Final

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ALLIANCE TO SAVE ENERGY

Municipal Network for Energy Efficiency - Armenia

Armenia:

Building Energy Efficiency Market Assessment

Yerevan, 2007

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PREFACE

The present study aims to provide a holistic assessment of the energy efficiency market in Armenia's buildings sector – largely comprised of residential buildings – the second fastest growing energy consumer.

The market assessment draws upon the earlier research conducted by the Alliance to Save Energy and attempts to evaluate the potential demand for energy efficiency products and services in the residential sector, as well as reveal the capacity of the market to satisfy this demand. The present assessment is part of a larger effort underway within the framework of the USAID Municipal Network for Energy Efficiency Program to address the issues of building energy performance in Armenia and the current legal framework (including standards and building codes) and market capacity to come up to the modern standards of building energy efficiency.

The assessment is targeted at existing building managers and owners, as well as designers and constructors of new buildings. To help guide the reader, the assessment provides an introduction to the energy efficiency measures applicable in the residential sector. Considering the significant lack of awareness among the parties involved in designing new buildings, the assessment also provides background on the materials and technologies involved.

The assessment includes an overview of the companies which supply energy efficiency products, including the types and parameters of thermal insulation, lighting and glazing supplied, as well as provide energy efficiency market services.

As the Armenian finance market does not presently have a designated financing mechanism for energy efficiency investments, the assessment further provides an overview of the current commercial financing available from the Armenian banking sector, which can be pursued for investment projects, including energy efficiency.

INTRODUCTION: Current Status of Energy Efficiency in the Armenian Economy

At the session of the Armenian Government held on 18 January 2007, the National Program on Energy Saving and Renewable Energy (ESRE) was approved.

The ESRE National Program was developed with technical assistance from the United States Agency for International Development (USAID) within the framework of the Municipal Network for Energy Efficiency (MUNEE) implemented by the Alliance to Save Energy (ASE). Over the past five years, the MUNEE Program has focused on energy efficiency policy reform needs through the development of the Armenian Energy Efficiency Council, technical assistance to the drafting of the Energy Saving and Renewable Energy Law (adopted in 2004), the aforementioned ESRE National Program, and more recently the energy efficiency standards and building energy codes.

The ESRE National Program[1] development provided an unprecedented cross-sectoral assessment of energy saving and renewable energy potential in the Armenian economy, and recommended actions for cost-effectively utilizing this potential. All large and energy intensive enterprises have undergone an in-depth energy examination, end-use consumption data was collected for all 35 economic sectors by all fuel types filling a five-year statistical gap in the Armenian energy balance. This allowed revealing the consumption trends, making projections, drawing comparisons with other comparable countries and, most importantly, calculating the nationwide, sector-specific and enterprise-level energy saving potential.

Some of the noteworthy sectors with the largest potential estimated in and highest priority assigned are as follows:

- 40% of national energy saving potential is in building sector. Building weatherization can save up to 30% thermal energy necessary for space heating equivalent to:
    - 3.35 million GCal in residential buildings; and
    - 0.67 million GCal in public/tertiary buildings.

[1] For more information, see http://www.munee.org.

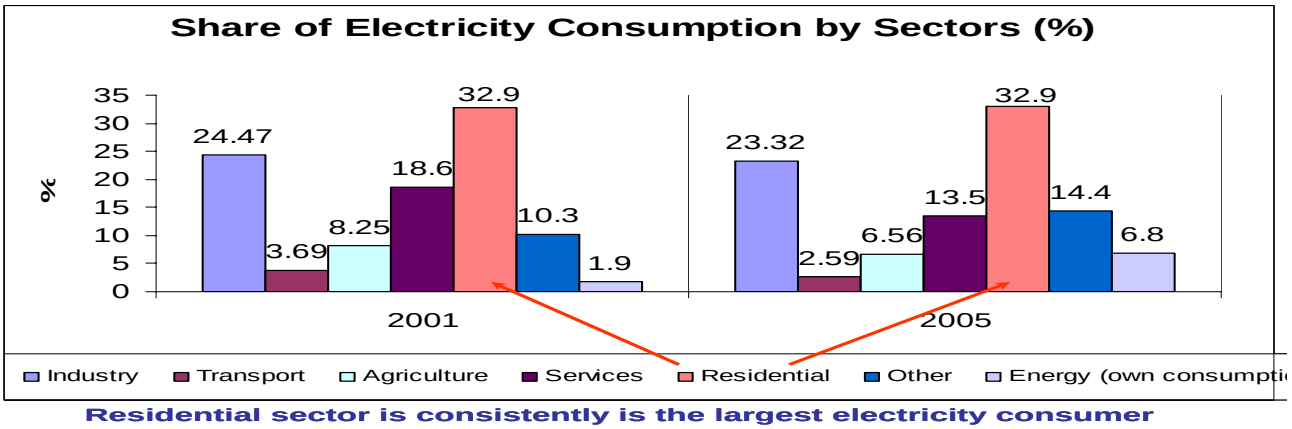
- 15% energy reduction potential was identified in water supply and irrigation;
- Optimization of lighting was calculated to save 475 million kWh over the next 10 years;
- Industrial energy efficiency measures were estimated to reduce energy use:
    - By 5% in mining industries;
    - By 23% in chemical industry; and
    - By 35-40% in food industry.
- 210 MW new gas turbine installation and transition to fuel conservation mode would annually save Yerevan Thermal Power Plant (TPP) from 184 to 265 million m^3 natural gas;
- Retrofitting of the fifth unit of Hrazdan TPP would annually save 223 million m3 natural gas; etc.

The National Program proposed 16 categories of energy efficiency measures (including technical, institutional, administrative, financial, etc.), setting a nationwide cut in energy use by 1 million t.o.e. annually.

Armenia can meet only up to 8% (35%, including the nuclear power) of the total demand for energy with its domestic energy resources, thus it is highly dependant on the imported energy resources. In addition, the energy efficiency of Armenian economy is much lower than the energy efficiency of the developed countries in the region. The existing technologies in Armenia have an efficiency coefficient that is many times lower than that of the newer or best available technologies.

