OeEB

Oesterreichische Entwicklungsbank AG

Energy Efficiency Finance

Task 1 Energy Efficiency Potential

Country Report: ARMENIA

Prepared for OeEB by Allplan GmbH
in cooperation with Frankfurt School and Local Partners
Vienna, October 2013

ALLPLAN GmbH

Address: Schwindgasse 10, 1040 Vienna, AUSTRIA
Tel.: +43-1-505 37 07-94; +43-1-505 37 07-55;
Fax: +49-1-505 37 07-27
Web: www.allplan.at

Dep. Energy & Environment: Dr. Helmut Berger, helmut.berger@allplan.at

Content

1 EXECUTIVE SUMMARY 4

2 AIM AND SCOPE OF THIS REPORT 5

3 STUDIES AVAILABLE 5

3.1 OVERVIEW 5
3.2 MAIN RESULTS OF EXISTING STUDIES 7

4 STATUS OF ENERGY EFFICIENCY 8

4.1 ENERGY SUPPLY 8
4.2 ENERGY DEMAND 10
4.3 GREENHOUSE GAS EMISSIONS (GHG EMISSIONS) 13
4.4 ENERGY EFFICIENCY OVERVIEW 13
4.5 ENERGY EFFICIENCY IN THE INDUSTRIAL SECTOR 14
4.6 ENERGY EFFICIENCY IN SMES 18
4.7 ENERGY EFFICIENCY IN THE RESIDENTIAL SECTOR 20
4.8 ENERGY EFFICIENCY IN THE AGRICULTURAL SECTOR 22

5 FRAMEWORK FOR ENERGY EFFICIENCY 23

5.1 LEGAL AND POLICY FRAMEWORK 23
5.2 TECHNICAL FRAMEWORK 24
5.3 ECONOMIC FRAMEWORK 25
5.4 AWARENESS AND INFORMATION LEVEL 27

6 CONCLUSION 28

7 RELEVANT INSTITUTIONS 29

8 LITERATURE 30

List of figures

Figure 1: Energy Flow Armenia 2007 8
Figure 2: Electricity consumption in different sectors, 2007-2011 [TJ] 10
Figure 3: Structure of electricity consumption 2012 10
Figure 4: Structure of natural gas consumption, 2011-2012 (mln. m³) 11
Figure 5: Structure of natural gas consumption, 2012 11
Figure 6: Structure of thermal energy sources for heating purposes, 2011 12
Figure 7: Technologies used for heating purposes, 2011 12
Figure 8: Annual greenhouse gas emissions by sectors 1990-2006 without LULUCF 13
Figure 9: Overview of saving potentials 14
Figure 10: Distribution of the multi-apartment buildings by age 20
Figure 11: Distribution of the multi-apartment buildings by envelope design 20

List of tables

Table 1: Overview of available reports 6
Table 2: Installed power generation capacities of Armenia 9
Table 3: Natural gas consumption per sector, 2012 12
Table 4: Greenhouse gas emissions by sectors of main sectors (MNP, 2010) 13
Table 5: Energy efficiency potentials industry 14
Table 6: Energy efficiency potential per industry subsector 15
Table 7: Energy efficiency potentials energy production and distribution 18
Table 8: Structure of GDP by SMEs and large enterprises in the branches of economy 18
Table 9: Classification of SMEs 19
Table 10: Distribution of SMEs and large enterprises by the sectors of economy 19
Table 11: Climatic zones of Armenia and length of the heating season 21
Table 12: Distribution of the population, according to housing resources and regional zones 21
Table 13: Energy efficiency measures in the agricultural sector 22
Table 14: Examples of EE product suppliers 25
Table 15: Energy tariffs (VAT included) in Armenia 26
Table 16: Payback periods in the public sector 27
Table 17: Relevant institutions 29

Abbreviations

ADB -	Asian Development Bank
AE -	Alternative Energy
CJSC -	Armenian Electric Network
CP -	Cleaner Production
EBRD -	European Bank for Reconstruction and Development
EC -	European Commission
EDTP -	Enterprise Development and Training Program
EE -	Energy Efficiency
ESRE -	Program on Energy Saving and Renewable Energy
GDP -	Gross Domestic Product
GIZ -	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
HH -	Household
HPP -	Hydro power plant
IFC -	International Finance Corporation
IFI -	International Financial Institution
kWh -	kilo Watt hour
LULUCF -	Land use, land use change and forestry
OSCE -	Organization for Security and Cooperation in Europe
RE -	Renewable energy
SME -	Small and Medium Enterprise
TJ -	Terajoule
TPP -	Thermal power plant
UNDP -	United Nations Development Programme
USAID -	United States Agency for International Development

1 Executive Summary

This report analysis the Potential of the Energy Efficiency Market in Armenia and is part of the overall study, which analyzes the potential for new financing lines of the OeEB in the field of energy efficiency in the countries Turkey, Ukraine, Armenia and Azerbaijan. The aim of the report is to investigate the status of energy efficiency in different economic sectors, to identify the sectors with highest potentials and to analyze the legal, economic and technical framework.

Armenia's **energy situation** with an average **primary energy flow of about 120 PJ** is characterized by strong import dependence and focus on natural gas (70 PJ primary energy input). Apart from natural gas the main energy source is nuclear power (28 PJ). The only mentionable share of currently used renewable energy is attributable to large hydro power plants (6.7 PJ). The transmission and distribution losses are higher than world average.

The major shares of electricity consumption relates to the industry and the residential sector, as well as the services sector (hotels, trade) (similar shares below 30% each). In the field of natural gas consumption the major share is attributable to the residential sector (34%). Heating is mainly served from natural gas (70%), followed by electricity (23%).

Regarding **energy efficiency potentials,** pertinent studies point at considerable saving potentials for natural gas consumption (around 32%) and electricity consumption (average 17%). Biggest potential is seen for natural gas consumption in the residential sector (46%), which is mainly due to the bad condition of building envelopes in Armenia.

In the industrial sector the biggest potentials have been identified in the metal industry (>50%), food industry (35-40%) and chemical industry (23%). Main measures are optimization of processes, insulation and replacement of inefficient machines.

In the field of energy supply there is a potential of around 20 PJ (which corresponds to 35% of current electricity and heat generation) which could be realized via more efficient gas turbines, insulation of facilities and again optimization of processes and control.

The energy efficiency potential of households is estimated at 14 PJ and mainly relates to improving insulation and lightening.

Agriculture, which still delivers a considerable share of GDP (25%), shows a low energy intensity and small share of overall energy consumption (1.9 %). However this is mainly due to the current low degree of mechanization and still offers mentionable potentials for energy improvement, e.g. for irrigation systems.

Among legal laws and regulations the most relevant ones are the **Energy Law (2001)** which define energy efficiency and renewable energy sources as one pillar of the energy strategy, **the Law on Energy Saving and Renewable Energy (2004)** and the **National Energy Efficiency Action Plan (2011)** which among others define priority measures such as establishing an agency for energy efficiency, a tariff adaptation, financial support as well as capacity building.

From a technical perspective, energy efficient technologies and services are a young market; also information and awareness levels need to be further increased. There are, however, some products which are already produced within the country and well established such as specific types of insulation, energy efficient windows, boilers and solar water heating.

Despite the fact that current gas and electricity prices are still well below EU figures (one third to one half of EU average), investment in energy efficiency makes sense. Energy cost still means a considerable burden and household budget. Amortization rates for industry are estimated to 3-7 years, but investments are considered to become more attractive with increasing costs of imported fossil fuels. Most attractive are low budget, organizational measures which show immediate impact on budgets.

Local experts advise to focus on owners of larger supermarkets or hotels and to establish a funding line for renovation of buildings. In the agriculture sector the current boom of glass houses opens a considerable potential for heat pumps, solar thermal applications and energy efficient heating and ventilation solutions. Capacity building is considered important, but should be distinct from already existing training programs in order to increase the real impact of such incentives.

2 Aim and Scope of this Report

The Development Bank of Austria (OeEB) aims at increasing its activities in the field of energy efficiency in selected countries via dedicated credit lines, but also via supportive programs for selected financial institutions and project developers. The present study is part of the overall study, which analyzes the status of energy efficiency in the countries Turkey, Ukraine, Armenia and Azerbaijan.

The Study is carried out in cooperation of ALLPLAN GmbH and Frankfurt School and is based on the latest available information collected directly in the country by local experts in June 2013.

This report focuses on Task 1, “Potential of the Energy Efficiency Market” in Armenia and analyzes the following questions:

- How is the Status of Energy Efficiency in different economic sectors?
- In which sectors is the efficiency potential considered to be highest?
- How can local framework for energy efficiency be characterized in terms of legal, economic and technical aspects?

3 Studies Available

3.1 Overview

Energy efficiency potentials have been analyzed in several studies, which are presented in Table 1. The studies provide a general overview of energy efficiency. Individual sectors are not analyzed in detail. Further benchmarks or detailed measures are not listed. These studies were prepared before the financial crisis and thus the data would require an update.

