ECONOMIC DEVELOPMENT AND RESEARCH CENTER

RESIDENTIAL ENERGY CONSUMPTION SURVEY

ANALYTIC REPORT

UNDP, RESIDENTIAL ENERGY CONSUMPTION SURVEY

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Executive Summary

- Development and promotion of energy-efficient and energy-saving energy consumption options in Armenia is an urgent issue. The present analytic report is based on the household sample-based survey findings and describes the overall picture of residential energy consumption in Armenia.
- The main component of residential energy consumption is heating. The heating season in Armenia is quite long and winter is quite severe in certain regions. Heating expenses have a large share in the budget of households.
- Choice of heating option by a household depends on socio-demographic peculiarities, housing conditions and thermo-physical parameters of the building. Nevertheless, the main factor determining the choice of a particular heating option is the income level.
- Not all households in Armenia opt for just one heating option. Considerably high portion of households – about 24% - also use secondary options in addition to the primary option. At the same time, about the half of households (47%) heated the house/apartment only partially (on average -43% of the total house area). There are very few households that do not heat their apartment/house at all.
- Natural gas is mostly used for heating in Armenia. 51% of households use natural gas for heating, while another 4% of households use natural gas for the secondary heating option.
- Natural gas is followed by heating with wood: 32% of households use wood. 3% of households use wood for secondary heating option. As a result, about 35% of households use wood for heating – to a certain degree.
- 13% of households use electricity for the main heating option, while 9% - for the secondary option. Electricity is the most widely used energy source for the secondary heating option.
- Use of natural gas is especially widespread in urban areas: it reaches 72% in Yerevan and 60% - in other cities and towns (as a primary heating option). Apartments in multi-apartment blocks are mostly heated with natural gas (71%). Electricity is used mostly in Yerevan (23%) and multi-apartment blocks (24%). Wood is largely used in rural areas (67%) and in individual houses (53%). Other energy sources (biofuel) are more often used in cold rural areas (up to 15%). Overall, about 10% of households in villages use biofuel as primary heating option, while 14% - for the secondary heating option.
- Individual heat boilers are mostly used for heating with natural gas – 50% of total. 81% of households using electricity use manufactured heating appliances. In case of heating with wood, almost all households use non-manufactured heaters. In this regard, safety is an issue in villages.
- Mostly small households use electricity for heating: they heat the apartment/house partially and temperatures are below 19 degrees (in evening hours) in 70% of cases.
- In case of heating with wood, in addition to safety and cleanness problems, average temperatures were mostly low and the houses were heated partially.
- In case of heating with natural gas, heated area was larger; cases of partial heating were few, while average temperatures were higher. In case of individual heat boiler, the energy cost of heating per heated unit area is relatively small – about AMD 600/sq.m. per month.
- Many households, when deciding upon the heating option, prefer or are forced to choose the one with lowest expenditures per month, thus compromising in the heated area, cleanness and comfort or choosing to heat partially. There are possibilities to divert to natural gas from wood; however this requires substantial initial investment of money from HHs.
- Option for hot water for bathing and other household purposes mostly depends on the choice of primary heating option. Nevertheless, more than 72% of households heat water with natural gas

during winter months, 16% - with electricity, while 10% - with wood. The picture does not change much in summer months. Almost no water is heated with renewable energy sources.

- Households mostly use gas stoves for food preparation – 63%. 76% of households use ovens, overwhelming majority of which are electric ovens. Use of microwave ovens is not widespread, while electric kettles are used in about third of households. Almost all households have fridges.
- Irons and washing machines are the most widespread home appliances. Vacuum cleaners are less widespread, especially in villages (67%). Almost all households have TVs; including 42% of them are the technological production of the recent years. Use of computers became widespread: there is at least one computer in about 70% of households.
- 5% of households use air conditioners. About half of households having air conditioners use them about on average up to 4 hours a day for 30 days in summer.
- The main option used for lighting in Armenia is incandescent lamps, although energy-saving lamps also became popular. 95% of households have incandescent lamps; however, only 53% use only incandescent lamps. 43% of households combine lamps (energy-saving and non-saving); while 5% use only energy saving lamps. The most widespread energy-saving lamps are compact luminescent lamps. Use of LED lamps is relatively high in Yerevan: they are used by 6% of households.
- According to our estimates, on average one household consumes 1.1kWt.h electricity a day for lighting. The share of electricity consumption for lighting constitutes 18% of total in summer months.
- The main factor determining the choice of households not to use energy-saving lamps is affordability or high price, as well as low awareness levels. Nevertheless, distrust in the quality and overall negative attitude towards such lamps also play an important role (about 15%).
- Overall, average monthly payment of households for electricity totaled to AMD 13 thousands in summer months and AMD 49 thousands in winter months. During 2014-2015 winter, household that heated with natural gas, on average paid AMD 41 thousands per month for natural gas. Meanwhile heating with wood on average costed AMD 31 thousands per month and heating with electricity – on average AMD 28 thousands per month.
- On average, heating cost constitutes about 14-20%[1] of household incomes (depending on the heating option). Thus, Armenian households divert considerable share of their incomes to heating, however the mostly have inefficient, insufficient and uncomfortable heating.
- In 2014-2015 winter, an average household consumed 1.8 c.m. wood per month or 7.7 c.m. – per season. According to our estimates, about 2 mln c.m. wood was consumed in Armenia for heating during the last winter. This is a worrying indicator and shall become subject to a clearly defined efficient policy.

[1]Calculations are based on the data of Integrated Living Conditions Survey of the NSS of RA, according to which per capita average monthly income equaled AMD 52,624 in 2014 (AMD 200,000 per HH), while the average HH had 3.8 members.

1. Introduction

Under UN Framework Convention on Climate Change (FCCC) within the development of the first Armenia Biannual Progress Report, a Survey on residential energy consumption structure was initiated with the objective to assess the greenhouse gas emissions potential in the residential sector.

In accordance with the Third National Communication of Armenia under the UN FCCC, 67% of greenhouse gas emissions in Armenia are produced by energy sector, including emissions by the residential sector. Development of efficient energy consumption and introduction of energy-saving measures has a huge potential in terms of reducing the greenhouse emissions. Therefore, it is necessary to study the possibilities for increasing the efficiency of energy consumption by the residential sector in order to develop respective policies and measures towards reducing the greenhouse gas emissions.

The UNDP assigned the task to carry out the Residential Energy Consumption Survey (RECS) to the Economic Development and Research Center[2] (EDRC).

The objective of the Survey was to obtain reliable data on energy consumption by the population in Armenian urban and rural communities, describe and analyze the current energy consumption picture in the country.

Overall, data on final consumption of energy by the population in Armenia are quite limited. The NSS of RA regularly provides data on heating options used by the population based on the findings of the ILCS. During 2005-2011, the Economic Development and Research Center (EDRC) carried out 5 detailed household surveys on heating options used by Armenian HHs: the surveys were assigned by Armenia R2E2 (Renewable Resource and Energy Saving Fund) and the UNDP (in 2010). However, the latter covered only heating options in multi-apartment buildings in urban areas of Armenia.

The present survey is unprecedented since it addresses all the major directions of energy consumption by population. In addition to the heating options, the Survey covered also other main directions of residential energy consumption, including lighting,

The main method is the Sample-based survey. The object of the Survey is urban and rural households (HHs) of Armenia - the main options of residential energy consumption. The actual sample size was 2417 HH. The Survey was carried out based on the pre-developed Questionnaire through face-to-face interviews. The Survey was carried out in all Marzes of the country and Yerevan, including 22 Marz cities and towns and 64 villages. HH selection was carried out through a multi-stage stratified proportional random sampling model which ensures high level of representation at 4 different cluster levels. The clusters were: 1) type of the community (Yerevan, Other cities and towns, villages); 2) type of housing (individual house, multi-apartment block), 3) Material of external walls (stone, monolith etc.) and 4) climate (areas).