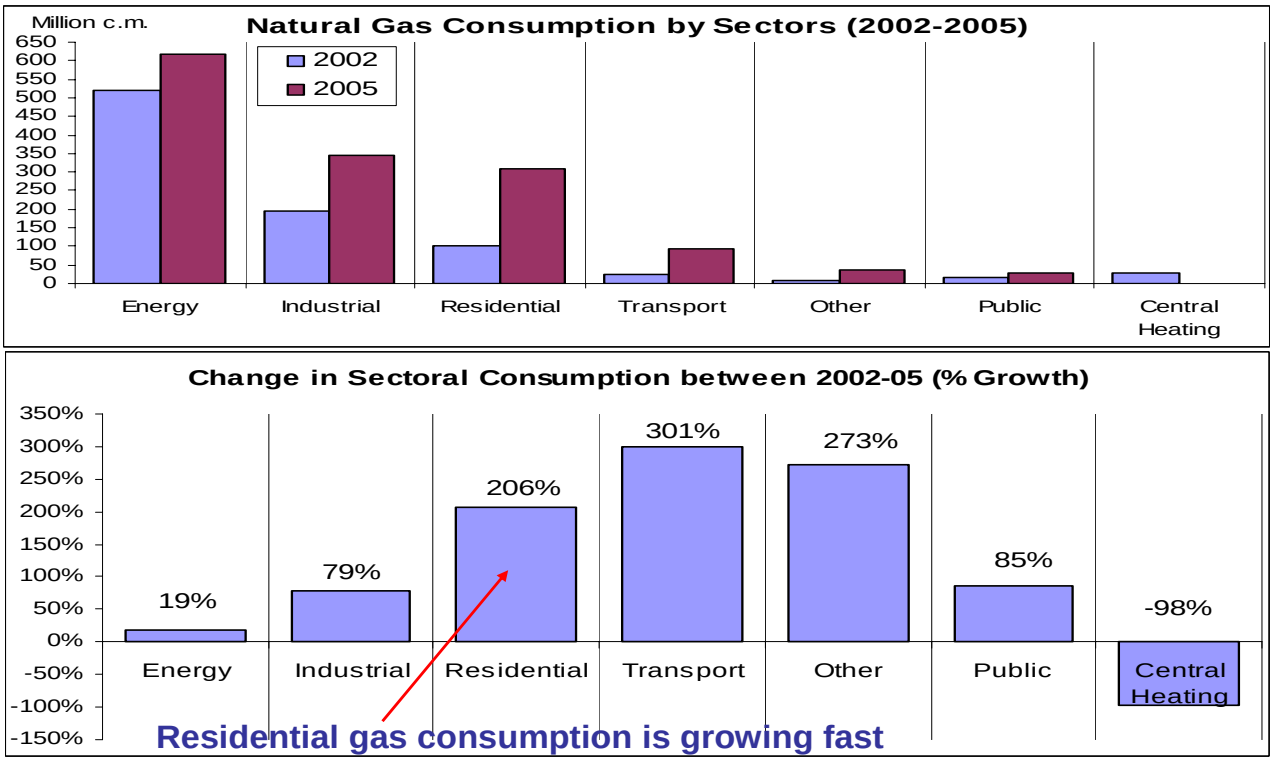
Thus, in order to secure the sustainable development of Armenia, the priority for the energy sector is to decrease the dependence on foreign energy resources through development of domestic energy resources, which implies a significant increase of energy efficiency in the whole economy and widespread utilization of renewable energy resources.

Figure 1. Armenia: Current Sectoral Electricity Consumption



Residential sector is consistently is the largest electricity consumer

Figure 1. Current Structure of Gas Consumption



This is of particular importance in the residential sector where electricity consumption is the largest (Figure 1) and gas consumption (Figure 2) is third largest and second fastest growing.

Moreover, the residential sector was found to have the largest potential for energy saving. The energy saving potential in the different end-use sectors of the economy is presented in table 1.

Table 1. Annual Energy Saving Potential in the End-use Sectors in Armenian economy

N	Sectors	ES potential	ES potential, 1000 toe	CO2 emission reduction, 1000 t.
1	**ES excluding transport and building heating systems (including industry, water supply, etc.)**	1,035,658 MWh	89.05	164.8
		84,734,000 m^3 (natural gas)	75.40	161.6
2	**ES in transport sector**	293.4 TJ	7.01	3.9
3	**ES in buildings**	**4.02 mln GCal**	**402.00**	**2.3**
	Total for these sectors		***573,46***	***331,52***

The key measures necessary for utilization of the energy saving potential in the buildings sector, in addition to administrative and institutional measures, are as follows:

1. thermal insulation;
2. efficient lighting; and
3. installation of modern, efficient windows.

The further sections of this paper analyze the market capacity to supply equipment and services for implementing the above measures. The efficiency improvements in the building heating systems are not included as the heating system is viewed as a separate infrastructure, which was covered in an earlier MUNEE assessment "The Armenian Heat Supply and Heating Equipment Market Assessment".[2] In addition to the conventional building energy efficiency measures, the present assessment also addresses the potential energy saving solutions with application of solar water heating.

Each of the following sections provides a brief background on the particular energy conservation method, types of materials applicable, and their availability and features in the Armenian market. The present assessment also includes a section on energy service companies which can help develop and implement energy efficiency projects with the application of modern technological solutions.

[2] Available in English and Armenian in the MUNEE Library at http://www.munee.org/go.idecs?c=57.

1. THERMAL INSULATION

Thermal insulation is the most effective way to improve the energy efficiency of the buildings and reduce energy bills. Thermal insulation of the building envelope helps preserve the indoor heat during the winter, while keeping the buildings cool during summer, improving comfort and saving energy. The annual thermal energy consumption for residential heating purposes in Armenia is 11.15 million GCal. In case of proper thermal insulation of residential buildings, the thermal energy consumption can be decreased by 30% accounting to 3.35 million GCal per annum. The annual energy saving potential in municipal buildings as a result of improved thermal insulation is estimated to be 0.67 million GCal. While the present report only focuses on building applications, the same thermal insulation materials have a wide range of applications, including in the industrial sector.

Table 2 shows the usual heat losses from different wall types under various climate zones and the potential heat energy savings when insulation of different thickness is applied.

Table 2. Heat losses from non-insulated walls and annual savings after insulation (thous. kCal/m2 year)

Structure of the wall	Heat energy components	Climate zone				
		I A[3]=4000	II A=3300	III A=2650	III[3] Yerevan A=2380	IV A=2200
1. One-layer concrete wall	Annual heat losses from non-insulated wall	102.1	84.3	67.7	60.8	56.2
	Insulation thickness (δ)	Annual savings				
	δ = 3 cm	39.8	32.8	26.4	23.7	21.9
	δ = 5 cm	52.5	43.3	34.8	31.2	28.9
	δ = 10 cm	69.5	57.3	46.1	41.4	38.2
2. Stone Midis laying *(double layer stone*	Annual heat losses from non-insulated wall	81.3	67.1	53.9	48.4	44.7

[3] A – degree -days of heating season

with concrete filling)	Insulation thickness (δ)	Annual savings				
	δ=3 cm	27.5	22.7	18.2	16.4	15.1
	δ=5 cm	37.4	30.9	24.8	22.3	20.6
	δ=10 cm	51.1	42.1	33.9	30.4	28.1
3. Stone wall *(single stone layer)*	Annual heat losses from the non-insulated wall	96.0	79.2	63.6	57.1	52.8
	Insulation thickness (δ)	Annual savings				
	δ=3 cm	36	29.7	23.9	21.4	19.8
	δ=5 cm	48	39.6	31.8	28.6	26.4
	δ=10 cm	64	52.8	42.4	38.0	35.2

The insulation market in Armenia is represented by perlite, glasswool, rockwool and polystyrene insulation. Perlite and rockwool insulation materials are produced locally. Glasswool insulation materials is imported from Turkey and Iran. Polystyrene is produced locally as well as imported from Turkey. The insulation materials produced in Turkey are imported through the territory of Georgia. It is worth mentioning that foreign suppliers of thermal insulation do not have official representatives in Armenia.