Table 1: Overview of available reports

Report Name/Author/Date/link	Scope	Brief description
National Program on Energy Saving and Renewable Energy of Republic of Armenia link	This program was prepared by the Scientific Research Institute of Energy for the Alliance to Save Energy, funded by the United States Agency for International Development (USAID). This cross-sectorial study shows estimations for improvements in several sectors. The study is based on national statistical data, collection and analysis of energy passports from 62 large energy consumers, Armenian Electric Networks CJSC and ArmRusGasprom CJSC.	The study gives an overview of the Armenian economy and the energy consumption in the country. Further, it gives estimations for improvements in several sectors. Armenian government approved the national program on Energy Saving and Renewable Energy (ESRE) in 2007. Larger improvements can be achieved in the following areas: • 40% of the total energy saving potential can be achieved in the building sector. Thermal insulation is able to reduce space heating demand by 30%, which is equivalent to 3.89 TWh in residential and 0.78 TWh in public buildings • Energy demand can be reduced by 15% in the water supply and irrigation sector • Improvement in lighting is able to reduce the energy demand by 0.475 TWh over the next 10 years • Raised energy efficiency reduces the energy demand in mining industry by 5%, chemical industry by 23% and food industry by 35-40% This program proposes 16 categories of energy efficiency measures (incl. technical, institutional, administrative, financial, etc.) with an annual total saving potential of 11.6 TWh.
Energy Efficiency: a new resource for sustainable growth **Researching energy efficiency practices among Armenian companies** **IFC (2008)** link	In 2008, the International Finance Corporation has conducted an Energy Efficiency survey of SMEs[1] from 5 industrial sub- sectors (food, chemical, building materials, metal processing and machine building). This report provides information about the valuation of energy efficiency, development of energy efficiency in the sector and provides organizational and administrative approaches for implementation and financing of energy efficiency measures. The study is based on a detailed questionnaire and face-to-face interviews with the management of 100 companies.	The energy efficiency situation is considered better than for comparable countries. Nevertheless, the industry could reduce energy costs by 14.5% with implementation of energy efficiency measures. Most companies have plans to invest in energy efficiency in the short term. The analyzed 5 sectors are responsible for 56% of the total Armenian industrial output and contribute 24% of Armenian GDP. The key energy efficiency indicators for the surveyed companies can be summarized as follows: • Prioritization of EE: low • Actual awareness of EE potential and measures: low • Historical EE investment: medium • Planned EE investment compared to historic: high • Average value of investment planned: low • Integration of EE into business planning: low • Perceived effectiveness of EE laws and regulations: medium
The Other Renewable Resource: The Potential for Improving Energy Efficiency in Armenia link	This report was published by the World Bank in 2008. It identifies priority sectors for investment in EE, analyzes barriers to EE investments and recommends policy measures to overcome these barriers. This report is mainly based on data of the National Program but additionally includes financial and technical analyses on the EE investment potential of various sectors	This study states a total energy saving potential of 1 TWh of electricity and 600 million m³ of natural gas (17% of total electricity and 32% of natural gas consumption). These savings can be achieved through EUR 230 million investments. Replacement of heating systems, thermal insulation and refurbishment of lighting can save about two-thirds of total potential savings in Armenia. Energy efficient lighting reduces the electricity demand by 50%. Variable speed motors and replacement of inefficient equipment further reduces the demand by 20%. Further, this report also shows barriers, which avoid energy efficiency measures in Armenia.

1 According to the Law of the Republic of Armenia "On State Support of Small and Medium Entrepreneurship" there are three broad parameters, which define SMEs:
- micro-entities are companies with up to 5 employees
- Small companies are companies with up to 50 employees in the industrial sector, 25 - in the construction, energy, science and education sectors and 15 - in the transport, trade and services sector
- Medium-sized enterprises are companies with up to 100 employees in the industrial sector, 50 in the construction, energy, science and education sectors and 30 in the transport, trade and services sector.

3.2 Main results of existing studies

The available studies listed in chapter 3.1 have different approaches and methodologies. The National Program on Energy Saving and Renewable Energy of Republic of Armenia (2007) is based on national statistical data as well as of data from energy consumers and suppliers. This study focuses on the total economy of Armenia. The industry is broken down in several sectors, which are displayed separately. The IFC (2008) report is based on detailed questionnaires and face-to-face interviews. This study focuses mainly on the industrial sector and gives approaches for implementation of energy efficiency in enterprises.

The World Bank report uses data of the National Program and includes financial and technical analyses and considerations. Due to the base data this study considers the whole country, but separately considers several industrial sectors. Further, this report shows necessary investment costs, cost savings and existing barriers for investments in energy efficiency investment.

The energy saving potential in the National Program for electrical drives or lighting is calculated “using new technologies”. What exactly is meant with “new technology” is not further explained in this report.

IFC (2008) focuses on the current situation, the valuation of energy efficiency measures and approaches for implementation and is based on a survey of 100 companies. The calculation of the total saving potential is not further mentioned and benchmarks are not used in this study.
The report of the World Bank uses estimations of saving potentials from the National Program. Therefore, the used benchmarks for the calculation of saving potentials are not disclosed to the reader.

Though previous work done provides a good overview of the market background, awareness and experiences of companies and barriers for investing in EE measures, it covers only one part of market players: the industry or residential energy consumers.

The studies show the potential and necessity of energy efficiency investment in the country but do not specify detailed measures. There are no further details on availability of technologies, suppliers, benchmarks, overview of existing technology, etc.

4 Status of Energy Efficiency

4.1 Energy supply

In 2010, Armenia covered less than one third of the energy demand with own resources (hydro energy and nuclear power) (MNP, 2010). About 69% of energy demanded is imported from a limited number of countries and thus the country shows a high dependence on energy imports.

The following chart provides a good overview of the energy flow in Armenia. Despite the fact that it depicts the situation in 2007 it is still considered a valuable document as it highlights the main factors of energy supply and use at one glance.

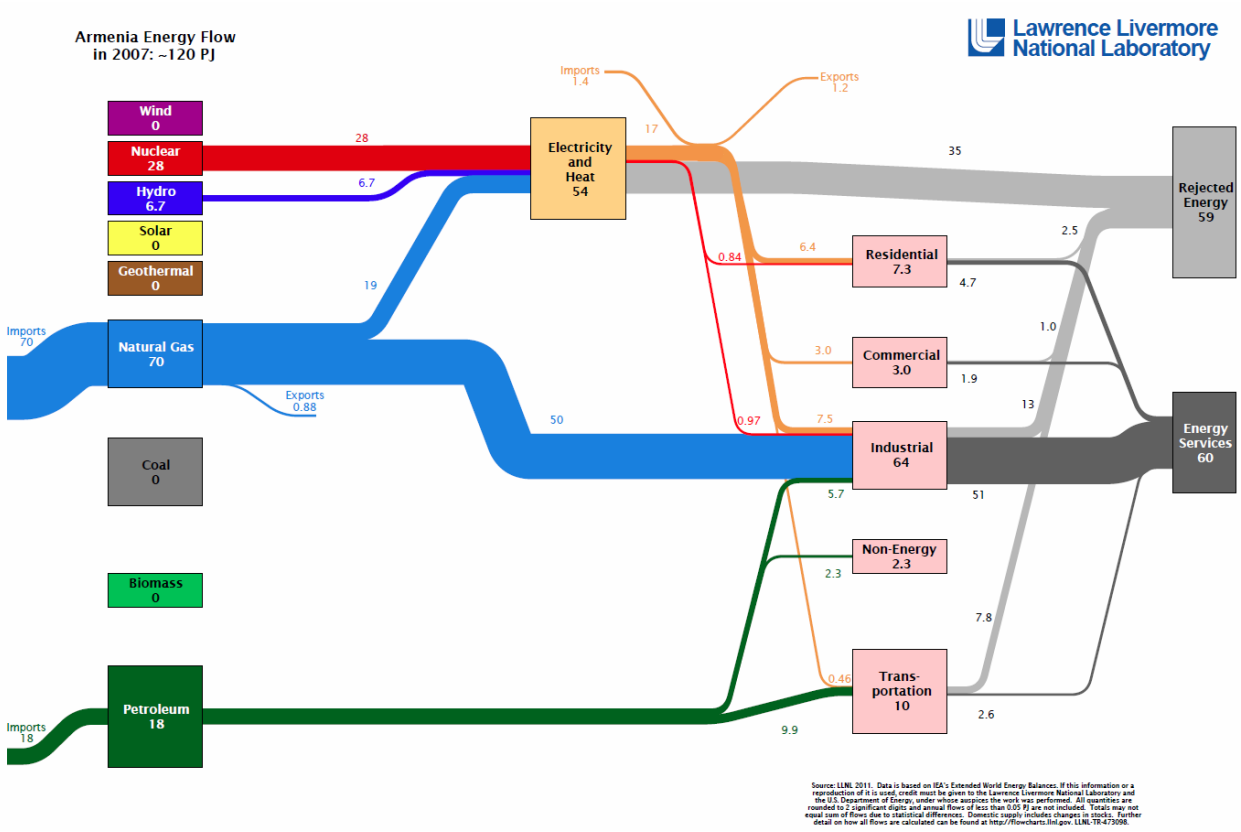

Figure 1: Energy Flow Armenia 2007
Source: LLNL, 2011

Following conclusions can be derived from the chart above, which shows an annual energy flow of about 120 PJ and from recent developments:

- Electricity and heat generation in Armenia is dominated by nuclear power, natural gas and large hydropower plants.
- Since 2007, the imports of electricity have decreased and exports increased. The share imports/exports in 2012 was only 5% (compared to 130% in 2007).
- Petroleum is fully imported.
- Natural gas plays the major role not only for supplying electricity and heat, but also for supplying energy needs in the residential and industrial sector. Natural gas accounts for about 53% of the total energy consumption.
- The rejected energy as depicted in the grey row amounting to 59 PJ is due to losses in electricity and heat generation.
- According to the chart above it could be concluded that the energy consumption in Armenia is dominated by the industrial sector and that the share of the residential sector compared to other countries is quite low. However, according to local expert's information the value for the residential sector seems to be underestimated. According to the Public Services Regulating Commission

data, the residential sector consumes 37% of electricity and 33% of natural gas, while the industrial sector consumes 23% and 16%.