The present report is the Final analytic report on the Residential Energy Consumption Survey in Armenia. It consists of 8 sections. The section following the Introduction describes HHs and housing conditions. In particular, physical parameters of houses or apartments, number of HH members, as well as geographic or climate areas are described.

Section 3 discusses the heating options used in HHs, together with appliances and average temperatures. Section 4 presents data on hot water used in household, while Section 5 addresses the situation with air conditioning. Section 6 covers use of home appliances. Section 7 discusses lighting: Estimates of electricity consumption for lighting are presented.

Section 8 presents data on HH consumption of energy sources (fuel types) and payments against their consumption. In particular, consumption volumes of natural gas, electricity and wood in winter and summer months are discussed, together with average monthly costs and comparison of expenses for various heating options. Estimates of total consumption of wood in the country are presented at the end of the Section.

Annexes on research design and details of sampling methodology are attached to the Report.

[2] For information on EDRC, please visit www.edrc.am

2. Households and Housing Conditions

Energy consumption by HHs is determined by price and various non-price factors, including the HH size (number of HH members), housing conditions and welfare, type of housing, material of external walls, climate etc. This section describes the HHs included in the Survey, as well as describes and compares apartments in multi-apartment blocks (MABs) and individual houses[3].

According to RECS data, 37% of Armenian HHs love in Yerevan, 30% - in other cities and towns and 33% - in ru7ral areas. 16% of HHs in Marzes lives in "cold" areas, 23% - in "moderate" and 24% - in "warm" areas. Majority of cities are located in "moderate" and "warm" climate areas. 18% of urban HHs and 33% of rural HHs live in "cold" areas. As a result, 67% of HHs living in "cold" climate lives in rural areas.

Table 1. Distribution of HHs per climate areas, %

	Yerevan	Other cities and towns	Rural areas	Total
Cold	-	17.5	32.6	16.0
Moderate	-	51.4	23.2	23.1
Warm	-	31.1	44.2	23.9
Total	**-**	**100**	**100**	**100**
Cold	-	32.9	67.1	100.0
Moderate	-	67.0	33.0	100.0
Warm	**-**	**39.2**	**60.8**	**100.0**
Total	**37.1**	**30.1**	**32.9**	**100.0**

Source: RECS, EDRC, 2015

More than half of HHs – 52% - live in individual houses while 45% - in MABs and about 3% - in temporary dwellings. Obviously, HHs living in MABs prevail in Yerevan – about 70%, while in HHs living in individual houses prevail in rural areas – 90%.

Overall, 59% of all MABs are situated in Yerevan, while 37% - in other cities and towns. 21% of HHs living in individual houses is located in Yerevan, 23% - in other cities and towns, while 57% - in rural areas. Temporary dwellings prevail in other cities and towns – 58% of total, as well as in rural areas.

Table 2. Breakdown of housing per type, %

	Yerevan	Other cities and towns	Villages	Total
MAB	71.1	55.3	5.9	44.9
Individual house	28.9	38.9	90.2	52.0
Temporary dwelling	0.0	5.8	3.9	3.0
Total	**100**	**100**	**100**	**100**
MAB	58.7	37.0	4.3	100.0
Individual house	20.6	22.5	56.9	100.0
Temporary dwelling	0.0	57.5	42.5	100.0
Total	**37.1**	**30.1**	**32.9**	**100.0**

Source: RECS, EDRC, 2015

According to the Survey, 73% of individual houses are one-storey buildings, while 26% - two-storey buildings. 19% of MABs have up to 4 storeys. The share of 5-storey MABs is large – 38%, together with 6-9-storeyed MABs – 32%.

[3] In a few cases, it includes temporary dwellings, if not otherwise specified.

Table 3. MABs and individual houses per number of floors, %

Individual houses and temporary dwellings	100
1 floor	73.1
2 floors	26.1
3 floors	0.8
MAB	100
1-4 floors	18.7
5 floors	37.7
6-9 floors	32.3
10 floors and more	11.3

Source: RECS, EDRC, 2015

Housing in Armenia is of medium age. Majority of HHs in the survey live in housing constructed before 1980s. In particular, 47% of housing was constructed during 1951-1975, 27% - in 1976- 1988, 13% - during 1989-1995 and about 7% - during the last 20 years.

Table 4. Breakdown of housing per construction year, %

	MAB	Individual houses	Temporary dwellings	Total
Before 1950	2.3	10.0	0.0	6.2
1951-1975	41.7	54.1	1.4	47.0
1976-1988	41.7	15.3	0.0	26.7
1989-1995	10.1	11.5	94.5	13.4
1996 – to present	4.1	9.1	4.1	6.7
Total	**100.0**	**100.0**	**100.0**	**100.0**

Source: RECS, EDRC, 2015

Thus, the average age of housing is about 43 years. MABs are relatively younger - 39.7 years and are even slightly younger in Marz cities and towns - 36.3 years. Average age of individual houses equals 46.5 years. They are slightly older in Yerevan (on average 49 years). Temporary shelters mostly appeared during the last 26 years (mostly after the 1988 earthquake).

Table 5. Average age of housing, years

	Yerevan	Other cities and towns	Villages	Total
MAB	41.2	36.3	48.5	39.7
Individual houses	49.0	46.6	45.5	46.5
Temporary dwellings		25.8	25.7	25.8
Total	**43.4**	**39.7**	**44.9**	**42.8**

Source: RECS, EDRC, 2015

69% of MABs are constructed from stone, 26% - have external walls made of reinforced concrete (panel or monolith), while for 5% - wood or other materials. For 89% of housing in rural areas, 67% of houses in Yerevan and 53% of houses in other cities and towns, external walls are made of stone. 66% of all panel or moonlit buildings are situated in Yerevan. Their numbers are very small in rural areas.

Table 6. Housing breakdown per material of external walls, %

	Yerevan	Other cities and towns	Villages	Total
Stone	53.0	66.7	88.8	68.9
Panel or monolith	46.8	26.4	3.4	26.4
Wood	0.2	5.9	4.3	3.3
Other	0.0	1.0	3.5	1.4
Total	**100.0**	**100.0**	**100.0**	**100.0**
Stone	28.5	29.1	42.3	100.0
Panel or monolith	65.7	30.1	4.2	100.0
Wood	2.5	54.4	43.0	100.0
Other	0.0	20.0	80.0	100.0
Total	**37.1**	**30.1**	**32.9**	**100.0**

Source: RECS, EDRC, 2015

In "cold" areas, about 85% of housing is made of stone. 18% of housing in "moderate" areas is monolith or panel, together with 16% of housing in "warm" areas. Panel and monolith buildings, as noted, are mostly located in Yerevan.

Table 7. Breakdown of housing per material of external walls and climate area, %

	Cold	Moderate	Warm	Yerevan	Total
Stone	84.5	70.6	81.5	53.0	68.9
Panel or monolith	7.5	17.9	15.6	46.8	26.4
Wood and others	8.0	11.5	2.9	0.2	4.7
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Stone	19.6	23.7	28.2	28.5	100.0
Panel or monolith	4.5	15.7	14.1	65.7	100.0
Wood and others	27.2	56.1	14.9	1.8	100.0
Total	**16.0**	**23.1**	**23.9**	**37.1**	**100.0**

Source: RECS, EDRC, 2015

Average number of HH members equals to 4.3. HHs' size is larger in rural areas and smaller in Yerevan. On the other hand, HHs living in individual houses are considerably larger than those living in MABs. If the average HH size in individual houses is 4.7, it is 3.8 in MABs (less by almost 1).