PERLITE INSULATION

Figure 3. Perlite slabs and sand

Perlite is an amorphous volcanic glass that has relatively high water content. When reaching temperatures of 850–900°C, perlite softens (due to its glass nature) and water trapped in the structure escapes and this causes the material expand to 7–15 times of its original volume. The expanded material is brilliant white, due to the reflectivity of the trapped bubbles. The bulk density of unexpanded ("raw") perlite is around 1100 kg/m³ (1.1g/cm³).

Whereas, the bulk density of typical expanded perlite is 30–150 kg/m³. Due to its low density and relatively low price, perlite has found many commercial applications. In particular, it is used in lightweight plasters and mortars, insulation and ceiling tiles in the construction and manufacturing fields.

The local producers supply the market with the following thermal insulation materials manufactured based on expanded perlite. The specifications and prices for perlite insulation are fairly uniform for all producers and are presented in tables 3 and 4, hence will not be specified by suppliers.

Table 3. The Specifications of the Perlite Insulation Materials

Product	Density, kg/m^3	Thermal Conductivity, $Wt/m\ ^0C$
Perlite fibrous slabs	175±25	0.05-0.053
Perlite insulation on non-organic binder (segments and slabs)	275±25	0.06-0.07
Flexible Perlite Insulation (mats)	80-120	0.04-0.045
Perlite Expanded Sand	50-100	0.038-0.043

Table 4. The prices of the thermal insulation based on perlite*

Name	Unit	Price (AMD)
Expanded perlite	m^3	12,000 – 14,000
Perlite slabs	m^2	1,300 – 1,500
Thermal insulating package with water proofing layer (thickness:10 cm)	m^2	2,600 – 2,700

** - based on information provided by suppliers in personal interviews.*

The following section lists the perlite-based insulation manufacturers – ArmPerlite, Ariko Perlit and EcoPerlit LTD and their contact information.

PERLITE INSULATION MANUFACTURERS

ARMPERLIT Ltd

Address	**4, Tigran Metsi Ave. Yerevan, RA**
Phone	+ (37410) 580043, 562800
Fax	+ (3410) 580043
Director	**Armen M. Mkrtchyan**

ARIKO PERLIT CJSC

Address	**49, Komitas str. Yerevan, RA**
Phone	+ (37410) 239 212
Fax	+ (3410) 239 232
E-mail	ariko-perlit@rambler.ru
Director	Y. Militosyan

ECOPERLITE LTD

Address	**40a Acharyan Str.., Yerevan, RA**
Phone	+ (37410) 616 804
Fax	+ (3410) 616 804
E-mail	ecoperlite@web.am
Director	H. Hakobyan

STONEWOOL INSULATION

Stone (basalt) wool or rockwool is a furnace product of stone molten at 1600°C and blown by a stream of air or steam. More sophisticated production techniques are based on spinning the molten rock (lava) on high-speed spinning wheels. The final product is a mass of fine intertwined fibers with a typical diameter of 3 to 12 micrometers. Mineral wool may contain a binder and an oil to reduce dusting and making it water repellent (hydrophobic).

Figure 4. Basalt super thin fiber and its application

Arjermek LTD is the only producer of stone wool in Armenia. The production technology is based on so-called super thin basalt fiber (BSTF). Basalt super thin fiber (See Figure 4) is the layer of mixed up staple fibers, fastened together by natural bond forces. BSTF has high heat and sound insulation properties (thermal conductivity - 0.036 Wt/m 0C), low hygroscopic property4 (8 times lower then that of glass fiber), high chemical stability to neutralizing and acid conditions, high application temperature. The Company has annual capacity about 100,000 m^2 of rockwool blankets (thickness 7 cm) with the average selling price 1,000 AMD/m2. In 2006, with the financial support from USAID, the company has established a new production line which allowed cutting energy consumption by 30%.

Rockwool is also imported in small, insignificant quantities from Finland (produced by Parok Company). No single official distributor exists; the shipments are usually sporadic, accompanying other merchandise.

ARJERMEK Ltd

Address	**Hrazdan TPP territory-3, Hrazdan, RA**

[4] Hygroscopy is the ability of a substance to attract water molecules from the surrounding environment through either absorption or adsorption.

Phone	+ (37491) 214 610
Fax	+ (37410) 444 448
E-mail	g.arabyan@gmail.com
Director	H. Arabyan

GLASSWOOL INSULATION

After fusion of a mixture of natural sand and recycled glass at 1,450°C, the produced glass is converted into fibers. The original feature of the standard production technology – Isover TEL process – lies in the combination of centrifugal drawing of the glass and its refining in a flow of hot gas. The cohesion and mechanical strength of the products are obtained by the presence of a binder that "cements" the fibers together. Ideally, a drop of bonder is placed at each fiber intersection.

This fiber matt is then heated to around 200°C (to polymerize the resin), and is calendered (pressed) to give it strength and stability.

Figure 5. Structure of Glasswool Imports, Armenia

The final stage involves cutting the wool and packing it in rolls or panels under very high pressure before palletizing the finished product in order to facilitate transport and storage. The fiberglass is imported to Armenia from Turkey (through the territory of Georgia), Iran and EU (see Figure 5). The prices of the glasswool range between 850-1200 AMD/m^2.

The following section lists the manufacturers of glasswool imported to Armenia and their contact information.

PRODUCERS OF GLASSWOOL

Izotoprak Insulation Factory

Izotoprak Glass Wools Factory (Turkey, since 1996) has an annual production capacity of 11,000 tons. Glass wool products are manufactured in the form of coated and uncoated mattresses (See Figure 6), plates, and cast and prefabricated pipes. Izotoprak carries out its operations as per TS-EN ISO–9001:2000 Quality Assurance System.

The company supplies glasswool blankets (See Figure 6) to Armenia with the specifications presented in the Table 5.

Figure 6. Glasswool Blanket Coated with Alu-Foil, Isover

Table 5. The Specifications of the Glasswool Blankets, Isotoprak

Density, kg/m^3	11
Thermal conductivity, W/mK	0.037
Thickness, cm	5
Packing (m^2/rolls)	12
Facing	Un-faced, Alu-foil

ISOCAM A.S.