Electricity production in Armenia is organized by Electric Networks of Armenia CJSC (ENA). ENA is the only electricity distribution company. It purchases electricity through direct contracts from generators and sells it to its customers. The installed power plants connected to the Armenian grid are shown in the following table:

Table 2: Installed power generation capacities of Armenia

Generation type	Installed capacity, MW	Ownership	NOTE
Thermal	**2,498**		
Hrazdan TPP	1,100	Russian Federation	Used for peak load
Yerevan TPP	550	GoA	50 MW operational
Vanadzor TPP	96	Zakneftgasstroy-Promethey	Not operational
Hrazdan TPP-5	480	Armrusgazprom (company Gazprom Russia)	
New CHP Unit in Yerevan TPP	272	GoA	Used for export to Iran
Hydropower	**1,182.2**		
Sevan-Hrazdan cascade	556	Rushydro	
Vorotan cascade	404.2	GoA	Lowest tariff
Small HPP (<10MW)	222	Private owners	Feed-in tariff and guaranteed purchase for 15 years
Nuclear Power	**408**		
Metsamor NPP	408	GoA	
Wind	**2.6**	GoA	Commissioned in 2005, funded by Iranian government
Biogas			
Lusakert biogas Plant	**0.85**	Private (Armenia, Norway)	CDM project

Source: (PSRC 1, 2013)

High Voltage Electric Networks CJSC (HVEN CJSC) is responsible for the transmission of energy via 220-110kV electric networks. There are a total of 1870.24km long overhead transmission lines in its balance, including 330kV – 164.0km, 220kV – 1301.13km and 110kV – 405.11km long lines with 15 substations of 220kV operated by HVEN CJSC and one "Agarak" 110-220kV Switching Point.

According to the Energy Law there is a purchase commitment for electricity generated by renewable energy sources of licensed entities for the first 15 years of operation. The Power Purchase Agreement (PPA) between a renewable energy supplier and the Electric Networks of Armenia CJSC (ENA) is signed after the construction of the power plant and obtaining the Operation License from the Public Services Regulating Commission (PSRC). The PSRC sets the feed-in tariffs for all generators, the transmission tariff for high voltage networks, and the service fees for the operator and the settlements center, which the ENA should pay to all mentioned market participants according to the Energy Law.

The main energy source for thermal energy is natural gas. Natural gas is used in the CHP plant in Yerevan and further for heating purposes in the residential and industrial sector.

The transmission losses in Armenia amount to 1.9%, the distribution losses to 13.6% (PSRC 2013). The world average **of transmission and distribution losses** amounts to 9% (ABB, 2012).

4.2 Energy demand

The residential sector was the main consumer of electricity and natural gas in 2012. The share of electricity consumption and gas consumption of the main sectors are shown in Figure 2 respectively Figure 4. These charts show a continuous increase in electricity consumption since 2007. The gas consumption is only available for 2011/2012 and is not adapted to climate conditions. About 70% of the Armenian population uses natural gas for space heating, whereas 23% use electricity for heating purposes. Other sources like firewood only have a minor share (EDRC, 2011).

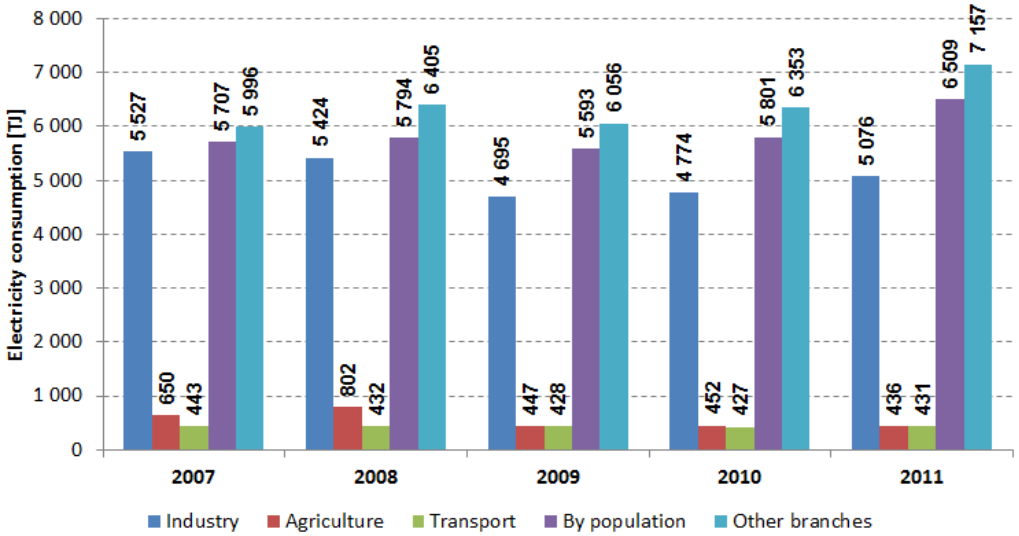

Figure 2: Electricity consumption in different sectors, 2007-2011 [TJ]
Source: Armstat 1, 2012

As shown in the figure above, the majority of electricity is consumed by industry and the residential sector. The electricity consumption of the agricultural and the transport sector is comparatively low. Mainly services (hotels, trade) are responsible for the high electricity consumption of “other branches”, amounting to 7,157 TJ in 2011.

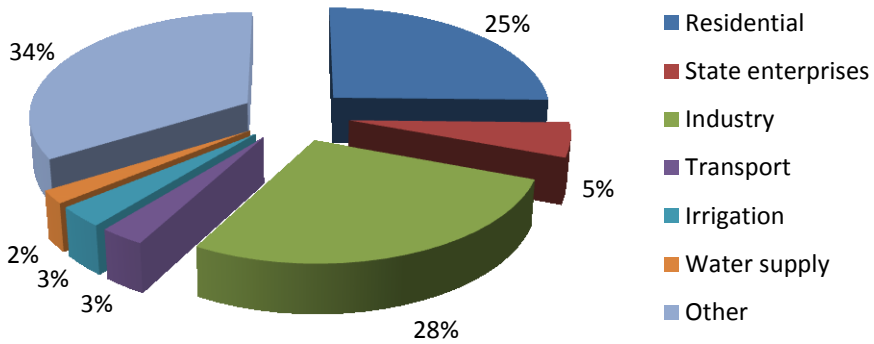

Figure 3: Structure of electricity consumption 2012
Source: PSRC, 2012

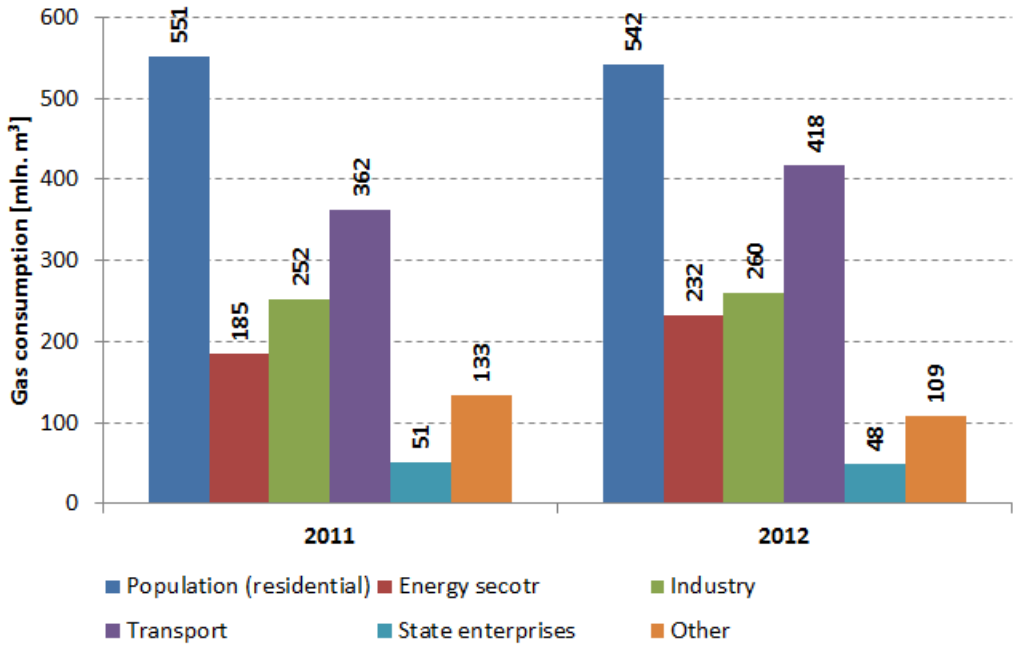

Figure 4: Structure of natural gas consumption, 2011-2012 (mln. m³)
Source: PSRC 2, 2013

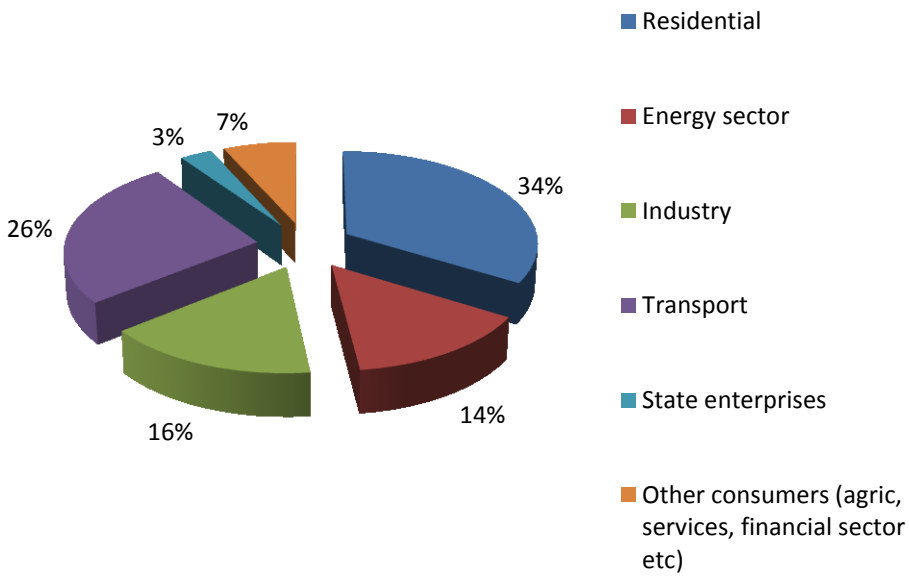

Figure 5: Structure of natural gas consumption, 2012
Source: PSRC 2, 2013

For a better comparison of the natural gas consumption figures are converted to PJ in the following table, which again underlines the importance of natural gas consumption in the overall energy system of Armenia.