Table 8. Average HH size, members

	Yerevan	Other cities and towns	Villages	Total
HH members				
Individual houses and temporary dwellings	4.6	4.6	4.9	4.7
MABs	3.8	3.9	4.1	3.8
Total	**4.0**	**4.2**	**4.8**	**4.3**
Actually living together				
Individual houses and temporary dwellings	4.50	4.37	4.59	4.52
MABs	3.74	3.75	4.02	3.76
Total	**3.96**	**4.03**	**4.56**	**4.18**

Source: RECS, EDRC, 2015

The housing areas per HH are larger in rural communities – 120 sq.m, and small – in Yerevan (79 sq.m.). Average area of individual houses is considerably larger than for apartments in MABs. According to the Survey findings, per capita housing area in Armenia equals 27.5 sq.m, in particular – 32.5 sq.m. in individual houses and 22.6 sq.m. – in MABs.

Table 9. Average house/apartment area per communities and housing type, sq.m.

	Yerevan	Other cities and towns	Villages	Total
Total average area				
MABs	69.0	66.0	70.8	68.0
Individual houses	102.6	118.5	126.6	119.8
Temporary dwelling		46.0	42.0	44.3
Total	**78.7**	**85.3**	**120.0**	**94.2**
Average per capita area *(according to the number of people actually living together)*				
MABs	23.0	22.1	21.6	22.6
Individual houses	28.0	34.1	33.5	32.5
Temporary dwelling		13.6	15.0	14.2
Individual houses and temporary dwellings	28.0	31.5	32.7	31.5
Total	**24.4**	**26.3**	**32.1**	**27.5**

Source: RECS, EDRC, 2015

According to self-assessments of HH members, significant energy savings may occur if windows and doors are replaced (for 44% of HHs). This indicator is higher in villages – 52% and in Marz cities and towns – 48%.

Table 10. Subjective estimates of potential for energy saving in case windows and doors are replaced, %

Question: will you have significant energy savings if those are replaced	Yerevan	Other cities and towns	Villages	Total
1.Yes, significant	34.7	48.1	51.6	44.3
2. Hardly, not significant	18.4	18.3	18.6	18.5
3.No	46.9	33.1	29.5	37.0
4.Difficult to answer	0.0	0.4	0.3	0.2
Total	**100.0**	**100.0**	**100.0**	**100.0**

Source: RECS, EDRC, 2015

3. Heating in Households

3.1. Heating Options and Energy Sources

Natural gas is mostly used for heating in Armenia, followed by wood. Use of natural gas for heating decreased during 2010-2013, meanwhile use of wood and electricity for heating increased. These statements base on data of ILCS of NSS of RA.

According to the same Survey data, 49% of HHs heated with natural gas, 30% - with woods and 16% - with electricity.

Findings of RECS survey are overall in line with data of recent Surveys of the NSS of RA. Nevertheless, certain trends have changed. This is mostly determined by the recent increases in electricity tariffs.

According to RECS which covered 2014-2015 winter seasons, 51% of HHs used natural gas for heating. This is slightly higher than the ILCS data for 2013 (49%) and almost equals the 2012 and 2011 levels. Thus, despite possible data compatibility issues, one can note that the previous trend of diversion from natural gas for heating purposes suspended or, in other words, the number of HHs using natural gas for heating purposes stabilized.

What concerns electricity, our Survey showed that 13% of HHs use electricity for heating. This is relatively high compared to NSS data for 2013. One could possibly state that the number of HHs using electricity for heating decreased. Number of HHs using wood for heating, according to RECS findings, slightly exceeds the NSS data showing possible increase.

Table 11. Comparison of existing data on heating in HHs, %

	NSS Of RA, ILCS				EDRC, RECS, 2015		
	2010	2011	2012	2013	Primary	Secondary	Altogether
Electricity	11.7	13.4	14.7	16.0	12.6	9.4	21.9
Natural gas	57.1	50.0	51.4	48.7	51.4	4.4	55.8
Wood	25.8	31.0	30.1	30.4	31.5	3.4	34.9
Other	5.1	5.6	3.8	4.6	4.6	6.3	10.9
o/w biofuel	-	-	-	-	3.4	5.2	8.5
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100**	**23.5**	**-**

Source: NSS of RA ILCSs and EDRC, RECS, 2015

Thus, according to RECS data, about 24% of HHs in Armenia used both primary and secondary (additional) heating options.

51.4% of HHs uses natural gas as primary heating option, while another 4.4% - for secondary (additional) option. Overall, 55.8% of HHs use natural gas for heating purposes.

The next largest heating option is wood which is used by 31.5% of HHs as primary option and by another 3.4% - as a secondary option. About 35% of HHs use wood for heating.

Although only 12.6% of HHs used electricity as primary heating option, another 9.4% used it as a secondary option.

Choices of heating options vary per types of community/area. 67% of HHs in rural areas used wood. Meanwhile only 26% of HHs in Marz cities and towns use wood and only 4.4% - in Yerevan. 72% of HHs in Yerevan and 60% of HHs in other cities and towns use natural gas as primary option. Interestingly, use of electricity is high in Yerevan: 23% use it as primary heating option.

About 5% of HHs, apart from the mentioned heating options, also used other options. The share of biofuel (animal-based) is high among these options, together with collected fuel and other sources. Biofuel is used as primary heating option by 3.4% of HHs; another 5% use it as secondary heating option.

In rural areas, 10% of HHs use biofuel as primary heating option, while 14% - as secondary option.

Table 12. Breakdown of heating options (energy sources), %

	Yerevan	Other cities and towns	Villages	Total
Primary heating option				
Electricity	23.0	11.7	1.6	12.6
Natural gas	71.9	60.0	20.4	51.4
Wood	4.4	26.1	66.9	31.5
Biofuel	0.0	0.6	9.7	3.4
Other	0.8	1.7	1.4	1.2
Total	**100**	**100**	**100**	**100**
Secondary heating option				
Electricity	8.6	12.4	7.4	9.4
Natural gas	2.4	4.8	6.4	4.4
Wood	1.0	2.1	7.3	3.4
Biofuel	0.0	2.2	13.7	5.2
Other	0.1	1.1	2.1	1.1
Total	**12.1**	**22.6**	**37.0**	**23.5**

Source: RECS, EDRC, 2015

There is no clear correlation between the choice of heating option and climate areas. According to the Survey findings, use of wood is equally widespread both in "cold" and "warm" areas (about 52% in each). Wood is used by 40% of HHs as primary option in "moderate" areas, whereas 47% use natural gas.

Overall, climate zones and HH welfare have quite strong correlation. In particular, villages in "warm" zones are larger and better off. While, mountainous, small and poorer villages are mostly located in "cold" zones. In contrast to "warm" and "cold" areas, urban HHs prevail in "moderate" areas (about 70%). These factors determine the choices of heating options by HHs. Nevertheless, the decisive factor is the ratio of urban and rural HHs in each climate zone. The large share of urban HHs in "moderate" areas determines the relatively low use of wood and high levels of using natural gas.

Climate zoning also reflects the choice of biofuel as heating option. About 14% of HHs in "cold" areas use biofuel as primary heating option and it is the third largest heating option, in general. 4% of HHs in "moderate" areas use biofuel, meanwhile, 1.4% of HHs use it in "warm" areas. This is explained by the fact that animal livestock is more widespread in cold communities.

Table 13. Main heating options per climate areas, %

	Total	Cold	Moderate	Warm	Yerevan
Electricity	12.6	3.6	7.7	7.1	23.0
Natural gas	51.4	29.0	47.4	38.4	71.9
Wood	31.5	52.3	39.7	51.6	4.4
Biofuel	3.4	13.5	3.8	1.4	0.0
Other	1.2	1.6	1.4	1.6	0.8
Total	**100**	**100**	**100**	**100**	**100**

Source: RECS, EDRC, 2015

Choice of heating options also varies depending on the type of house and material of external walls. 71% of HHs in MABs heated the apartment with natural gas. The next largest heating option is electricity – 24%. The main heating option in individual houses was wood – 53%, followed by natural gas – 36% of HHs. 64% of HHs are houses made out of materials other than stone used natural gas, together with 45.5% of HHs in stone houses/apartments. It is worth noting that individual houses in Armenia are mostly made of stone.