Address	Dilovasi Mevkii, Gebze 41455 KOCAELI
Phone	+ 902627546390
Fax	+902627546162
E-mail	izoposta@izocam.com.tr

Izocam (1965) belongs to the largest in Turkey Koc group which is the biggest group and has 108 conglomerates. Izocam offers a wide product range of insulation materials for buildings and industrial sectors.

The product line has the following capacities:

- Glasswool 30,000 ton/year;

Table 6. The Specifications of the Glasswool Blankets, Isocam

Density, kg/m^3	12
Thermal conductivity, W/mK	0.037
Thickness, cm	5
Packing (m^2/rolls)	12
Facing	Un-faced, Alu-foil, Kraft paper

- Stonewool 25,000 ton/year;
- Extruded polystyrene 125,000 m^3/year;
- Expanded polystyrene 3,180 ton/year (board), 4000 ton/year (mould); and
- Elastomeric rubber 500 ton/year.

The company holds the ISO 9001 quality certificate, ISO 14001 environmental assurance certificate. The company supplies glasswool blankets to Armenia with the specifications presented in the Table 6.

POLYSTYRENE INSULATION

Polystyrene (also often referred to as "foam plastic") is a polymer made from the monomer styrene, a liquid hydrocarbon that is commercially manufactured from petroleum. At room temperature, polystyrene is normally a solid thermoplastic, but can be melted at higher temperature for molding or extrusion, then re-solidified. Styrene is an aromatic monomer, and polystyrene is an aromatic polymer.

Figure 7. Polystyrene Insulation

Polystyrene's most common use is as expanded polystyrene (EPS). Expanded polystyrene is produced from a mixture of about 90-95% polystyrene and 5-10% gaseous blowing agent, most commonly pentane or carbon dioxide. The solid plastic is expanded into foam through the use of heat, usually steam. Extruded polystyrene (XPS), which is different from expanded polystyrene (EPS), is commonly known by the trade name Styrofoam. The voids filled with trapped air give it low thermal conductivity. This makes it ideal as a construction material and it is used in structural insulated panel building systems. Expanded polystyrene's is significantly more flammable than the extruded polystyrene, which makes it undesirable for internal weatherization.

Production methods include sheet stamping (PS) and injection molding (both PS and HIPS).

The market in Armenia is represented by the EPS produced locally and imported from Turkey. The main producer of EPS is Prof AL LTD (See figure 7).

The specifications of the polystyrene insulation are presented in the Table 7.

Table 7. The Specifications of the Polystyrene Insulation

Density, kg/m^3	15 - 23
Thermal conductivity, W/mK	0.028-0,035
Thickness, cm	5 - 15

PROF AL LTD

Address	**1 Paronyan St., Yerevan 0015,,**
Phone	+ (374 10) 544 296, 544 291, 398 711, 398 712
Fax	+ (374 10) 544294
E-mail	info@profalonline.com
Url	http://www.profalonline.com
Director	Makar P. Mkrtchyan

2. LIGHTING

With current widespread use of inefficient lighting such as incandescent and halogen lamps (about 95-97% of the market) and very limited use of efficient lighting (including compact fluorescent bulbs, motion sensor- and time-operated controlling equipment) energy efficient lighting in Armenia is one of the most important areas for energy saving. Introduction of energy efficient light-bulbs can cut the electric energy consumption by about 470 million kWh annually in 10-year period through. Notwithstanding that the market is still dominated by the energy inefficient lighting, the interviews with lighting equipment suppliers showed that there are positive dynamics in sales of the compact fluorescent lamps (CFLs). The following producers represent the supply on the CFL market: Osram, General Electric and Philips (Osram and Philips products are presented in Figures 8 and 9).

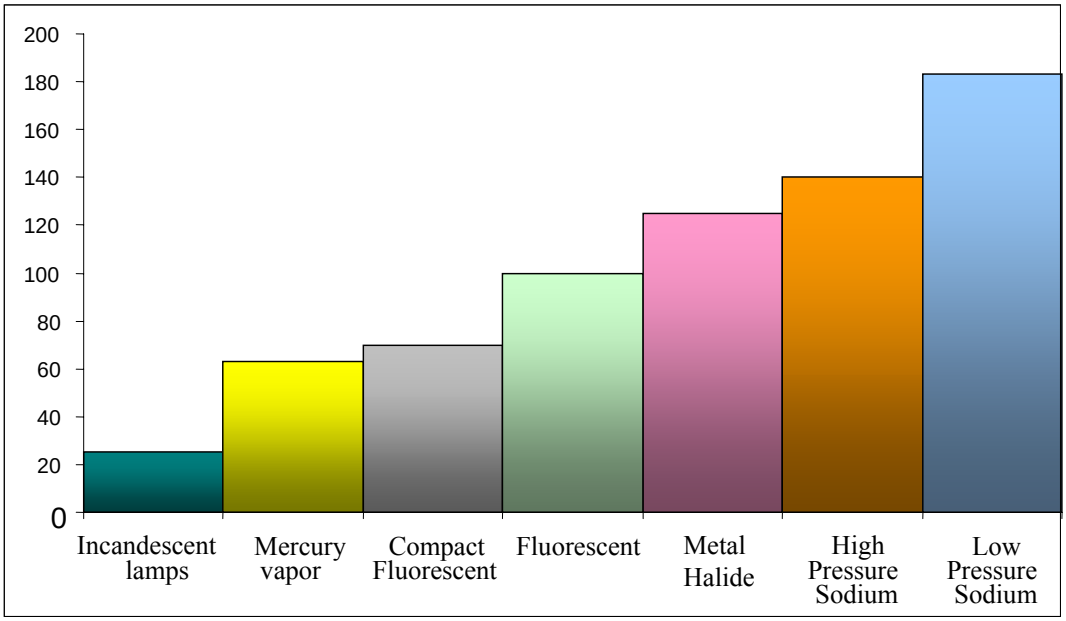
Figure 9. Compact Fluorescent Lamp, Philips

Figure 10. Compact Fluorescent Lamps, Osram

The street lighting also has a huge potential for energy saving. The street-lighting pilot project implemented by USAID with the municipality of Kapan demonstrated that simple replacement of existing non-efficient lamps with efficient ones led to 40% of saving. Similarly, the municipality of Yerevan has already started to exchange the existing inefficient mercury lamps with Natrium lamps which will lead to 30-40% energy saving. The main supplier of lamps for street lighting is Osram.

In order to compare the efficiency of different types of lighting sources in terms of their light productivity per used energy Lumens per Watt (LPW) can be used. Figure 10 below shows the relative efficiency of various lamp types.

Figure 10. The efficiency of light sources (in LPW)[5]



The following section lists the manufacturers of efficient lighting equipment imported to Armenia and their local contact information.