Table 3: Natural gas consumption per sector, 2012

Structure of natural gas consumption, 2011-2012 applied calorific value: 36.4 MJ/m³	1000 m³	PJ
Population	542 000	19.73
Energy sector	232 000	8.44
Industry	260 000	9.46
Transport	418 000	15.22
State enterprises	48 000	1.75
Other	109 000	3.97
Total	**1 609 000**	**59**

Source: Own calculation, based on PSRC data

The share of energy sources for heating purposes is shown in Figure 6. Used technologies for heating are shown in Figure 7. Both show the dominance of natural gas use for heating purposes.

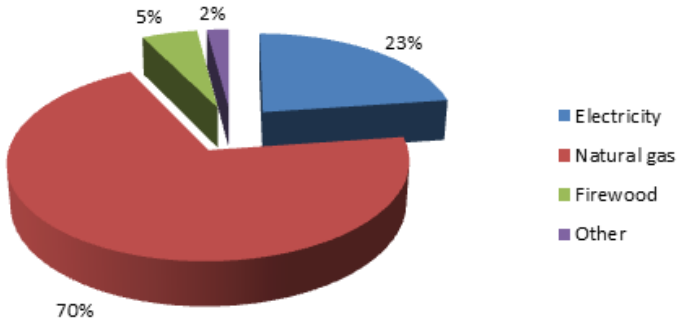

Figure 6: Structure of thermal energy sources for heating purposes, 2011
Source: EDRC, 2011

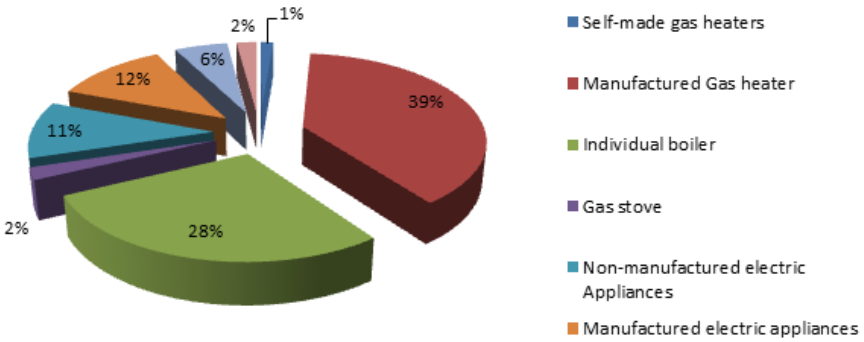

Figure 7: Technologies used for heating purposes, 2011
Source: EDRC, 2011

The electricity demand in the industrial sector decreased in the period from 2007 - 2009. Since 2009, the consumption has been increasing again. The main electricity consumers in the industrial sector are the mining of metal ores industry with about 30%, metal and non-metal industry with 23% and the food industry with 10%. Further, the electricity, gas, steam and air conditioning industry consumes 18.7%; water supply, sewerage, waste management and remediation activities demand the missing 6.1%.

4.3 Greenhouse gas emissions (GHG emissions)

In 2006, the total emissions of Armenia were 6.42 million tons of CO_{2equ}.
GHG emissions dropped by 80% in 2000 compared to the baseline (1990) due to the economic crisis in 1992-1995. Since this date, the emissions are slightly increasing.

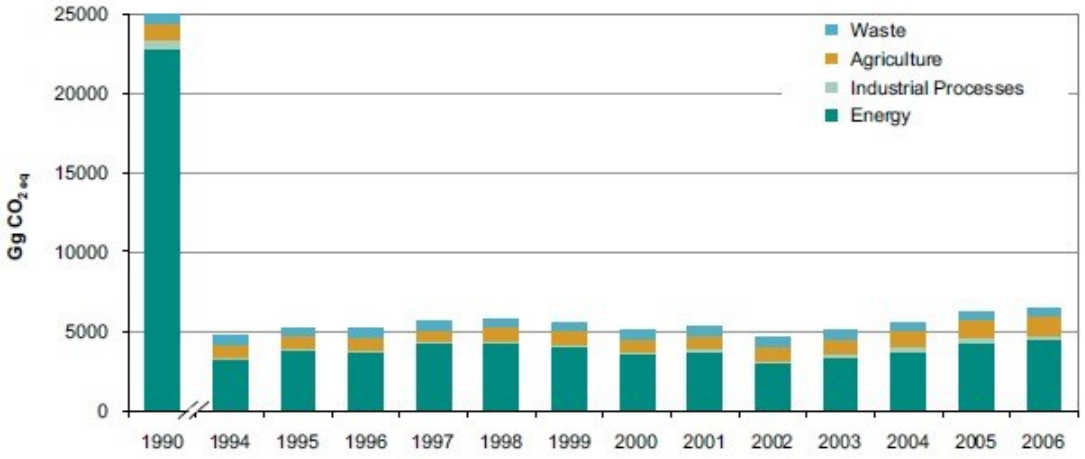

Figure 8: Annual greenhouse gas emissions by sectors 1990-2006 without LULUCF
Source: MNP, 2010

In 2006, the Energy sector accounted for 64.7% of total GHG emissions. The agricultural sector grew in this period to 17.9% as well as the waste sector with 7.9% in 2006. The industrial processes sector shares about 5% of total GHG emissions. The total numbers are shown in Table 4.

Table 4: Greenhouse gas emissions by sectors of main sectors (MNP, 2010)

kt CO_2 equ.	1990	1994	2000	2006
Energy	22,777.0	3,268.6	3,550.6	4,441.4
Industrial processes	630.3	53.0	119.7	323.8
Agriculture	982.6	812.6	840.7	1,149.5
Waste	564.9	544.9	560.3	508.0

Source: MNP, 2010

4.4 Energy efficiency overview

All energy efficiency measures and potential estimations were based on the National Program on Energy Saving and Renewable Energy of Republic of Armenia (USAID, 2007) and on local experts' estimations.

The main estimations available concentrate on the industry and household sector and on potentials to reduce natural gas and electricity consumption. The following figure provides an overview of the estimated potentials as percentage of 2007 consumption. Figures related to overall saving potentials covering more sectors or fuel types are shown as values over two rows or columns respectively. It has to be stated that some figures are contradicting within the report and would require further investigation. This especially refers to overall saving potentials versus specific potentials for selected measures or subsectors.

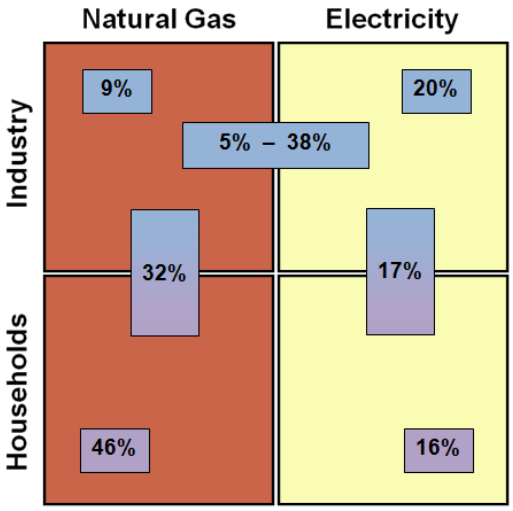

Figure 9: Overview of saving potentials
Source: Data USAID (2007), own figure

4.5 Energy efficiency in the industrial sector

The following table summarizes the saving potentials in the Armenian industrial sector. Detailed consumption figures per sub-sector are not available.

Table 5: Energy efficiency potentials industry

	Consumption		Saving potential		Saving potential of total sector (%)	
	gas (1000 m³)	electricity (MWh)	gas (1000 m³)	electricity (MWh)	gas (1000 m³)	electricity (MWh)
Industry, including	**259,900**	**1 180 300**	**23,906**	**230,294**	**9.20%**	**19.51%**
Metal ore extraction			2,843	74,963	1.09%	6.35%
Other branches of mining			18	-	0.01%	0.00%
Food and beverages			7,484	36,458	2.88%	3.09%
Tobacco			37	15,955	0.01%	1.35%
Textile			-	566	0.00%	0.05%
Publishing and printing			-	66	0.00%	0.01%
Chemical			3,203	52,733	1.23%	4.47%
Rubber and plastic goods			1	517	0.00%	0.04%
Other non-metal extraction			5,952	32,775	2.29%	2.78%
Metallurgical industry			4,047	9,067	1.56%	0.77%
Ready-made metal products			25	42	0.01%	0.00%
Machinery and equipment			-	2,285	0.00%	0.19%
Electrical machines and equipment			291	4,681	0.11%	0.40%
Other branches of industry			5	186	0.00%	0.02%

Source: own table based on: Data USAID, 2007

The table below shows the saving potential in PJ per industry subsector in detail and states typical EE measures.