Table 14. Heating options per type of housing and material of external walls, %

	Total	External walls made of:		Type of housing	
		Stone	Other	MAB	Individual houses*
Electricity	12.6	9.6	19.2	23.5	3.7
Natural gas	51.4	45.5	64.3	70.5	35.8
Wood	31.5	39.4	14.0	5.1	52.9
Biofuel	3.4	4.4	1.1	0.1	6.0
Other	1.2	1.1	1.5	0.8	1.6
Total	**100**	**100.0**	**100.0**	**100.0**	**100.0**

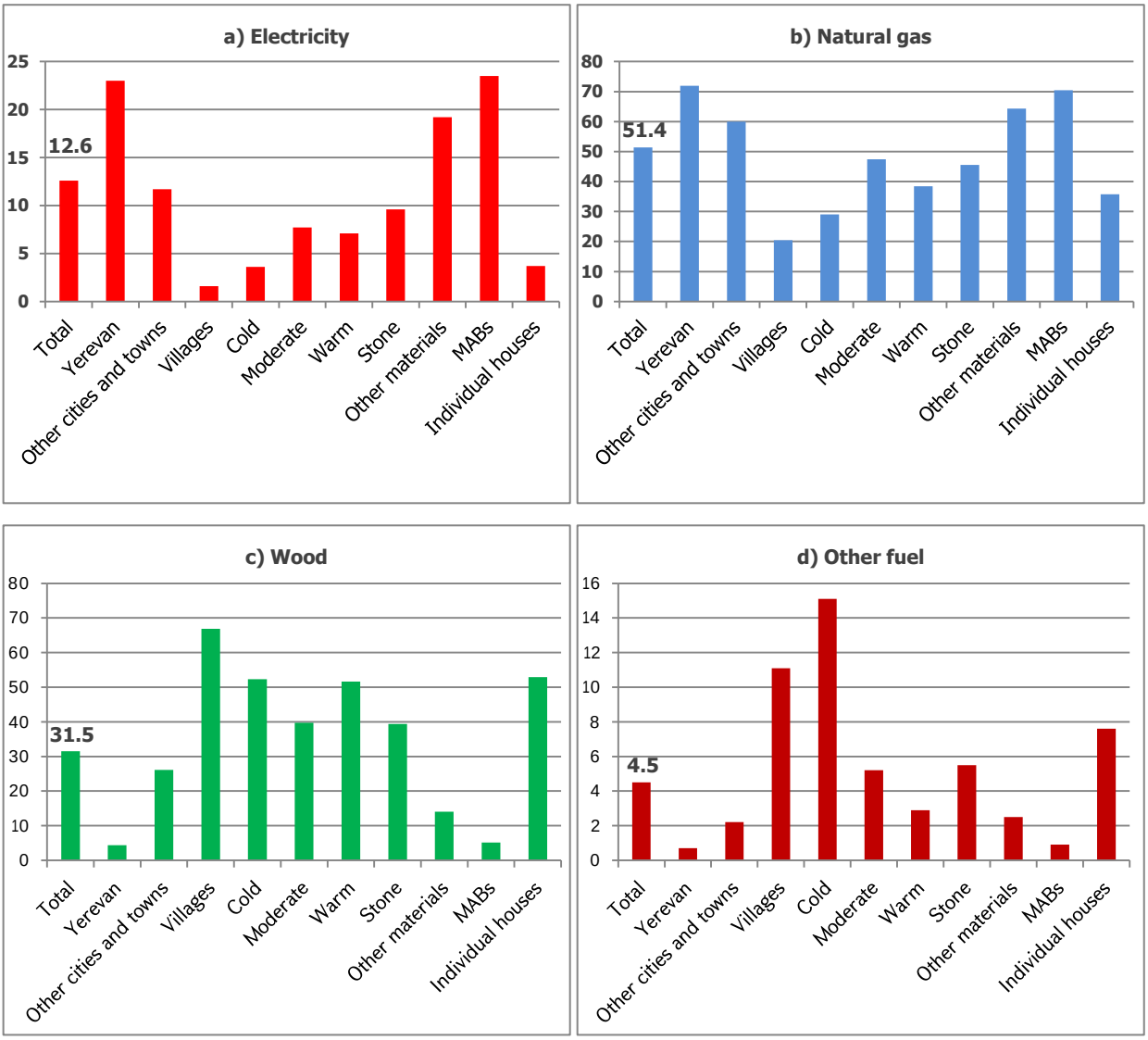
* Includes also temporary and other dwellings

Source: RECS, EDRC, 2015

Thus, the choice of primary heating option (source of energy) depends on the welfare of a HH. Nevertheless, it is apparent that there are certain peculiarities depending on the type of the community (urban/rural) and type of housing (individual house/MAB).

Electricity as a primary heating option is mostly used in Yerevan and in MABs. Use of natural gas is widespread in urban areas and MABs. Wood is mostly used in rural areas and individual houses. Other options/types of fuel are used in "cold" rural areas.

Figure 1. Primary heating options, %



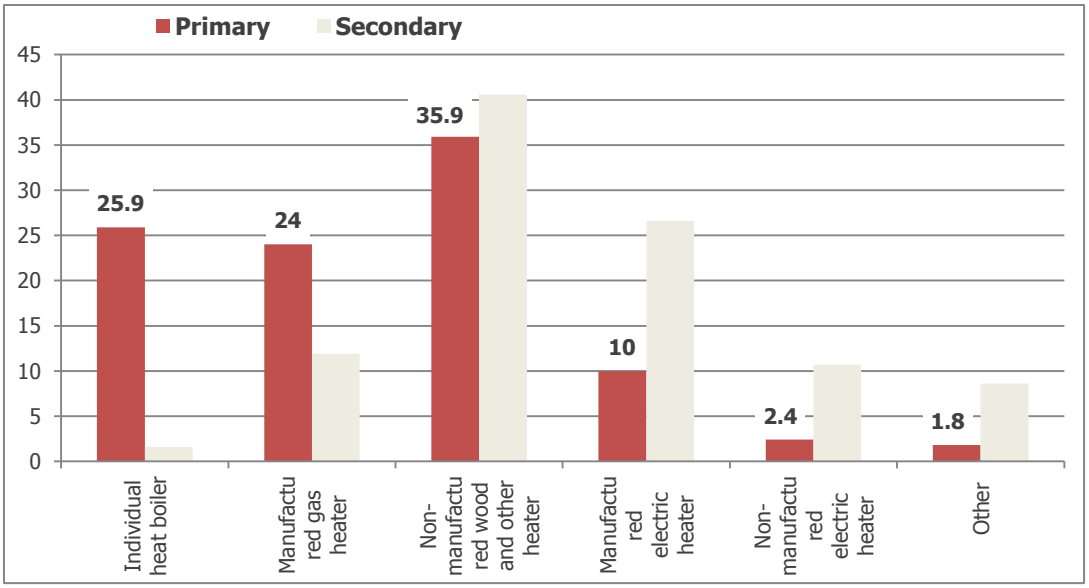
Source: RECS, EDRC, 2015

3.2. Heating Equipment/Appliances Used

The most widespread heating appliance is the self-made (non-manufactured) heater which is used by 36% of HHs. Individual heat boilers are the next largely-used equipment (26% of HHs), followed by manufactured gas heaters (24% of HHs).

The most widespread equipment used for secondary heating option is non-manufactured heaters, followed by manufactured electric heaters.