EFFICIENT LIGHTING PRODUCT SUPPLIERS

EUROTECHNOLUCE SHOWROOM

Address	**15a Alex Manoogian St., Yerevan 0070**
Phone	+ (374-10) 572 300
Fax	+ (374-10) 555 498
Director	**Andre Kourtian**
Distributor of:	GENERAL ELECTRIC (Belgium-USA); GEWISS (Italy); LEGRAND (France); MARLANVIL (Italy); MERLIN GERIN (France); OSRAM (Germany); PHILIPS (Netherlands); PICCOZZO LIGHTING (Italy); RADIUM (Germany);SYLVANIA (Germany); VOSSLOH SCHWABE (Germany)

LUYS SPECIALIZED CHAIN STORE

Address	**Vardanants St. 22; Vardanants St. 26, Yerevan 0070**
Phone	+ (374-10) 570 108
Fax	+ (374-10) 570 801
Director	**Hrach Vardanyan**
Distributor of:	Dorma (Germany); Eco (Italy); General electric (USA); Leuchi (Italy); Mazda (Belgium); Narvan (Germany); Osram (Germany); Philips (Netherlands); Radium (Germany); Reico (Italy); Silvania (USA); Vossloh schwabe (Germany)

[5] Source: www.wbdg.org

3. WINDOWS

The old-fashioned and worn-out windows still represent a large share in Armenia's building stock and serve as a major source of unwanted heat loss, discomfort, and condensation problems. In recent years, windows have undergone a technological revolution. It is now possible to have lower heat loss, less air leakage, and warmer window surfaces that improve comfort and minimize condensation. The installation of energy efficient windows can result in 25% of energy consumed for heating purposes. [6]

Windows can gain and lose heat in the following ways:

- Direct conduction through the glass or glazing, frame, and/or door,
- The radiation of heat into a house (typically from the sun) and out of a house from room-temperature objects, such as people, furniture, and interior walls, and
- Air leakage through and around windows.

These properties can be measured and rated according to the following energy performance characteristics:

R-value - the measure of the window's thermal resistance to heat conduction, windows with higher R-values are more energy efficient. It's usually expressed in units of $m^2 \cdot °C/Wt$[7].

Air leakage - the rate of air infiltration around a window, door, or skylight in the presence of a specific pressure difference across it. It's expressed in units of kg/m^2*h. A product with a low air leakage rating is tighter than one with a high air leakage rating.

Visible transmittance (VT) - the fraction of the visible spectrum of sunlight (380 to 720 nanometers), weighted by the sensitivity of the human eye, that is transmitted through a window's, door's, or skylight's glazing. A product with a higher VT transmits more visible light. VT is expressed as a number between 0 and 1 or in percents.

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[6] http://www.eere.energy.gov
http://www.efficientwindows.org/

[7] The new Inter-state construction norms (building code) on Energy Efficiency in Buildings propose minimum performance requirements for all the components of the buildings, including windows. Particularly, the required R-value for the buildings located in Yerevan is about 0.35 $m^2 \cdot °C/Wt$.

A brief description of the technical features of the key window types is presented below, while Table 8 provides information on the properties and prices of the frames currently used in Armenia.

ALUMINUM

Aluminum window frames are light, strong, durable, and easily extruded into the complex shapes required for window parts. Aluminum frames are available in anodized and factory-baked enamel finishes that are extremely durable and low-maintenance. The biggest disadvantage of aluminum as a window frame material is its high thermal conductance. It readily conducts heat, greatly raising the overall U-factor of a window unit. In cold climates, a simple aluminum frame can easily become cold enough to condense moisture or frost on the inside surfaces. In hot climates, where solar gain is often more important than conductive heat transfer, improving the insulating value of the frame can be much less important than using a higher-performance glazing system.

ALUMINUM WITH THERMAL BREAK

As mentioned above, the biggest disadvantage of aluminum as a window frame material is its high thermal conductance. The most common solution to the heat conduction problem of aluminum frames is to provide a "thermal break" (also referred to as thermal bridge) by splitting the frame components into interior and exterior pieces and using a less conductive material to join them.

WOOD

The traditional window frame material is wood, because of its availability and ease of milling into the complex shapes required to make windows. Wood is favored in many residential applications because of its appearance and traditional place in house design. Wood is not intrinsically the most durable window frame material, because of its susceptibility to rot, but well-built and well-maintained wood windows can have a very long life. Paint protects the exterior surface and allows an easy change in color schemes.

VINYL

Vinyl window frames are usually made of polyvinyl chloride (PVC) with ultraviolet light (UV) stabilizers to keep sunlight from breaking down the material. PVC is a very versatile plastic with good insulating value. Vinyl window frames also do not require painting and have good moisture resistance. However, at high temperatures, they may expand and warp; at extremely low temperatures, they may crack. Also, if sunlight hits the material for many hours a day, colors other than white may tend to fade over time.

Insulated vinyl frames are also available. Unlike standard vinyl frames, their hollow cavities are filled with insulation. This makes them thermally superior to standard vinyl and wood frames. Usually these high-performance frames are used with high-performance glazing.

FIBERGLASS

Window frames can be made of glass-fiber-reinforced polyester, or fiberglass, which is extruded into lineal forms and then assembled into windows. These frames are dimensionally stable and have air cavities (similar to vinyl). When the cavities are filled with insulation, fiberglass frames have thermal performance superior to wood or vinyl (similar to insulated vinyl frames). Because the material is stronger than vinyl, it can have smaller cross-sectional shapes and thus less area. Another polymer-based approach is to use extruded engineered thermoplastics, another family of plastics used extensively in automobiles and appliances. Like fiberglass, they have some structural and other advantages over vinyl. Usually these high performance frames are used with high performance glazing.

Table 8. Key Properties of the Different Windows Types

Quality index		Wood	Wood Clad	Aluminum	Aluminum with Thermal Break	Fiberglass	Vinyl
Name	**Unit**	**1**	**2**	**3**	**4**	**5**	**6**
R-value	°C*m^2/Wt	0,55	0,55	0,46	0,78	0,79	0,70
Air penetration	G, kg/m^2*h	5,2					
Glazing *	Thickness, mm	6-20Ar-6k	4-16Ar-4k	4-16-4	4-12-4-8Ar-4k	4-12-4-12Ar-4k	4-12-4-8Ar-4k
Acoustic insulation	r_w, dB	35	31	31	37	39	33
Visible Light Transmittance	%	74	75	82	70	70	70
Price	$/m^2	180-220	130-180	60-120	120-200	185-220	80-130

* - “Ar” – stands for Argon and “k” stands for Krypton. These are filling gases with low heat conductivity.