Table 6: Energy efficiency potential per industry subsector[2]

Name of the subsector	Typical EE measures	Total potential, PJ
Metal ore extraction	Elimination of failures and improvement of technological processes, organizational measures, decrease of idling process, Introduction of new energy efficient technological units and automation of electric drives, utilization of secondary energy resources, improvement of thermal insulation of furnaces and heating networks as well as use of EE lighting	0.365
Other branches of mining industry	Improvement of thermal insulation of furnaces and heating networks	0.0006
Food and beverage production	Introduction of new energy efficient technological units and automation of electric drives, improvement of thermal insulation of furnaces and heating networks as well as the use of energy efficient electric lamps	0.38
Tobacco production	Variable speed drives, replacing old equipment and motors, automated electricity metering, thermal insulation, improvement/optimization valves, introducing new management and control systems and energy efficient lighting	0.16
Textile production	EE motors, introducing new management and control systems as well as energy efficient lighting	0.002
Chemical industry	Streamlining technological processes and eliminating system faults, reducing idle (no load and standby) operations, variable speed drives, replacing old equipment, more energy efficient motors, compensating reactive power, automated electricity metering equipment, organizational measures, insulation and measures to reduce gas losses, utilization of secondary energy resources, fuel switching, improvement/optimization valves, introducing new management and control systems and methods as well as improved insulation and energy efficient lighting	0.20
Rubber-plastics production	Replacing old equipment (using electricity), EE motors, organizational measures, utilization of secondary energy resources, introducing new management and control systems, improved insulation	0.001

[2] The estimates rely on energy consumption data, energy savings estimates, and capital cost estimates from Armenia's National Program on Energy Saving and Renewable Energy (USAID 2007). Thus all data dates back to 2007.

Other branches of non-metal mining industry	Reducing idle (no load and standby) operations, variable speed drives, replacing old equipment, EE motors, compensating reactive power automated electricity metering equipment, organizational measures, insulation and measures to reduce gas losses, introducing new management and control systems, energy efficient lighting	0.14
Metal industry	Streamlining technological processes and eliminating system faults, reducing idle (no load and standby) operations, variable speed drives, replacing old equipment (using electricity), more energy efficient motors, compensating reactive power, automated electricity metering equipment, organizational measures, insulation and measures to reduce gas losses as well as energy efficient lighting	0.04
Trade, technical maintenance and repair of vehicles	Reducing idle (no load and standby) operations, replacing old equipment (using electricity), EE motors and organizational measures	0.024
Retail trade	EE lighting	0.002
Hotels-restaurants	Insulation and measures to reduce gas losses, improvement/optimization valves, improved insulation as well as energy efficient lighting	0.005
Provision of healthcare and social services	Reducing idle (no load and standby) operations, variable speed drives, organizational measures, insulation and measures to reduce gas losses, fuel switching, improvement/optimization valves, introducing new management and control systems and methods improved insulation as well as energy efficient lighting	0.05

Source: Armenia Renewable Resources and Energy Efficiency Fund, 2008

In the industrial sector the highest saving potentials for natural gas consumption (referring to the 2007 energy consumption of the overall industrial sector) can be found in the subsectors

- Metal ore extraction
- Food and beverages
- Chemical industry
- Other non-metal extraction
- Metallurgical industry

In the field of electricity consumption in addition to the table above also the tobacco sub-sector shows considerable energy efficiency potentials. It is important to note that the **mining sector** consumes about 30% of the total industrial electricity demand, thus increasing energy efficiency in this sector would have a considerable impact. Although the **food industry** is not so big in terms of the current consumption, it is

assumed that an implementation of energy efficient technologies would be able to reduce the energy demand by 35-40% in this sector. The energy saving potential of raising energy efficiency in the chemical industry is estimated at 23%.

The energy saving potential in the **copper, ore, canned food, rubber and metal industries** is estimated up to 52% compared to the baseline energy use. Improved optimization or introduction of technical and other low cost measures already lowered the energy demand in this sector by up to 18%. Design and application of new energy efficient technologies in the production facilities reduced the annual energy demand by 30%. Further, short term measures in regulation of production facilities or energy efficient technologies are estimated to reduce the annual energy consumption by up to 52%.

As specific measures indicated in the USAID report do not allow a link to overall consumption figures, the most important measures in terms of saving potentials are summarized below without relation to further quantification.

The following measures were identified for several branches of the production industry:

- Elimination of failures, improvement of technological processes, organizational measures, decreasing of idling process
- Improvement of thermal insulation of furnaces and heating networks
- Introduction of energy efficient motors and new control systems
- Use of efficient lighting systems
- Organizational measures
- Use of efficient fuel resources (without further explanation in the USAID report)

In the field of **production and distribution of electricity, natural gas, hot water and steam** considerable emission reduction potentials are estimated from the following measures:

- Elimination of failures, improvement of technological processes, organizational measures, decreasing of idling process
- Introduction of new energy efficient technological units and automatization of electric drives
- Installation of gas turbine units in TPPs
- Improvement of thermal insulation of furnaces and heating networks, decrease of losses in gas distribution system
- Reactive power compensation
- Introduction of automatic metering for electricity
- Use of secondary energy and efficient fuel-energy resources
- Valve system improvement.

The following table summarizes the energy saving potentials in the field of **production and distribution of electricity, natural gas, hot water and steam.**

Table 7: Energy efficiency potentials energy production and distribution

Saving potential in production and distribution of electricity, natural gas, hot water and vapor			
applied calorific value natural gas: 36.4 MJ/m³	Gas 1000 m³	Electricity MWh	Gas / Electricity TJ
Installation of gas turbine units in TPPs	488,000		17,763
Improvement of thermal insulation of furnaces and heating networks; decrease of losses in gas distribution system	57,936		2,109
Elimination of failures and improvement of technological processes, organizational measures, decrease of idling process		24,972	90
Introduction of new energy efficient technological units and automation of electric drives		42,495	153
Reactive power compensation		15,088	54
Introduction of automatic metering for electricity		5,898	21
Use of secondary energy and efficient fuel-energy resources		5,935	21
Valve system improvement		2,850	10
Total	**545,936**	**97,238**	**20,222**

Source: Data USAID (2007), own table

4.6 Energy efficiency in SMEs

The table below shows the GDP of SMEs and Large Enterprises in the different branches of economy.

Table 8: Structure of GDP by SMEs and large enterprises in the branches of economy

	2007		2008		2009	
	SMEs	Large	SMEs	Large	SMEs	Large
	%					
Industry	27.9	72.1	22.3	77.7	30.6	69.4
Construction	41.2	58.8	48.5	51.5	37.2	62.8
Trade	47.3	52.7	51.4	48.6	49.4	50.6
Transport and communication	28.6	71.4	20.8	79.2	28	72
Services	42.3	57.7	45	55	45	55
Total GDP*	41	59	41.7	58.3	42.5	57.5

*GDP not including agriculture and net taxes
Source: SME DNC, 2007-2009

As of 01.01.2010 the number of **SME**s in Armenia amounted to 132,923 (SME DNC, 2013). The classification of SMEs in Armenia is shown in the table below.

Table 9: Classification of SMEs

Sector	SMEs		
	Micro (number of employees)	Small (number of employees)	Medium (number of employees)
Industry	5	50	100
Construction and energy	5	25	50
Science and education	5	25	50
Transport, trade and services	5	15	30

Source: SME DNC, 2007-2009

The development of the distribution of large Companies and SMEs during the period 2007 to 2009 is shown in the table below.

Table 10: Distribution of SMEs and large enterprises by the sectors of economy

Sector	2009	
	Large	SME
	%	
Industry	95	5.0
Agriculture	93.4	6.6
Construction	89.6	10.4
Trade	98.9	1.1
Transport and communication	87.3	12.7
Services	90.5	9.5

Source: SME DNC, 2007-2009

Statistics for energy consumptions and detailed assessment of energy efficiency potential in SMEs are currently not available in Armenia. Nevertheless, the available reports (USAID 2007) on energy efficiency potential in Armenia suggest that the following sectors, where SMEs are active have the highest EE potential:

- Trade
- Industry (metal and non-metal mining, chemical industry)
- Food processing

Available data suggests that the following measures have the highest potential and return in the aforementioned sectors:

- Replacement of old equipment
- Utilisation of the variable speed drives
- Thermal insulation
- Energy efficient lighting

4.7 Energy efficiency in the residential sector

The residential sector in Armenia includes a total number of 434,892 appartments and 419,129 dwelling houses. The urban population reached 2.1million people, while the rural population amounted to 1.18 million in 2012 (armstat.am).

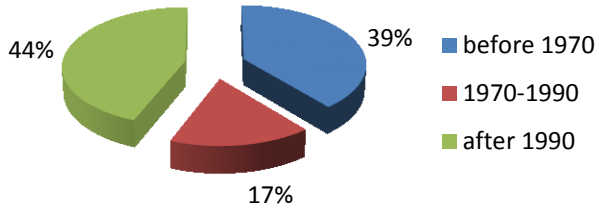

Figure 10: Distribution of the multi-apartment buildings by age
Source: Ministry of Urban Development, 2013

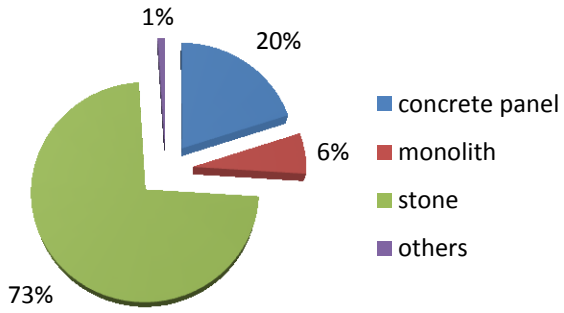

Figure 11: Distribution of the multi-apartment buildings by envelope design
Source: Ministry of Urban Development, 2013

The figures underline that more than half of all multi-apartment buildings are older than 20 years and almost 40% are older than 40 years. The most popular envelope material by far is stone.

