May 2003	and executive ministries. 2. Interlinkages of agricultural sector and environmental conventions. a) UN CBD; b) UNFCCC; c) UNCCD. 3. Introduction of the NCSA project objectives. 4. Discussion and recommendations on possible ways for collaboration. Participants: UNDP, Ministry of Agriculture, Ministry of Nature Protection, UNCBD Focal Point, UNFCCC Focal Point, UNCCD Focal Point, “Agricultural and Rural Development Unit” project coordinator, “Community Development” project coordinator, and “National Capacity Self Assessment” project coordinator.
28.	**Round table discussion “Integration of Climate Change issues into the Educational System of Armenia”** *Yerevan, Union of Writers, 26 July 2003*	Mr. Gabrielyan presented the UN Framework Convention on Climate Change and its objectives. He mainly emphasized on one of the main activities of the Project, i.e. the Article 6 of the Convention “Education, Training and Public Awareness”. Among the participants were representatives from the Ministry of Nature Protection, Ministry of Education and Science, lecturers from Yerevan State University, State Institute of Economics, Center of Educational Improvements, ect.
29.	**Joint Conference on “Renewable Energy Conference. Reality and Perspectives for Armenia”** *Yerevan, Hotel “Hrazdan” 28 July 2003*	The goals and objectives of the Conference are to present the state of the art with renewable energy development in Armenia, foster information exchange between different field actors and consolidate previously gained experience in renewable energy field, present new technologies, success stories and negative experience, etc. Mr. Gabrielyan’s presentation was devoted to environmental aspects of renewable energy. The proceedings of the Conference are published.

PRESENTATION OF REPORTS BY PROJECT EXPERTS IN PARTNER ORGANIZATIONS

	Title, venue and date	Comments
1.	**ArmHydroMet** *Yerevan, ArmHydroMet department, 26 December 2002*	The reports of "Studies of climatic systems and systematic observations" working group were discussed. Discussions had 21 participants.
2.	**Scientific-applied center for hydro-meteorology and ecology** *Yerevan, Scientific-applied center for hydro-meteorology and ecology, 15 January 2002*	The reports of "Studies of climatic systems and systematic observations" working group were discussed. Discussions had 13 participants.
3.	**Armenian Agricultural Academy** *Yerevan, Armenian Agricultural Academy, 15 January 2002*	The reports of "Adaptation technologies for mitigating impacts of climate change (natural ecosystems, agriculture)" working group related to agriculture were discussed. Discussions had 13 participants.
4.	**Center for especially dangerous infectious diseases** *Yerevan, Center for especially dangerous infectious diseases, 24 January 2002*	The reports of "Adaptation technologies for mitigating impacts of climate change (population's health)" working group related to healthcare were discussed. Discussions had 23 participants.
5.	**Hydro-ecology and ichthyology institute of the National Academy of Sciences** *Yerevan, Hydro-ecology and ichthyology institute of the National Academy of Sciences, 1 March 2002*	Project expert B. Gabrielyan touched upon Armenia's membership in UN FCCC and related issues. Encouraged institute's staff to participate in project implementation. Project coordinator A. Gabrielyan and assistant D. Harutunyan participated in discussions. Number of participants was 18.

THEMATIC LECTURES IN EDUCATIONAL INSTITUTIONS

During the project implementation there have been delivered a number of lectures aimed at to enhance general awareness and knowledge on climate change related issues – UNFCCC objectives and goals, IPCC assessment reports, commitments of Armenia under the Convention, greenhouse gas effect, the Kyoto Protocol to the Climate Change Convention, global environmental issues in the context of sustainable development, etc. The lectures were followed with the demonstration of the films and distribution of materials prepared, translated and published in frames of the Project.

Thematic lectures were delivered in the following institutions:

1. Academy of Fine Arts in Yerevan
2. Faculties of Geography and Biology of Yerevan State University
3. Faculty of Chemistry of Armenian State Engineering University in Yerevan
4. Agro Business Center of US Department of Agriculture Marketing at the Agricultural Academy of Armenia in Yerevan
5. State University in Gavar
6. “Progress” University in Gyumri
7. Pedagogical Institute after M. Nalbandyan in Gyumri
8. Inter-Regional Teachers Training Institute in Gyumri
9. Fine Arts Academy in Gyumri
10. Pedagogical Institute in Vanadzor
11. Teachers Training Institute in Vanadzor
12. School N 83 in Yerevan
13. School N 29 in Yerevan
14. School N 196 in Yerevan