All the well-known types of the windows are represented on the Armenian market. The development of the market started in 1990s when some companies established local production of windows using imported aluminum frames. Currently the market is dominated by the aluminum and PVC (polyvinylchloride) frames. 90% of the profiles are imported from Turkey. The rest are imported from China, Germany, Belgium, Canada, etc. The description of frames used in Armenia

is presented in the sections below. With the exception of fiberglass frames, which are currently produced by Onyx-GS CJSC only, the rest of the window types are supplied by all the companies listed at the end of this section.

EFFICIENT WINDOWS MANUFACTURERS

AAB CONCERN

Address	**0037, Yerevan, Arabkir, 39th St., House 1a**
Phone	+ (37410) 259559
Fax	+ (3410) 545259
Director	**Armen Badalyan**

ARMAND GROUP OJSC

Address	**0001, Yerevan, Tumanyan St. 11**
Phone	+ (37410) 520272, 520262
Fax	+ (3410) 520262
Url	http://www.armandgroup.am
Director	**Armen Hakobyan**

BYUR KARAT LTD

Address	**Shirak Marz, Artik, Abovyan St. 2**
Phone	+ Tel (374-244)51750, 51686, 54715
Director	**Garik H. Grigoryan**

EUROMETAL LTD

Address	**0051, Yerevan, Mamikonyants St. 49**
Phone	(374-10) 255 073
Fax	(374-10) 255 073
Director	**Sergey A. Chatoyan**

EUROSTAN-UYUT LTD

Address	**0047, Yerevan, Armenakyan St. 250, 2nd Building; Mashtotsi Ave. 39/12; Moskovyan St. 31**
Phone	(374-10) 655752, 652870
Fax	(374-10)255073
Director	**http://www.eurostan.am**

GSG WINDOW AND DOOR MANUFACTURING ENTERPRISE

Address	**0050, Yerevan, Nor Aresh, 50th St., House 10**
Phone	(374-10) 455992, (374-91)208927 (mobile)
Fax	(374-10)255073
Director	**Garnik V. Sargsyan**

MMM LTD

Address	**0007, Yerevan, Arshakunyats Ave. 254/1** **(374-10)442212, 446199 office** **Fax: (374-10)442202**
Phone	(374-10) 442212, 446199
Fax	+ (374-10) 442202
E-mail	info@mmm.am
Url	www.mmm.am
Director	**Meruzhan A. Mirijanyan**

MOST GROUP

Address	**0014, Yerevan, Azatutyan Ave. 16**
Phone	(374-10)281311, 294017
Fax	(374-10)289335
Director	**Raffi Kamayan**

ONIX GC CJSC

Address	**0053, Yerevan, Artsakhi Ave. 55; Charentsi St. 1**
Phone	(374 10) 474612, 571951
Fax	(374 10) 474616
E-mail	onix.g.co@netsys.am
Url	http://www.onix-g.com
Director	**Gagik A. Kirakosyan**

RAF ELIT LTD

Address	**0053, Yerevan, Charentsi St. 1**
Phone	(374 10) 474612, 571951
E-mail	raf_elit@yahoo.com
Url	http://www.raf-elit.am
Director	**Arman Arevyan**

V.AGHABABYAN LTD

Address	**Lori Marz, Vanadzor, S.Aghababyan St. 5; Tigran Metsi St. 41/19**
Phone	374-322) 44528, 43397
Fax	+ (374-322)44528
Director	**Vahagn R. Aghababyan**

VAL-AN PROF WINDOW AND DOOR MANUFACTURING ENTERPRISE

Address	**0010, Yerevan, Tigran Metsi Ave. 6**
Phone	(374-10)543512, 523512
Fax	+ (374-10)543512
Director	**Sargis V. Karapetyan**

4. SOLAR WATER HEATING SYSTEMS

Solar water heaters—also called solar domestic hot water systems—can be a cost-effective way to generate hot water for your home. They can be used in any climate, and the fuel they use—sunshine—is free.

Solar water heating systems include storage tanks and solar collectors. There are two types of solar water heating systems: active, which have circulating pumps and controls, and passive, which don't.

Most solar water heaters require a well-insulated storage tank. Solar storage tanks have an additional outlet and inlet connected to and from the collector. In two-tank systems, the solar water heater preheats water before it enters the conventional water heater. In one-tank systems, the back-up heater is combined with the solar storage in one tank.

Figure 11. Solar Water Heating System

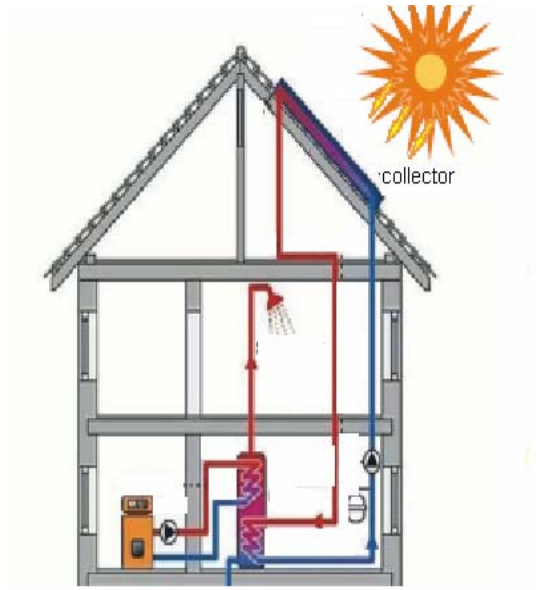

Figure 12. Solar Water Heating System, private house

SOLAREN LTD

Address	**0068, Yerevan, Shrjanain St. 2/2**
Phone	(374-10) 777113
Fax	+ (374-10) 777741
Director	**Victor V. Afyan , Director**

Solar En is a private Company is a private, project developing and consulting company focusing on clean energy. SolarEn has over a quarter-century experience in solar and wind energy engineering, project development and implementation. SolarEn's team has been associated with the deployment of many solar photovoltaic (PV) and thermal systems as well as win and biogas projects.

SolarEn deigns and manufacturers custom sized solar water heating systems (SWHS) for hot water supply, space heating and cooling. As SWHS utilize energy from the sun they are reliable sources for energy saving.

TECHNOKOM LTD

Address	**0036, Yerevan, Alikhanyan Yeghbayrneri St. 2**
Phone	(374-10) 344 255, 350 143
Fax	+ (374-10) 350 143
E-mail	technokom@web.am
Url	http://www.technokom.am
Director	**Ashot V. Papyan**

Technokom research-production Company was founded in 1991. The company is specialized in the areas of design and production of heating engineering, solar water heaters, water engineering, refrigerating devices, ultrasonic stone-processing machines and optional equipment. In the scope of its main activities, Technokom utilizes special technologies developed within the company. Technokom is comprised of highly qualified specialists each experienced in several fields.

Technokom has also won the tender of the Government of the Netherlands on the production of solar water heaters and technological equipment. Due to this initiative, SunEnergy company was established as a joint venture.