In Armenia, **73% of all apartment buildings are stone buildings** (tuff walls or double layer stone with concrete filling). All of these buildings were constructed in urban areas during the 40's, 50's and partly 60's. That is why they are popularly called "Stalinki", "Hrushchovki" and "Czech design" i.e. built during Stalin and Hrushchov rule. Brick apartment buildings have at least three or up to five upper floors and a basement. That type of apartment buildings is made from masonry of classical metric perforated stones (usually local stones like tuff or basalt). The standard thickness of the outdoor wall is 40 / 50 cm, depending on the level of the floor. The walls have exterior lime-cement render with paint finish or exposed masonry. Additional, thermal insulation is almost not practiced at all. The real heat energy consumption of that type of residential buildings varies from **150 to 180 kWh/m^2** and year.

20% of the overall number of apartment buildings in Armenia is built with **concrete panel**. All of these buildings were constructed in urban areas during the 60's, 70's and 80's. About 8 % of all panel buildings are a "tower" type with about 10 to 14 floors. The remaining 92 % of panel buildings are a "line-type", which have between five and 12 floors. During the 60's and 70's mostly "line-type" buildings with a number of floors from six to eight were built. Later constructions built during the 70's and 80's have eight to 12 floors. Major problems of panel apartment buildings are related to the sticks and joints of panels. Most of

these buildings were raised quickly under low construction quality and with the use of cheap materials. Nowadays, the cover of the panel joints is in obsolete condition and needs rehabilitation. Other problems are related to the state of windows and transparent constructions. These have high rate of infiltration, which increases the energy demand of panel buildings. The real heat energy consumption of that type of residential buildings varies from **140 to 210 kWh/m^2** and year.

6% of the overall number of apartment buildings in Armenia is built with monolithic concrete or concrete frame. All of these buildings have been constructed in urban areas from the 70's up to now. Those constructed from the 90's up to now have a skeleton structure with brick wall filling. About 60% of all monolith buildings are a "tower" type with about ten to 14 floors. The remaining 40% are a "line-type" with eight to 12 floors. Outdoor walls have a thickness of approximately 35 cm. The most common type of outdoor walls is expanded clay concrete with expanded clay as a thermal insulating additive. **Additional thermal insulation is almost not practiced** at all. Major problems of monolithic concrete apartment buildings are related to the low insulation value of expanded clay additive, which results in a thermal property lower than initially designed. (Source, Ministry of Urban Development, Interview 2013). Comparing the average heat consumption figures per m² with average figures for Austria high saving potentials can be assumed (according to OIR Guideline 6 (version 2011) max. 54,4 kWh/m²a are allowed for new buildings).

Taking into account the duration of the heating season and the outside average air temperature, the territory of the Republic of Armenia can be divided into four climatic zones:

Table 11: Climatic zones of Armenia and length of the heating season

No	Climatic zone	Heating degree days
1	Shirak, Kotayk and Gegharkunik regional zone	3600-4920
2	Lori-Pambak and Dilijan regional zone	2800-3600
3	Ararat valley regional zone	2400-2800
4	Syunik and Meghri regional zone	1500-2400

Source: Construction norms "Construction Climatology" II-7.61-96 i

For the heating degree days calculation above, a base temperature of 18°C and a heating threshold temperature of 12°C was used. For comparison, the average heating degree days in Vienna amount to 3235 and the Austrian average to 3744 (IFEA, TU Graz – note that this source uses a base temperature of 20°C). The following table shows the distribution of the population of Armenia according to residential property and regional zones.

Table 12: Distribution of the population, according to housing resources and regional zones

Residential buildings	Regional zones (%)				Total in Armenia (%)
	1	2	3	4	
Multi-apartment buildings	25.92	2.29	2.65	5.52	30.38
Private houses (urban)	17.34	1.23	4.20	9.81	32.58
Private houses (rural)	16.21	3.07	2.02	9.74	31.04
Total	59.47	6.59	8.87	25.07	100

Source: Armstat.am

From the figures above it becomes obvious that the majority of people lives in zones with high heating degree days which again underlines the importance of building rehabilitation.

According to the National Program on Energy Saving and Renewable Energy of the Republic of Armenia (USAID 2007) the annual saving potential in the residential sector was estimated to about one third referring to the consumption figures for 2007. The annual saving potential is estimated to 14 PJ, which is more than 10% of the country's annual energy flow. These savings can mainly be achieved with proper thermal insulation of buildings. A further measure could be energy efficient lighting with an annually estimated saving potential of 1 PJ.

4.8 Energy efficiency in the agricultural sector

According to the USAID report (2007), the **agricultural sector** was responsible for about **1.9%** of the total electricity consumption in 2011. The energy intensity of Armenian agriculture sector, which contributes up to 25% of Armenian's GDP (Austria 1.5% according to CIA factbook), is low (around 1.36 MJ/EUR), which shows a low level of mechanization in this sector. Despite this relatively low energy consumption figure, energy efficiency measures in this sector could contribute to the overall efficiency improvement, since the reduction **potential** in this sector compared to the current consumption is considerable as shown in Table 13. Moreover, it is considered crucial for future efficiency figures that additional machines and equipment added to the existing ones show high efficiency values.

The measure with the highest impact is the utilization of gravity flow in irrigation systems, which should reduce the energy demand in this sector by up to 44%. Other identified measures comprise the elimination of failures and the improvement of technological processes as well as the adaptation of operational procedures, decrease of idling process, and implementation of energy efficient technologies and automation of electric drives.

Table 13: Energy efficiency measures in the agricultural sector

Energy efficiency measures	Total energy efficiency potential	
	PJ	%
Elimination of failures and improvement of technological processes, organizational measures, decrease of idling process	0.018	5.5
Introduction of new energy efficient technological units and automation of electric drives	0.04	13.6
Utilization of gravity flow in irrigation systems	0.15	44

Source: USAID, 2007

5 Framework for Energy Efficiency

This section of the report analyzes the framework conditions for carrying out energy efficiency. The main questions to be asked are:

- Is energy efficiency, its actors, targets or specific measures mandated or supported in any legal or policy related document?
- Are the technical capacities in place in Azerbaijan in order to realistically realize specific measures?
- Does it make sense to invest in energy efficiency in the country in economic terms?

5.1 Legal and policy framework

ENERGY LAW OF THE REPUBLIC OF ARMENIA (Republic of Armenia, 2001)
Aim of this law is the regulation of relationships between different entities (government bodies, legal entities of the energy sector operating under this Law, and consumers of electricity, thermal energy and natural gas).

The four pillars of Armenian National Energy Strategy are:

- Utilization of renewable energy sources and improving energy efficiency
- Development of nuclear energy
- Diversification of primary energy resources and import/export routes
- Regional integration and cooperation

One basic principle of the state policy is the encouragement of scientific-technical progress and employment of new energy-efficient and energy-saving technologies. Further, electricity generated of renewable sources by licensed entities shall be purchased within the next 15 years.

THE LAW OF THE REPUBLIC OF ARMENIA ON ENERGY SAVING AND RENEWABLE ENERGY (Republic of Armenia, 2004)
This law defines the principles of the state policy on energy efficiency and usage of renewable energy sources in order to force economic and energy independence, raise energy security, create a new market and reduce technology related adverse impacts on the environment and human health.
Article 5 of the Law describes the main principles of state policy in energy saving and renewable energy:

(i) State policy in the area of energy saving and renewable energy shall be based on the principle of voluntary participation of the involved parties; and
(ii) The principles of state policy in energy saving and renewable energy are:

a. **Increasing the level of supply of indigenous renewable energy** carriers to satisfy the energy demand of the economy;
b. Implementation of energy saving strategies, as well as development and enforcement of legal and economic mechanisms for the promotion of renewable energy;
c. **Ensuring high priority of efficient use** of energy given the increasing volumes of imported and extracted energy resources;
d. Ensuring increasing usage of renewable energy resources as well as the application and development of new renewable energy technologies
e. Ensuring competitiveness of renewable energy resources and protection/enforcement of the rights of businesses engaged in the area of renewable energy;
f. Ensuring high priority of issues of environmental protection and efficient (economic) usage of natural resources while implementing measures/activities aimed at the development of energy saving and renewable energy;
g. Promotion of **energy efficient production of electric and/or heat energy**, including for autonomous energy producers;
h. Promotion of integrated activities between the autonomous energy producers, using renewable energy resources, and the energy system aimed at the exchange of electric energy;

i. Promotion of consumer choices and use of different energy carriers and energy efficiency technologies; and
j. Implementation of energy saving and renewable energy state (national) targeted programs.

As mentioned above the National Program on Energy Saving and Renewable Energy was adopted in 2007. Further, in 2011, the Government has adopted the **National Energy Efficiency Action Plan** (NEEAP). This action plan was established to define concrete actions in order to reach the aims of the national policy to improve energy efficiency and usage of renewable energy sources. The action plan is elaborated for the period 2011-2020.