MATERIALS PUBLISHED AND TRANSLATED

1. Միավորված Ազգերի Կազմակերպության Կլիմայի փոփոխության մասին շրջանակային կոնվենցիային կից Կիոտոյի արձանագրությունը: 33 էջ:
2. Կլիմայի փոփոխության հապավումների և ժարգոնային արտահայտությունների բառարան: Երևան, 2002. 20 էջ (թարգմանություն անգլերենից Glossary of Climate Change Acronyms and Jargon)
3. Ինչպե՞ս ենք հասկանում կլիմայի փոփոխությունը: Ուղեցույց սկսնակների համար՝ Կլիմայի փոփոխության ՄԱԿ-ի շրջանակային կոնվենցիայի և Կիոտոյի արձանագրության մասին: Երևան, 2002. 32 էջ (թարգմանություն անգլերենից Understanding Climate Change: A Beginners Guide to the UN Framework Convention and its Kyoto Protocol)
4. Ամեն ինչ կլիմայի փոփոխության մասին (Կլիմայի փոփոխության տեղեկատվական թերթիկներ) Երևան, 2002. 89 էջ (թարգմանություն անգլերենից Climate Change. Information Kit)
5. Կլիմայի փոփոխության գործընթացների ուղեցույց: Երևան, 2002. 30 էջ (թարգմանություն անգլերենից A Guide to the Climate Change Process).
6. Գարոյան Հ.Բ. Կլիմայի փոփոխության հիմնախնդիրները: Մեթոդական ուղեցույց. 2002. 26 էջ
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10. Вермишев М. Энергоэффективность энергопотребления для покрытия потребности в отоплении и горячей воде в жилищном и общественном секторах РА //Доклады второй международной конференции по энергетике.-Ереван, 2002.
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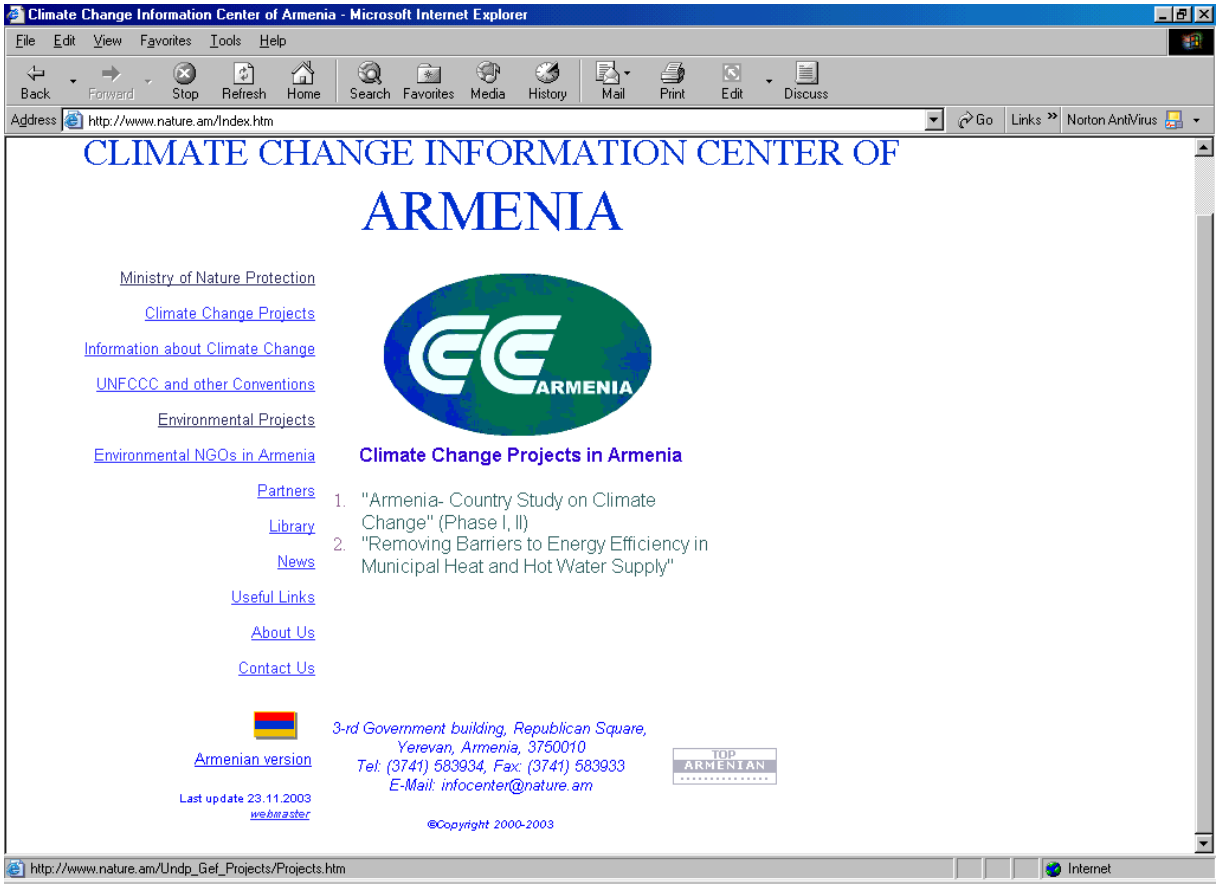
PROJECT WEBSITE

“ARMENIA. COUNTRY STUDY ON CLIAMTE CAHNGE”

http://www.nature.am



Project website is in English, Armenian and Russian languages. The website includes the following information.