Figure 2. Heating equipment used, %



Source: RECS, EDRC, 2015

81% of HHs heating with electricity use manufactured appliances. 50% of HHs using natural gas us individual heat boilers, while 47% - manufactured heaters and 3% - other appliances. Almost all HHs using wood and biofuel use self-made heaters/ovens.

Table 15. Heating equipment per heating options, %

	Electricity	Natural gas	Wood	Biofuel	Other	Total
Individual heat boiler		50.4	0.0	0.0	0.0	25.9
Manufactured gas heater		46.7	0.0	0.0	0.0	24.0
Self-made, non-manufactured wood or biofuel heater		0.0	100.0	100.0	83.3	35.9
Manufactured electric appliances	80.8	0.0	0.0	0.0	0.0	10.0
Non-manufactured electric appliances	19.1	0.0	0.0	0.0	0.0	2.4
Other	-	2.9	0.0	0.0	16.7	1.9
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: RECS, EDRC, 2015

78% of rural HHs use non-manufactured heater for the primary heating option. Individual heat boilers are the most widespread heating equipment in Yerevan (in 44% of HHs), followed by manufactured gas heaters (27% of HHs). 34% of HHs in other cities and towns use manufactured gas heaters, while 28% - self-made wood heaters and 25% - individual heat boilers. Overall, the safety levels are low especially in rural areas.

Table 16. Main equipment used for heating, %

	Yerevan	Other cities and towns	Villages	Total
1. Centralized heating	0.1	0.6	0.0	0.2
2. Individual heat boiler	43.8	24.6	7.1	25.9
3. Manufactured gas heater	26.7	33.5	12.2	24.0
4. Non-manufactured gas heater	0.8	1.1	1.1	1.0
5. Gas stove	0.7	0.8	0.0	0.5
6. Non-manufactured heater *(wood, biofuel etc.)*	5.0	27.7	78.0	35.9
7. Manufactured heater, fan heaters, oil-filled radiator or other heaters	19.4	7.9	1.4	10.0
8. Air conditioner	0.4	0.0	0.0	0.2
9. Self-made or non-manufactured electric heater (tubular heater, fan heater, spiral stove, tile)	3.1	3.9	0.3	2.4

Source: RECS, EDRC, 2015

Use of self-made or non-manufactured heaters for the secondary heating option is especially widespread in rural areas – in 62% of HHs. 50% of HHs in Yerevan and 35% of HHs in other cities and towns use manufactured electric appliances. These are the most widespread equipment for secondary heat options in urban areas. Use of gas stoves as secondary heating option is also widespread in Yerevan – in 13% of HHs.

Table 17. Equipment used for the secondary heating option, %

	Yerevan	Other cities and towns	Villages	Total
1. Centralized heating	0.0	0.0	0.0	0.0
2. Individual heat boiler	0.0	2.4	1.7	1.6
3. Manufactured gas heater	7.1	13.9	12.6	11.9
4. Non-manufactured gas heater	0.0	1.2	1.7	1.2
5. Gas stove	13.4	4.2	1.7	4.7
6. Non-manufactured heater *(wood, biofuel etc.)*	8.9	23.6	62.2	40.6
7. Manufactured heater, fan heaters, oil-filled radiator or other heaters	50.0	35.2	12.9	26.6
8. Air conditioner	9.8	1.2	0.7	2.6
9. Self-made or non-manufactured electric heater (tubular heater, fan heater, spiral stove, tile)	10.7	18.2	6.5	10.7

Source: RECS, EDRC, 2015

3.3. Heated Area and Average Temperatures

According to RECS data, the number of HHs in Armenia that do not heat their houses in winter is very small. Nevertheless, 47% of HHs heated their houses only partially.

The share of HHs that heat only partially is high in rural areas – 65%. 44% of HHs in other cities and towns heated their houses partially, together with 44% of HHs in Yerevan.

Table 18. Breakdown of heating per heated area (entire/partial) in 2014-2015 winter, %

	Yerevan	Other cities and towns	Villages	Total
Heated entirely	65.6	55.8	35.5	52.8
Heated partially	33.9	43.9	64.5	47.0
Was not heated	0.4	0.3	0.0	0.2

Source: RECS, EDRC, 2015

As for climate breakdown, HHs that heat partially are numerous both in "warm" (64%) and "cold" (59%) areas. 42% of HHs in "moderate" areas did not heat houses at all, while 58% heated the entire house.

Table 19. Breakdown of HHs per heating partiality per climate areas, %

	Cold	Moderate	Warm	Yerevan	Total
Heated entirely	41.2	58.1	35.5	65.6	52.8
Heated partially	58.8	41.8	64.3	33.9	47.0
Was not heated	0.0	0.2	0.2	0.4	0.2

Source: RECS, EDRC, 2015

HHs that heat partially heated slightly less than half of the entire house/apartment – 42.7%. Heated areas were slightly larger in MABs compared to individual houses (except for Yerevan).

Table 20. Heated area in a HH, average % in total area

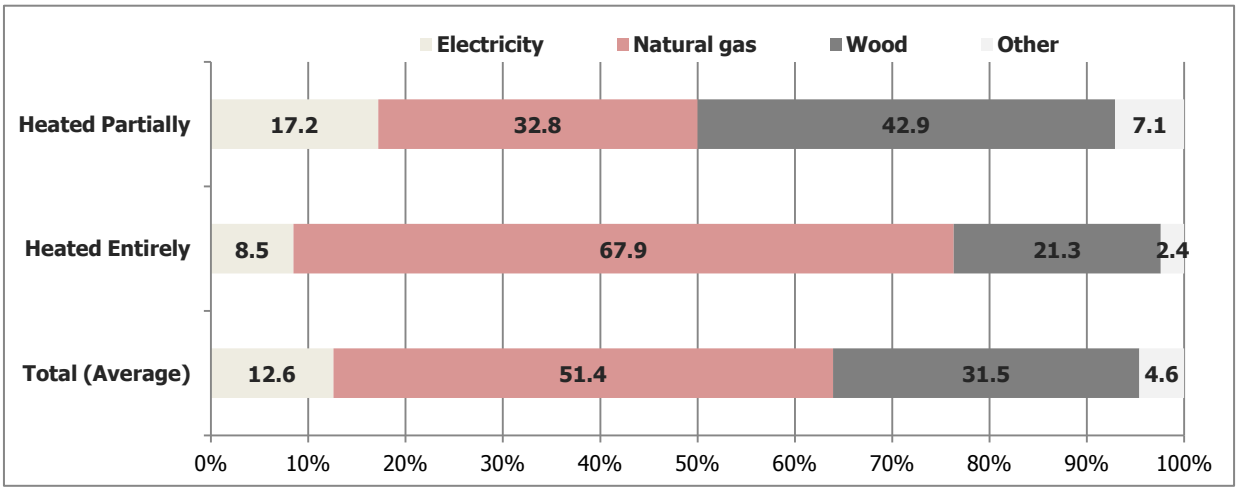
	Yerevan	Other cities and towns	Villages	Total
For partially heated housing				
MABs	44.3	47.5	48.9	45.9
Individual houses	46.6	41.1	40.2	41.3
Total	**45.2**	**43.9**	**40.6**	**42.7**

Source: RECS, EDRC, 2015

Partial heating is more widespread among the HHs that use biofuel, as well as electricity and wood for heating. 64% of all HHs that use electricity or wood as primary heating option heat their houses/apartments partially. As for HHs using natural gas, 30% of HHs heated partially (70% of HHs heated the entire house/apartment).

Thus, the primary heating option is wood for 43% of partially heated HHs, natural gas – for 33% and electricity – for 17%. Wood is a primary heating option for 21% of entirely heated HHs, while natural gas – for 68% and electricity – for 8.5% of HHs.