The Action plan prioritizes following sectors for implementation of EE measures:

- Residential buildings
- Social and private services
- Industry
- Transport
- Water

The following measures are included in the action plan:

- Introduction of regular energy statistics
- Establishment of an EE Agency
- Financial assistance to EE measures in all sectors
- Capacity building programs
- Introduction of EE promotional tariffs for natural gas and electricity
- Implementation of State Energy efficient procurement programs

5.2 Technical framework

No specific studies about availability, publicity demonstration projects or feasibility studies of energy efficiency measures are publicly available. According to a local expert's opinion the provision of the energy efficiency technologies and services has to be considered a new sector in the economy. Following technologies are established in the Armenian market:

- Thermal insulation (based on perlite and rockwool)
- Energy efficiency windows
- Lighting
- Solar heaters

These technologies are well known on the market due to existing production facilities in Armenia.
There are more than 20 Armenian companies producing thermal insulation and more than 100 producing windows. The following table lists relevant local, national and international companies (manufacturers and suppliers), e.g. producers of HVAC-R equipment, boilers, solar water heaters, efficient windows, insulation materials. Detailed analysis will be provided in a separate report.

Table 14: Examples of EE product suppliers

Name of the company	Headquarter
Thermal insulation	
Arjermek	Armenia
Knauf	Austria
Izotoprak	Turkey
Ecoperlite	Armenia
Thermoplex	Armenia
Energy efficient windows	
Rehau	Germany
KBE	Germany
Aluplast	Germany
Salamander	Germany
Veka	Germany
Shuko	Germany
Inline fiber glass	Canada
Energy efficient boilers	
Herz	Austria
Baxi	Italy
Buderus	Germany
Ferolli	Italy
Sime	Italy
Viesmann	Germany
Energy efficient lighting	
OSRAM	Germany
GE	USA
Philips	Netherlands

5.3 Economic framework

The GDP energy intensity (energy consumed per USD of GDP) of Armenia is on a low level and is close to the one of countries such as Estonia, the Czech Republic and Hungary. However, the low GDP energy intensity in Armenia is mainly a result of low installed power per capita (end-use consumption of electricity). The increase of the installed power per capita (towards the developed countries' index) will result in worsening the GDP energy intensity index. This fact has to be taken into account when comparing indices with other countries and also while discussing benchmarks implicitly assuming the same standard of living.

Tariffs for electricity and gas are regulated by the State. Natural gas tariffs were subsidized until May 2008. Since this date, gas tariffs have increased by 42% for small consumers and by 51% for large consumers. The Public Services Regulating Commission is responsible for setting up tariffs of the regulated sectors, including wholesale (feed-in) tariffs and retail tariffs for electricity and natural gas.

Starting from July 7th, 2013 the PSRC set new distribution tariffs. The tariffs are low in comparison to EU member states due to old plants, which lead to the fact that tariffs have a negligible capital cost component. The current tariffs for electricity and natural gas are shown in the table below (converted in EURO) and compared to current EU values.

Table 15: Energy tariffs (VAT included) in Armenia

Electricity	Tariff Armenia (EUR cent/kWh)	Tariff EU-27 (EUR cent/kWh)
35 kV and above connection	5.37	11.5 (average industry)
night-time rate	4.63	
6(10) kV connection	6.48	
night-time rate	6.48	
0.38 kV networks	7.04	
night-time rate	5.18	
residential customers	7.04	18.9 (average residential sector)
night-time rate	5.18	
Natural gas	**Tariff (EUR cent/m³)**	
Monthly consumption < 10,000 m³	29	63
Monthly consumption > 10,000 m³	20	40

Sources: PSRC 1, 2013, PSRC 2, 2013, Exchange rate: 1 AMD = 0.185 EURcent
EU-27 values for 2012: EUROSTAT

The increasing costs of natural gas are essential especially for low-income households. Up to 50% of the income of poor families (the salary threshold of a poor family is 30 000 AMD - around 55 Euro - or lower) is used for heating purposes during winter months.

In 2011, households spent about 56.9% of their total expenditures on food, 27.7% on services and 15.4% on other goods (Armstat 2, 2012). The expenditure for electricity, heating and hot water accounted for about 6.8% of the total expenditure (EBRD, 2005). If these figures are compared with the relevant shares in the EU in 2011 (EUROSTAT, 2011) - (4.5% expenditures for fuel and 13% for food and beverages) - the limited availability for funds to invest in EE measures become apparent. The situation is further worsened by the recent economic crisis. Further impact of the crisis is a restricted crediting policy of banks, which results in difficulties (or even impossibility) for enterprises to obtain a loan.

Public support for RE/EE investments is limited to the feed-in tariff scheme for electricity from renewable sources, which provides preferential tariffs for small hydro power plants < 10 MW, wind power plant and biogas plants. The connection to the grid as well as the purchase is guaranteed for 15 years. Tariffs undergo an annual adjustment based on the consumer price index and the USD/AMD exchange rate.

Payback periods of 3 to 7 years for energy efficiency investments are – according to the study of the USAID “National Program” (2007) – quite high. The financial returns in the utility and industrial sectors are the lowest and the payback periods are longer because the capital expenditures are high.

The greatest returns are expected in the public sector. The highest return on investments in the public sector is achieved with organizational measures which often amortize immediately. By using more energy efficient lighting, repair or replacement of valves in the heat and water delivery systems within government buildings, and the use of variable speed drives high saving potentials can be used. It is estimated that the capital investment for those measures amounts to EUR 255,600 with a payback period of 2-4 years. Public administration buildings have the highest saving potential and the highest returns with a payback period of less than 2 years. Around EUR 3.7 million are needed to realize the potentials in the healthcare, social and education sectors. Those sectors have lower, but still very high positive returns and a payback period of 5-10 years.

Table 16: Payback periods in the public sector

Energy saving measure	Capital cost	Gross annual savings	Payback period	Return on Investment	Total Savings
	(EUR)		(years)	(percent)	(EUR)
Use of energy efficient lighting (in public administration, and health and social and healthcare buildings)	105,000	586,000	<1 year	2,484	2,600,000
Use of variable speed drives in all public buildings	220,000	446,000	1-2 years	1,437	3,550,000
Repair or replace valves in building heating and water systems	107,000	461,000	1-2 years	2,115	1,600,000

Source: Own calculations, based on USAID, 2007

Following two decisions of the Public Service Regulation Commission (PRSC) from 2005 and 2006 respectively, consumers are obliged to install meters both for gas and electricity consumption, which are a prerequisite for energy efficiency measures.

5.4 Awareness and information level

Following barriers for energy efficiency investments have been identified:

Cross- sectoral:

- Lack of sufficient information, skills and data
- Lack of supportive measures and legislation, absence of incentives
- Low and inadequate tariffs (in particularly the natural gas tariff for the consumers with a monthly consumption of more than 10,000 m^3 is 50% lower than for consumers who consume less, which obviously does not promote investments in energy efficiency).

Sectoral:

- Limited borrowing capacity of public administration
- Poor insulation of public spaces in residential buildings and lack of interest and incentives to invest in EE of those spaces.

Energy utility regulation in Armenia (as in many countries) encourages utilities to sell as much as they can to recover their fixed costs, and encourages investment in new production capacity, rather than measures to reduce load.

Managers of industrial companies are aware of energy efficiency but underestimate potentials in their companies. Surveys show that only less than half of the enterprises evaluate energy efficiency as an important business priority and 24% of the companies have not implemented energy efficiency measures at all (IFC, 2008).

6 Conclusion

The existing studies and local experts' experience estimate a huge potential for energy efficiency measures in Armenia.

Estimations of greenhouse gas emissions predict a huge increase in a business as usual scenario until 2020, which is related to an increase in the **local energy demand** for electricity and heat. Investments in rehabilitation and construction of new power plants will be necessary in order to cover the raising demand.

There are programs for energy efficiency and renewable energy approved in **legislation**. The objective of these programs is to reduce the energy demand on one hand and raise the electricity production from renewable energy sources on the other hand. Due to the high energy imports these measure shall also raise energy security in the country.

Energy tariffs of natural gas were subsidized until 2008. Since the subsidization is eliminated the energy tariffs have increased by 41% for small consumers and by 51% for large consumers.

Energy efficiency opportunities exist in all economic sectors and mainly target measures reducing gas and electricity consumption. Improvements of operational procedures, processes and implementation of energy efficient technologies show large saving potentials in the overall industrial sector. Due to raising costs of energy imports and thus high operation costs companies have to reduce energy costs in order to remain competitive.

Target group for EE investments can include energy intensive industries with high capital investing activity as machinery and owners of outdated equipment as food industry, metal ore extracting industry and other energy intensive industries as metallurgy or chemical industry. Considerable potential is also expected in the modernization and upgrade of heat, electricity and steam production and distribution facilities. Further, there is a huge potential in the residential sector for thermal insulation and replacement of heating systems. These technologies are already produced by Armenian companies, whereas this industry can be boosted forcing EE investments in this sector.

According to the local expert's view it is recommended to focus on the following sectors for energy efficiency financing:

- Commercial buildings (hotels, supermarkets): Owners of such buildings are very interested in EE financing due to increasing gas and electricity prices.
- For the residential sector it is proposed to establish a housing renovation facility, which will finance the renovation of the apartments or private houses based on obligatory EE measures (for example the loan is eligible if 50% is spent on EE measures)
- Investments in agriculture: Currently there is a "boom" of construction of green houses in Armenia. Heat pumps, solar heaters, EE efficient heating and ventilation schemes could be the focus of new financing schemes.
- Manufacturing: The food and beverages sector is considered to be an interesting target sector. Own comparisons of energy consumption figures of bakeries with European ones showed that the consumption in Armenia is two times higher than in the EU.