SUNENERGY Ltd

Address	**0036, Yerevan, Alikhanyan Yeghbayrneri St. 2**
Phone	(374-10) 344 255, 350 143
Fax	(374-10) 350 143
E-mail	M.Martorosyan@technocom.am
Url	http://www.sunenergy.am
Director	**Mikhayil Martirosyan**

SunEnergy company is the Armenian-Dutch joint venture of Technokom (Armenia) and ZEN International (the Netherlands). SunEnergy is the leader of production and installation of solar water heaters on the Armenian market having mounted over 60 small and large-scale solar water heating systems around the country.

Figure 13. Solar Water Heating System, Hotel Blue Sevan

Figure 14. Solar Water Heating System, Private house, Vahakni Community, Yerevan

5. SERVICES PROVIDED BY ESCOs

An energy service company (ESCO) is a business that provides energy management services to the energy users. Services provided by an ESCO may be contracted through an Energy Services Agreement (e.g., an Energy Performance Contract) or through specific energy management solutions identified by the ESCO that provides maximum return on investment for the customer. Energy Service Companies are one of the most effective mechanisms for the development and implementation of energy efficiency projects.

The services provided by the ESCO include identification and evaluation of energy-saving opportunities and recommendation of package of improvements to be paid for through savings. The ESCO guarantees that savings meet or exceed annual payments to cover all project costs. Many types of building improvements can be funded through such an agreement, including new lighting technologies, thermal insulation, energy management controls, etc.

Table 9. The List of ESCOs[8]

COMPANY NAME	CONTACT INFORMATION	SERVICES PROVIDED
Anergo Two	14 Mazmanian St., apt.12 Yerevan, RA Tel.: (374 10) 25 17 69, 25 81 55 anergo@rambler.ru	Installation of heating, electric supply systems, renewable energy, natural gas systems, HVAC; system maintenance; weatherization.
Artstrom	2a Gevorg Chaush St., Yerevan, RA Tel.: (374 10) 34 59 44, 35 06 30 artgroup1@yahoo.com	Heating; electric supply systems; natural gas; HVAC; weatherization work and system maintenance.
Construction Engineering Services Company (CESCO), Ltd.	11a Isakov Ave. Yerevan, RA Tel.: (374 10) 562980, 567697, 582451 cesco@arminco.com	Construction engineering; Consulting/analysis; Supply / installation / maintenance.
Elektroshinarar	24 Isahakyan St., Yerevan, RA Tel.: (34710) 54 38 42, 54 29 77 elshin@rambler.ru	Installation of heating, electric supply systems, natural gas, HVAC; system maintenance; telecommunications.
EIICG, Energy and Industry Infrastructure Construction	40a Charents Street Yerevan 375025 RA Tel.: (374 10) 556843 (374 91) 400875	Civil and industrial construction Energy and mechanical engineering; Management consulting; Technical design and analysis;

[8] Some of the presented ESCOs have undergone substantive capacity strengthening and evaluation within the framewokr of the the USIAD–funded Armenia Energy Efficiency, Demand-Side Management and Renewable Energy Program. More information on this effort can be found at http://www.aeai.am/escos.html.

Group, LTD.	eiicg@arminco.com	Energy audits; Supply / installation / maintenance services in HVAC and communication systems.
Energocor LTD	68/10, Micro district, Hrazdan, RA Tel.: (37491) 423369 g.arabyan@gmail.com	Heating system installation, thermal insulation, consulting and design.
Muzungu	3 A Saroyan St., Gyumri, RA Tel.: (041) 3 38 74, 3 38 62 (374 91) 49 72 27	Installation of heating systems
SolarEn, LTD.	2/2 Shrjanayin Street Yerevan 375068, RA Tel.: (374 10) 77 71 13 Fax: (374 10) 77 71 82 info@solaren.com http://www.solaren.com	Manufactures flat solar collectors and solar water heating systems, and operates as a photovoltaic system integrator. Wind data measurement, analysis and small wind turbine installation.
South Therm, Ltd.	33 Sayat Nova St., Yerevan, RA Tel.: (374 10) 54 16 41	Heating systems construction, installation; Maintenance and operation of energy systems.
Technokom	2 Alikhanyan Eghbayrneri St., Yerevan, RA Tel.: (374 10) 34 42 55 technokom@web.am http://www.technokom.am	Renewable energy
Thermoservice	25/1 Gyurjyan St., Yerevan, RA Tel.: (374 10) 36 92 46 (374 91) 48 11 43 termoservice@list.ru	Installation of heating; electric supply systems, natural gas, HVAC; system maintenance.

Some of the ESCOs have joint with support from the USAID-funded Energy Efficiency Demand-Side Management Program and established the Association of Armenian ESCOs.

ESCO ASSOCIATION

The Association of Energy Service Companies of Armenia was established in May 2005 by a group of local ESCOs. The overarching mission of the Association is to promote the efficient use of energy and expanded use of renewable energy resources as a means of promoting both economic prosperity and environmental protection in Armenia. The Association is a forum for its members to share ideas, information and experience and the organizational structure through which ESCOs can raise funds for the implementation of joint projects.

Address	**39 Israyelian Street, Apt. 2** **Yerevan, Republic of Armenia**

Phone	(374-10) 535 945
Fax	(374-10) 535 945
E-mail	info@armesco.am
Url	http://www.armesco.am
Contact person	**Mikhayil Martirosyan**

6. FINANCING ENERGY EFFICIENCY IN ARMENIA

The implementation of EE measures faces specific financial barriers. The capital costs involved in a project pose a barrier, especially considering the high interest rates prevailing in the lending field of Armenia, and also the fact that the available credit lines are not sufficient to cover the required investment expenditures for this project. Even though many energy efficiency measures have very short payback periods, many such measures are not undertaken due to the fact that the commercial banks and credit organizations in Armenia are not interested in funding these types of projects The average interest rate in commercial banks of Armenia is around 17%, and they are not interested in providing loans with more than 2-3 years crediting period. The commercial banks in Armenia do not provide loans larger than 500,000 USD (this amount usually ranges from 50,000 USD to 100,000 USD). It is worth noting that there are no direct subsidies or promotional support for the implementation of EE measures. Another barrier is at least 110% collateral requirement from the banks.

The business credits available from the local commercial banks and their respective terms are presented in a summary in Annex 1.