Figure 3. Main heating options broken down per HHs that heated entirely or partially, %



Source: RECS, EDRC, 2015

The choice of heating option also determines the average temperatures in HHs. The table below presents the breakdown of houses per average temperature estimates in evening hours. In particular, Table 21 presents these estimates broken down per types of communities and partially or entirely heated HHs.

According to estimates, average temperatures reached 15-18 degrees in evening hours during the heating season in 47% of HHs, while for 38% of HHs, they equaled 19-21 degrees. For more than 9% of HHs, average temperatures were below 15 degrees, while they exceeded 21 degrees in 5% of HHs.

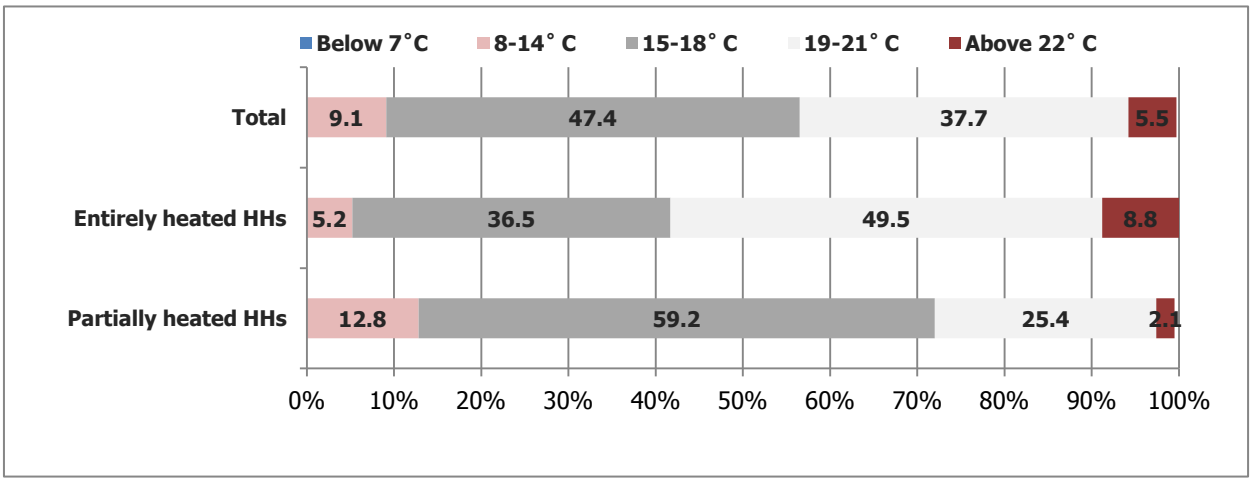
Table 21. Breakdown of HHs per estimates of average temperatures, %

	Yerevan	Other cities and towns	Villages	Total
For all HHs				
Up to 7° C (unbearably cold)	0.3	0.3	0.3	0.3
8-14° C (we hardly cope)	7.9	8.9	10.5	9.1
15-18° C (close to comfortable)	35.4	53.2	55.5	47.4
19-21° C (comfortable)	47.4	33.7	30.5	37.7
Above 22° C	8.9	3.9	3.3	5.5
Total	*100*	*100*	*100*	*100*
For HHs heated entirely				
Up to 7° C (unbearably cold)	0	0	0	0
8-14° C (we hardly cope)	1.9	8.3	7.5	5.2
15-18° C (close to comfortable)	25.2	44.1	48.9	36.5
19-21° C (comfortable)	59.5	41.8	40.0	49.5
Above 22° C	13.4	5.8	3.6	8.8
Total	*100*	*100*	*100*	*100*
For partially heated HHs				
Up to 7° C (unbearably cold)	0.9	0.3	0.4	0.5
8-14° C (we hardly cope)	17.3	9.5	12.1	12.8
15-18° C (close to comfortable)	53.7	64.6	59.1	59.2
19-21° C (comfortable)	26.9	24.1	25.3	25.4
Above 22° C	1.2	1.5	3.1	2.1
Total	*100*	*100*	*100*	*100*

Source: RECS, EDRC, 2015

Figure 4 shows that average temperatures are comparatively higher in entirely heated HHs compared to partially heated HHs. Average temperatures equaled 19-21 degrees in 50% of entirely heated HHs and above 21 degrees – in 9% of such HHs. Nevertheless, in large number of HHs, average temperatures were below 19 degrees despite the fact of heating the house/apartment entirely. Average temperatures equaled 15-18 degrees in 37% of entirely heated HHs and 8-14 degrees in 5% of such HHs.

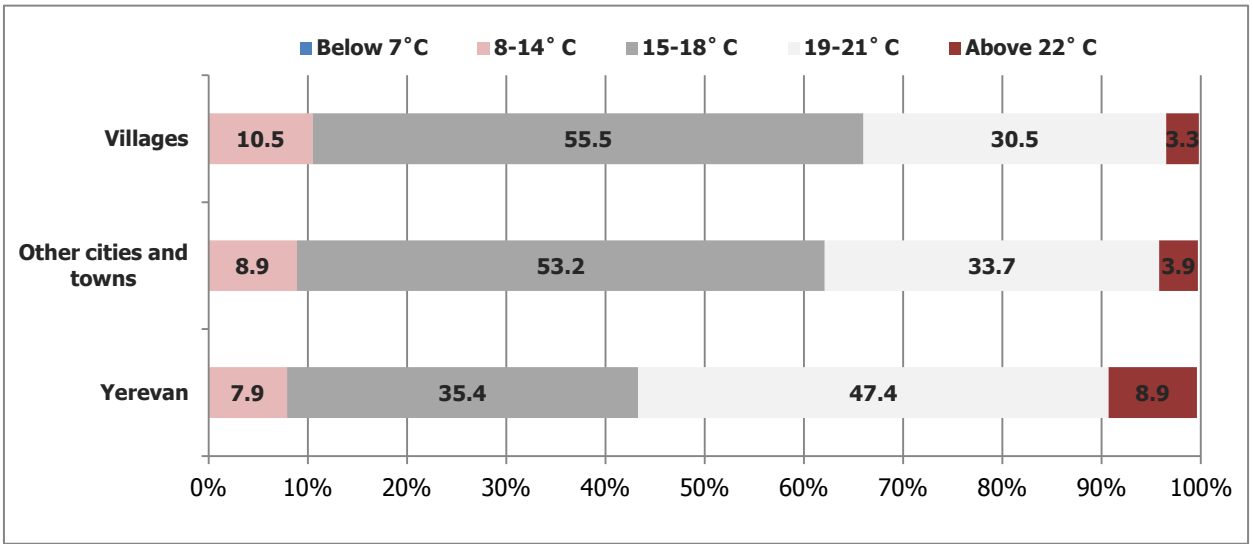
Figure 4. Average temperatures broken down per HHs that heated entirely and partially, %



Source: RECS, EDRC, 2015

Average temperatures also vary depending on the type of community. Average temperatures exceeded 19 degrees in 56% of HHs in Yerevan. Average temperatures in 53% of HHs in other cities and towns equaled 15-18 degrees, while in 9% of such HHs – 8-14 degrees. The situation in this respect is worse in rural areas.