Low awareness is regarded as one of major barriers to prevent penetration of EE technologies in Armenia. Capacity building programs are considered indispensable, however they should apply new methods and approaches, since the 5 capacity buildings programs implemented in Armenia in the last years by different donors did not show the expected results.

7 Relevant Institutions

The following table provides an overview of institutions relevant for EE in Armenia.

Table 17: Relevant institutions

State bodies	
Ministry of Energy and Natural Resources	The Ministry of Energy and Natural Resources is responsible for the energy sector, including the reform process. The Ministry is supported by other organizations, such as the Energy Research Institute and the Energy Strategy Centre. The main activity of the ESC includes the elaboration of the energy policy, feasibility and audits of energy projects, demand side management and renewable energy.
Armenia Renewable Resources and Energy Efficiency Fund (R2E2)	Armenia Renewable Resources and Energy Efficiency Fund (R2E2) is responsible for the facilitation of investments in EE and RE sectors, promote the development of EE and RE markets in Armenia and increase the use of clean, efficient, safe and affordable heating technologies in multi-apartment buildings and schools in Armenia.
Public Services Regulatory Commission (PSRC)	The Energy Regulatory Commission is responsible for licensing of entities operating in the regulated sectors, coordination of reporting by licensed entities, setting up tariffs for the regulated sectors, including wholesale (feed-in) tariffs and retail tariffs, regulation of contractual agreements between licensed entities involved in energy and/or natural gas provision, as well as between licensed entities and final consumers, setting up market rules, setting up quality requirements for the regulates sectors and assessment of development plans of licensed entities and adjustment of the existing tariffs to meet the investment requirements.
Private institutions	
Armeria Group, Energy Advisory, Energocor, AE Consulting, Scientific Energy Institute	These companies also offer energy efficiency consulting, which is, however, not the core business of these enterprises.
ERA LLC, Hydroenergetika LLC, Hydro Design Institute	These companies offer project development of hydro power projects. The renewable energy consulting market is more developed in Armenia than the EE market. The reason therefore is the rapid development of small hydro power plants in this country. The size of the consultancy market for SHPP (design, engineering etc) can be estimated to be 520,000 – 740,000 EUR consultancy market for SHPP e.g. design, engineering, etc in the period of 2014-2016. However, there are no consulting companies, which are specialized on other renewable energy projects (wind, PV, biomass).

8 Literature

Armenia Renewable Resources and Energy Efficiency Fund, 2008, *The Potential for Improving Energy Efficiency in Armenia, Report to the World Bank,* http://r2e2.am/wp-content/uploads/2012/07/The-Potential-for-Improving-Energy-Efficiency-in-Armenia.pdf

ABB, 2012, *Turkey Energy Efficiency Report*, www05.abb.com/global/scot/scot316.nsf/veritydisplay/bcfe8957cb2c8b2ac12578640051cf04/$file/turkey.pdf

Armstat 1, 2012, *National Statistical Service of the Republic of Armenia - Industry*, www.armstat.am/file/doc/99474793.pdf [last access 15th of July 2013]

Armstat 2, 2012, National Statistical Service of the Republic of Armenia - *Living Conditions – Incomes of Population*, www.armstat.am/file/doc/99471443.pdf [last access 15th of July 2013]

EBRD, 2005, European Bank for Reconstruction and Development, Can poor consumers pay for energy and water? An affordability analysis for transition countries, www.ebrd.com/downloads/research/economics/workingpapers/wp0092.pdf [last access 15th of July 2013]

EDRC, 2011, Economic Development and Research Center, *Assessment of Heat Supply and Heating Options in Multi-Apartment Blocks in Armenia*, http://r2e2.am/wp-content/uploads/2012/01/Termo-Small-Eng.pdf [last access 15th of July 2013]

ERIA, 2007, Energy Research Institute of Armenia, *National Program on Energy Saving and Renewable Energy of Republic of Armenia*, www.renewableenergyarmenia.am/download/National_Program_English_Draft_Part_1.pdf , [last access 15th of July 2013]

EUROSTAT, 2011, http://epp.eurostat.ec.europa.eu/statistics_explained/images/b/b9/Shares_of_different_types_of_expenditure_between_2001_and_2011.png [last access 15th of July 2013]

IFC, 2008, *Energy Efficiency: a new resource for sustainable growth, Researching energy efficiency practices among Armenian companies*, www.ifc.org/wps/wcm/connect/4d383f80404cd15a87429782455ae521/ArmeniaEESurvey.pdf?MOD=AJPERES [last access 15th of July 2013]

IFEA, TU Graz, Institute für technische Anlagen, 2013, *Klimatabelle,* www.ifea.tugraz.at/hp_old/heizlast/wertetab2.htm [last access 7th of October 2013]

LLNL, 2011, Lawrence Livermore Laboratories, C. A. Smith, R. D. Belles, A. J. Simon, 2007 *Estimated International Energy Flows*, https://e-reports-ext.llnl.gov/pdf/473335.pdf

MINEENERGY, 2007, Ministry of Energy and Natural Resources of the Republic of Armenia, *National Program on Energy Saving and Renewable Energy of Republic of Armenia,* www.minenergy.am/images/stories/documents/national__program_english.pdf, [last access 7th of October 2013]

Ministry of Urban Development, 2013, Personal interview with a representative of Ministry of Urban Development, Samvel Srapyan, Position - Head of Housing Stock Management and Communal Policy Division, Interview on: 23.08.2013

MNP, 2010, Ministry Of Nature Protection, *Second National Communication*, under the United Nations Framework Convention on Climate Change, http://unfccc.int/resource/docs/natc/armnc2e.pdf [last access 16.07.2013]

Oesterreischisches Institut für Bautechnik OiB (2007a), *OIB Richtlinie 6,* www.oib.or.at/RL6_061011.pdf

PSRC 1, 2013, Public Services Regulatory Commission of the Republic of Armenia, http://psrc.am/am/?nid=236, [last access 10th of October 2013]

PSRC 2, 2013, Public Services Regulatory Commission of the Republic of Armenia, http://psrc.am/download.php?fid=19489 , [last access 13th of October 2013]

Republic of Armenia, 2001, *Energy Law OF THE REPUBLIC OF ARMENIA*, Section 1, General Provisions, www.google.at/url?sa=t&rct=j&q=energy%20law%20of%20the%20republic%20of%20armenia&source=web&cd=1&ved=0CCwQFjAA&url=http%3A%2F%2Fwww.erranet.org%2Findex.php%3Fname%3DOE-eLibrary%26file%3Ddownload%26id%3D2407&ei=-p_iUcGnLcPvObXFgFg&usg=AFQjCNEYIvCE7ojCJNY6JRc-V5Mo3VtGcA&cad=rja

Republic of Armenia, 2004, *The law of the Republic of Armenia on energy saving and renewable energy*, www.parliament.am/legislation.php?sel=show&ID=2119&lang=eng [last access 15th of July 2013]

Republic of Armenia, 2010, *National Energy Efficiency Action Plan 2010*, www.nature-ic.am/res/pdfs/documents/strategic/draft-report_based-on-protocol_N43_06.11.10_eng.pdf, [last access 15th of July 2013]

Republic of Armenia, 2008, *: The Potential for Improving Energy Efficiency in Armenia*, Report to the World Bank, http://r2e2.am/wp-content/uploads/2012/07/The-Potential-for-Improving-Energy-Efficiency-in-Armenia.pdf

SME DNC, 2007-2009, *Small and Medium Entrepreneurship Development National Centre of Armenia*, www.smednc.am/?laid=1&com=module&module=menu&id=189. [last access 8th of October 2013]

SME DNC, 2007-2009, *Share of Industry, SME, Agriculture and Residential sector in Armenia by their contribution to Gross Domestic Product (GDP),* Reference book Small and medium entrepreneurship sector in Armenia 2007-2009, www.smednc.am/download.php?f=1252&fc=REFERENCE%202007-2009%20english.pdf [last access 7th of October 2013]

SME DNC, 2007-2009, *Structure of GDP by SMEs and Large Enterprises in the branches of economy, Reference book Small and medium entrepreneurship sector in Armenia 2007-2009*, Page 12, www.smednc.am/download.php?f=1252&fc=REFERENCE%202007-2009%20english.pdf [last access 8th of October 2013]

SME DNC, 2007-2009, Distribution of SMEs and large enterprises by the sectors of economy, in 2007-2009, *Reference book Small and medium entrepreneurship sector in Armenia 2007-2009*, *Page 23,* www.smednc.am/download.php?f=1252&fc=REFERENCE%202007-2009%20english.pdf [last access 8th of October 2013]

SME DNC, 2007-2009, The Classification Criteria of SME units, *Reference book Small and medium entrepreneurship sector in Armenia 2007-2009*, *Page 5,* www.smednc.am/download.php?f=1252&fc=REFERENCE%202007-2009%20english.pdf [last access 8th of October 2013]

USAID, 2007, *National Program on Energy Saving and Renewable Energy of Republic of Armenia*, www.minenergy.am/images/stories/documents/national__program_english.pdf

USAID, 2007, *Energy efficiency measures in the agricultural sector National Program on Energy Saving and Renewable Energy of Republic of Armenia*, Page 42, www.minenergy.am/images/stories/documents/national__program_english.pdf

Oesterreichische Entwicklungsbank AG

1011 Vienna, Austria
Strauchgasse 3
Tel. +43 1 533 12 00-0
Fax +43 1 533 12 00-5262
office@oe-eb.at
www.oe-eb.at