ANNEX 1. BUSINESS CREDITS [9]

Loan types, amount and conditions	Maturity date	Annual percent
ACBA-CREDIT AGRICOLE BANK		
Express loaning – 1,500,000 AMD	12 months (in special cases - up to 18 months)	25%
Commercial loans - up to 33,000,000 AMD	3-36 months	15-24%
ARARAT BANK		
1,000,000 – 15,000,000 AMD	up to 3 years	19-22%
15,000,000 – 50,000,000 AMD	up to 3 years	18-21%
more than 50,000,000 AMD	up to 3 years	16-19%
ARDSHININVESTBANK		
Consumer loans	up to 2 years	19-24%
Business credits	up to 2 years	18-24%
AREXIMBANK		
Express (micro-loan) - up to 15,000 USD	up to 18 months	AMD - from 16% foreign currency - from 14%
Express - businessman (small business) - up to 50,000 USD	up to 18 months	AMD` from 16% foreign currency - from 14%
Businessman (medium business) - up to 200,000 USD	up to 36 months	AMD` 16% foreign currency - 14%
Deal (medium business) - up to 200,000 USD	up to 18 months	AMD` 16% foreign currency - 14%
ARMECONOMBANK		
For developing micro, small and medium business (in AMD and foreign currency)		
subjects in trade and service sphere	up to 4 years	15-22%
subjects in production sphere	up to 4 years	15-18%

[9] www.banks.am

Together with European Bank for Reconstruction and Development loaning to the production enterprises (minimum amount - 400 000 USD)	up to 5 years	12-15%
Loans provided for trade stimulation in the frames of EBRD program for issuing letters of credit bank guarantees		up to 30000 EUR (or equivalent in other currency) - 4%
Loans provided for trade stimulation in the frames of EBRD program for issuing letters of credit bank guarantees		30001 EUR and more (or equivalent) - 9%
In case of paying to the bank's own expenses in the letter of credit line (bank guarantee) starting from payment date the following is accounted for the amount paid. - 14% annually in case of paying off the sum during 91 days - 15-22% annually in case of paying off the sum more than in 91 days		
ARMENIAN DEVELOPMENT BANK		
loan minimum amount – 5,000 USD or equivalent AMD/EURO loan/security correlation - maximum 70% security - real estate, fixed assets	3 years	12-22%
ARMSWISSBANK		
10,000,000 – 220,000,000 (AMD or equivalent amount)	up to 3 years	16-20%
ARTSAKHBANK		
Loans and credit lines for small and medium business for adding fixed and circulating assets - up to 150 000 USD	up to 36 months	18-22%
BTA-INVEST BANK		
Loans for small business (cash)		
Maximum amount of loans - up to 50,000 USD Provided amount - up to 70% of estimated pawning price Loan currency - AMD, USD Providing loan - estate, fixed assets Opening and conducting loan amount - free of charge	adding circulating assets - up to 18 months, acquiring fixed assets, building construction - up to 36 months	up to 22%
Loans for medium business (cash, cashless)		
Maximum amount of loans - up to 200,000 USD Provided amount - up to 70% of estimated pawning price Loan currency - AMD, USD	adding circulating assets - up to 18 months, acquiring fixed assets,	up to 20%

Providing loan - estate, fixed assets Loaner can pay off loan and added percents before the maturity date and get back the pawn (in case of advance payment no fines and pennies are added) Opening and conducting loan amount - free of charge	building construction - up to 36 months	
Loans for corporate business (cash, cashless)		
Maximum amount of loans - from 200,000 USD Provided amount - up to 70% of estimated pawning price Loan currency - AMD, USD Providing loan - estate, fixed assets, goods in circulation Opening and conducting loan amount - free of charge	adding circulating assets - up to 18 months, acquiring fixed assets, building construction - up to 36 months	up to 18%
Credit line (cash)		
Provided amount - up to 70% of estimated pawning price Loan currency - AMD, USD Providing loan - estate, fixed assets Opening and conducting loan amount - free of charge	up to 12 months	up to 20%, percent for unused cars - up to 3%
CASCADE BANK		
Unlimited	up to 5 years	18%-20%
CONVERSEBANK		
at own expense	maximum 3 years	15-24%
loaning in the frames of World Bank's international program of agricultural reform - program of rural area economic development - program of agricultural development assistance (for juridical people) - program of agricultural development assistance (for farmers)	 up to 7 years up to 5 years up to 18 months	 10% 12% 12%
loaning in the frames of the international program of Armenian-German Fund - up to 100,000,000 AMD or equivalent in USD - 1,000,000 AMD or equivalent in USD (small and medium business)	 up to 3 years up to 1 year	 16-24% 24% + 2% comission payments
HSBC BANK ARMENIA		

9,000,000 – 1,100,000,000 AMD	up to 12 months	12%-18%
20,000 - 2,500,000 USD	up to 60 months	12%-18%
INECOBANK		
corporate loans	up to 3 years	19%
corporate credit lines	up to 1,5 years	21%
express loans	up to 1 year	25%
small and micro loans	up to 3 years	21%
"Agricultural loans" in frames of international programs	up to 7 years	14%
ITB INTERNATIONAL TRADE BANK		
on a contractual basis	on a contractual basis	12%-22% AMD
-	-	11%-22% USD
PROMETEY BANK		
small and medium business - up to 50,000 USD or equivalent in AMD	up to 3 years	
for developing production - up to 1,000,000 USD or equivalent in AMD	up to 5 years	
for building construction - 1,000,000 USD or equivalent in AMD	up to 5 years	
for wholesale and retail - 500,000 USD or equivalent in AMD	up to 3 years	
consumer loans - 50,000 USD or equivalent in AMD	up to 3 years	
pawning loans - 90% of the pawn defined	-	
UNIBANK		
up to 1,200,000 USD	up to 3 years	from 16%
up to 150,000 USD (agricultural loan)	up to 7 years	from 10%
VTB-ARMENIA BANK		
-	up to 3 years	13%-20 %

AGROLEASING

-	from 6 months to 3 years	10-16%
CASCADE-CREDIT		
Short-term Loan (working capital) - 1,000,000 - 100,000,000 AMD	up to 1 year	15%
Long-term Loan (capital financing) - 2,000,000 - 120,000,000 AMD	up to 5 years	15%
Leasing (capital financing) - 500,000 - 100,000,000 AMD	up to 5 years	15%
Guarantee (working capital, capital financing) - 500,000 - 100,000,000 AMD	up to 3 years	3%
Energy loan (capital financing) - 45,000,000 - 450,000,000 AMD	up to 8 years	12-14%
short-term loans (3,000 up to 100,000 USD or the equivalent sum)	up to 1 years	16%-24%
long-term loans (4,000 up to 175,000 USD or the equivalent sum)	up to 5 years	16%-24%
IZMIRLIAN-EURASIA		
up to 200,000 USD	up to 48 months	15%
SEF INTERNATIONAL		
1,000 - 20,000 USD (in Yerevan)	3-36 months	30%
Collective agricultural loans (150,000 - 700,000 AMD, in Syunik Marz)	6-24 months	20,4%-24%
Individual agricultural loans (500,000 - 2,500,000 AMD, in Syunik Marz)	6-24 months	20%-24%

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