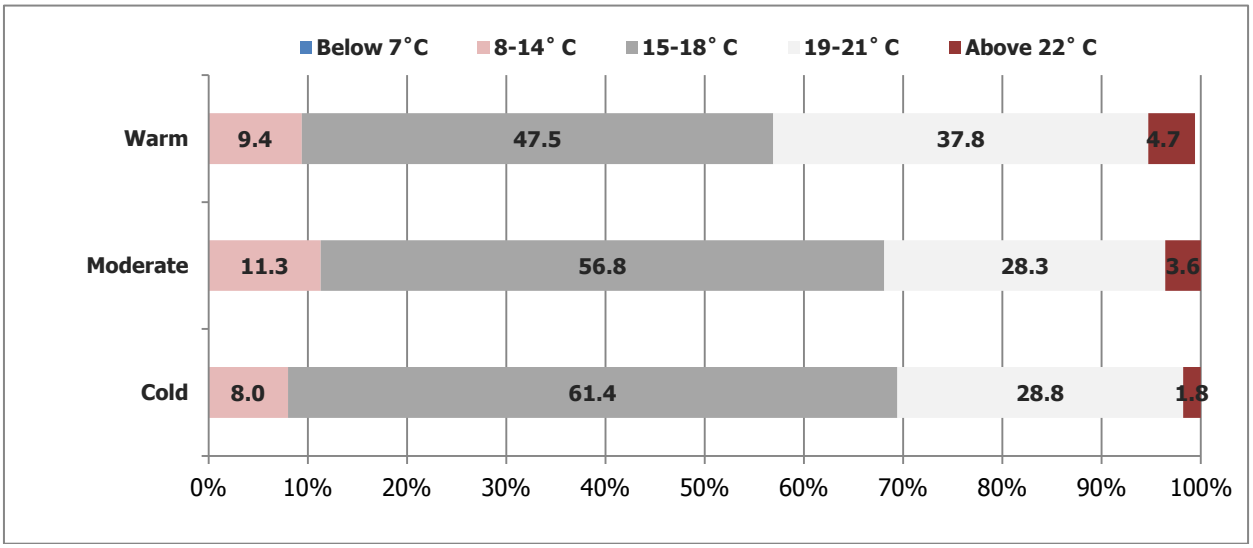
Figure 5. comparison of average temperatures per communities, %



Source: RECS, EDRC, 2015

Temperatures in houses largely depend on the outside temperatures. Observations of HHs broken down per climate areas showed that average temperatures in winter in "warm" areas were considerably higher. For the majority of HHs in "moderate" areas, average temperatures were below the norm: 15-18 degrees in 57% of HHs and 8-14 degrees in 11% of HHs. The situation was worse in "cold" areas.

Figure 6. Comparison of average temperatures per climate areas, %

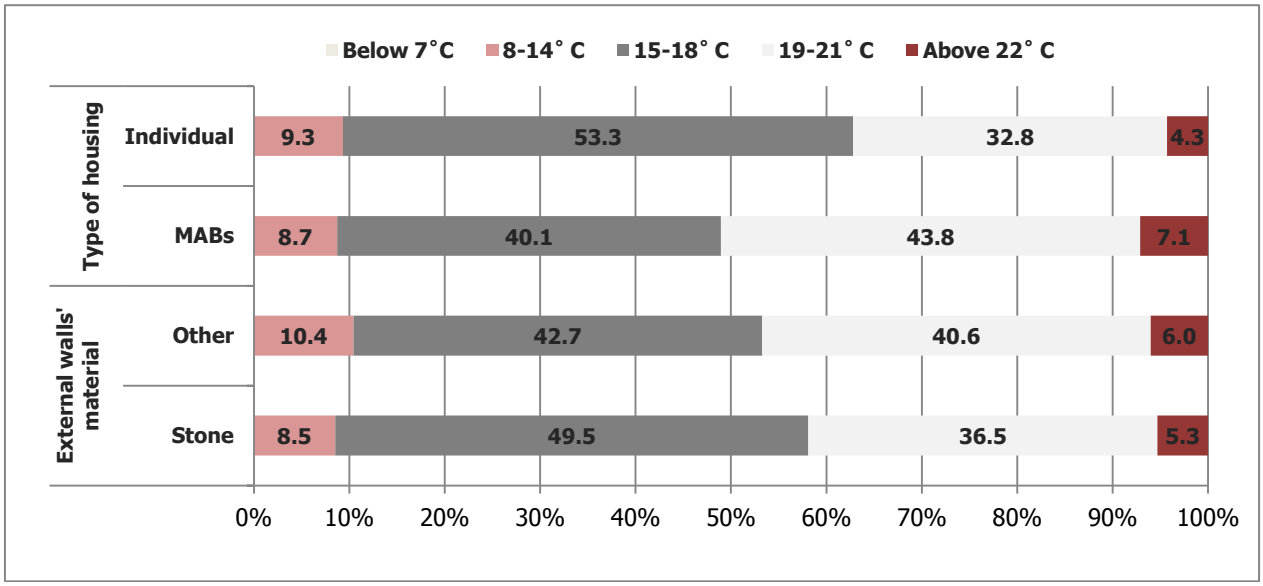


Source: RECS, EDRC, 2015

Comparisons per types of housing showed that average temperatures in individual houses are lower than in MABs. They were in the range of 19-21 degrees in 44% of HHs in MABs and above that range – in 7.1% of such HHs. As for HHs in individual houses, average temperatures were in the range of 19-21 degrees in 33% of HHs and above 21 degrees – in 4 % of such HHs.

Although the stone buildings in comparable conditions provide better thermo-isolation, according to the Survey findings, average temperatures in Armenian HHs living in stone-made buildings/houses were lower than in housing made of other materials. This phenomenon is explained by the large share of individual houses (especially in rural areas) among stone-made housing which are heated with wood.

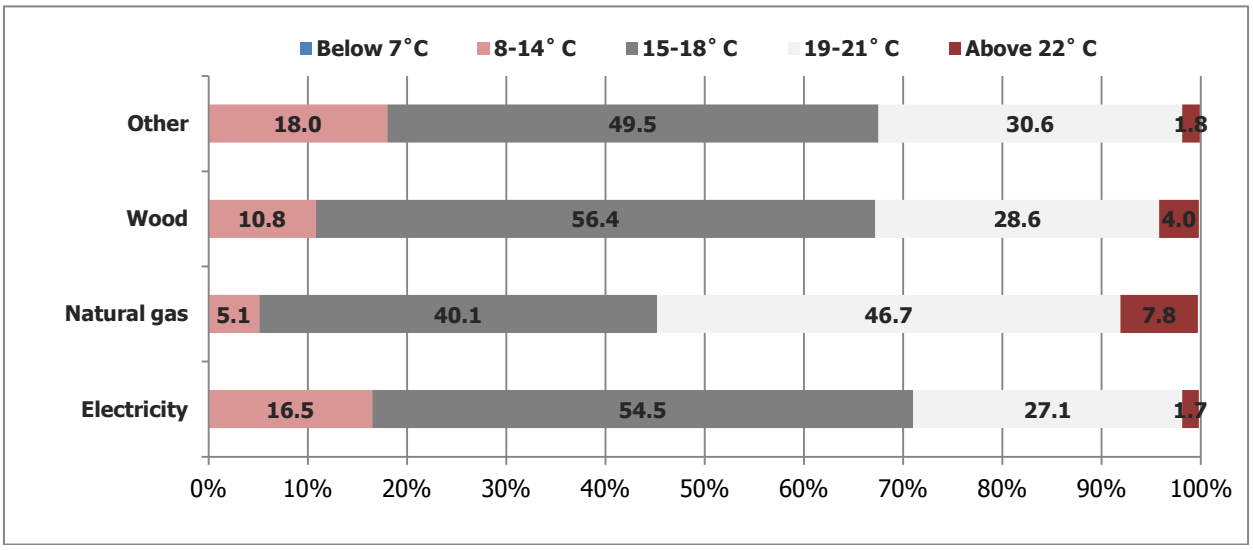
Figure 7. Comparison of average temperatures per type of housing and material of external walls, %



Source: RECS, EDRC, 2015

Thus, apartments in MABs are more energy-efficient compared to individual houses, although the latter are mostly made of stone. Second, the choice of heating option has a stronger correlation with average temperatures than the physical parameters of the building or material of external walls. Use of natural gas for heating is widespread in MABs and panel-monolith buildings. Compared to all other options, temperatures are much higher if natural gas is used for heating.

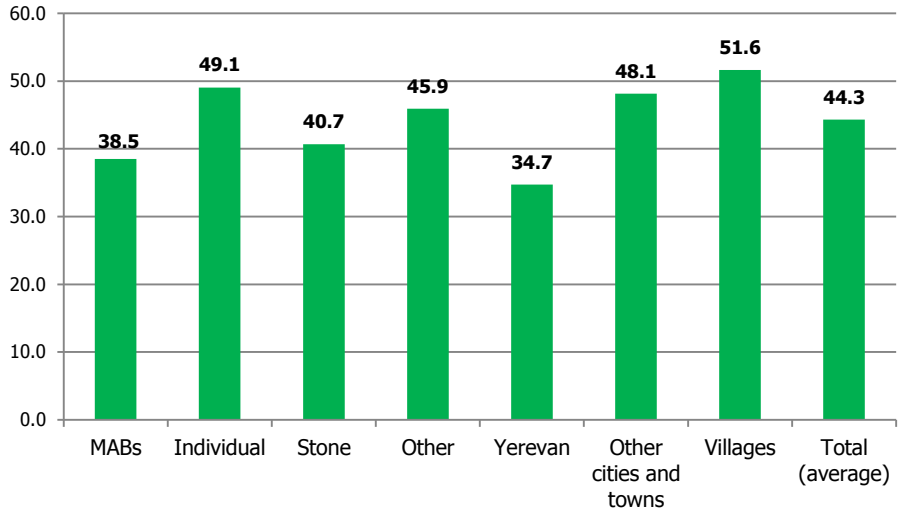
Figure 8. Comparison of average temperatures per main heating option, %



Source: RECS, EDRC, 2015

Possibilities to increase heating efficiency in HHs are not limited to only the choice of heating option which, of course, is an important factor. Coming back to estimates of HHs on potential energy savings in case of window and door replacement, it is worth noting that 44% of HHs believed they will achieve energy savings in that case. 52% of HHs in rural areas or 49% of HHs living in individual houses believed so. Replacement of windows and doors is expected to bring in substantial energy savings and comfortable temperatures also in panel-monolith buildings (46% of HHs), as well as in MABs (39% of HHs).

Figure 9. Breakdown of HHs expecting significant energy savings if windows and doors replaced, %



Source: RECS, EDRC, 2015

4. Hot Water

The main option for hot water for bathing and other purposes in HHs is natural gas. 72% of HHs heated the water with natural gas during the heating season. The next largest option is electricity – 16%. In Yerevan, electricity is more often used as compared to other communities: 23% of HHs heated the water with electricity. In rural areas, 22% of HHs heated the water with wood during the heating season.

The picture does not change much before and after the heating season. Again, HHs using natural gas constituted the largest share in total. The share of HHs using electricity is, again, high in Yerevan. 7% of HHs in rural areas continued using wood for that purpose.

Table 22. Main energy source for hot water, %

	Yerevan	Other cities and towns	Villages	Total
During heating season				
Electricity	22.9	13.2	10.1	15.8
Natural gas	75.9	78.7	62.1	72.2
Wood	0.8	7.3	22.3	9.8
Biofuel	0.0	0.1	4.0	1.4
Other	0.4	0.7	1.5	0.6
Off heating season				
Electricity	23.8	17.2	16.0	19.3
Natural gas	75.4	81.0	70.7	75.6
Wood	0.1	1.1	7.2	2.7
Biofuel	0.0	0.1	2.5	0.9
Liquid gas և Other	0.3	0.5	3.6	1.5

Source: RECS, EDRC, 2015

The Table below summarizes the main options for heating water during the heating season. Interestingly, heating water with natural gas is quite large regardless of the choice of the main heating option. 47% of HHs using electricity for heating, 59% of HHs using wood for heating and 47% of HHs using biofuel for heating, heat the water with natural gas.

Table 23. Main options for hot water during the heating season per main heating options, %

	Main heating option						
Hot water with:	**Electricity**	**Natural gas**	**Wood**	**Biofuel**	**Other**	**Did not heat**	**Total**
Electricity	52.8	9.8	12.1	2.5	13.3	40.0	15.8
Natural gas	46.9	90.0	56.8	46.9	56.7	40.0	72.2
Wood	0.0	0.2	30.0	8.6	0.0	0.0	9.8
Biofuel	0.0	0.0	0.1	39.5	0.0	0.0	1.4
Other	0.3	0.1	0.9	2.5	30.0	20.0	0.9
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: RECS, EDRC, 2015

Cases of using renewable energy sources for either heating or hot water are very insignificant or statistically almost non-existent. In rural areas, use of direct sunlight to heat water in large tanks is quite usual, though.

5. Air Conditioning

Air conditioning in houses and apartments became popular in recent years. Nevertheless, only 5% of HHs have air conditioners installed. Use of air conditioners is relatively widespread in Yerevan – 10% of HHs.

Table 24. Air conditioners in HHs, %

	Yerevan	Other cities and towns	Villages	Total
Have	10.3	1.4	2.0	4.9
Do not have	89.7	98.6	98.0	95.1
Total	**100.0**	**100.0**	**100.0**	**100.0**

Source: RECS, EDRC, 2015

About half of HHs that had air conditioners used it for 1 month in summer. 25% of HHs in Yerevan use air conditioning 1-2 months, another 25% - 3 months.

Duration of air conditioning during the day mostly equals 4 hours. 30% of HHs in Yerevan was air conditioning for 5-10 hours and only 6% - more than 10 hours.

Table 25. Frequency of air conditioning and duration in summer months in HHs, %

	Yerevan	Other cities and towns	Villages	Total
Frequency of use in summer months				
About 1 month	49.5	60.0	50.0	50.4
1-2 months	25.3	20.0	18.8	23.9
3 months	25.3	20.0	31.3	25.6
Total	**100.0**	**100.0**	**100.0**	**100.0**
Duration of use per day				
Up to 4 hours	64.7	80.0	69.2	66.7
5-10 hours	29.4	20.0	23.1	27.8
11-18 hours	5.9	0.0	7.7	5.6
Total	**100.0**	**100.0**	**100.0**	**100.0**

Source: RECS, EDRC, 2015

6. Home Appliances

6.1. Kitchen Appliances and Food Preparation

HHs mainly use gas stoves for food preparation – 63%. Meanwhile, 5.9% of HHs use electric stoves and 31% - combined stoves (both with gas and electricity). Overall, almost all HHs (99.3%) have one of the mentioned types of stoves (see Table 26 and Figure 12).

Ovens are used by 76% of HHs. Notably, electric ovens are more widespread. 64% of HHs use electric ovens and 15% - gas ovens (about 2% have both types).

Microwave ovens are used by 9% of HHs. They are more popular in Yerevan – 15% of HHs. 35% of HHs have electric kettles which are, again, more widespread in Yerevan (41%). Only 1% of HHs have dishwashers with 2% of HHs only in Yerevan.

Almost all HHs have fridges and only 4.3% of HHs have freezers.

Table 26. Main kitchen appliances in HHs, %

	Yerevan	Other cities and towns	Villages	Total
Kitchen stoves				
Electric	5.4	6.1	6.4	**5.9**
Natural or liquid gas	55.2	67.1	68.8	**63.2**
Combined: electricity and gas	39.9	27.0	25.1	**31.1**
Ovens				
Electric	56.1	65.1	71.4	**63.8**
Natural or liquid gas	14.4	17.5	12.8	**14.8**
Microwave oven	14.6	6.9	4.2	**8.9**
Electric kettle	40.6	33.8	30.5	**35.2**
Dishwasher	2.0	0.4	0.8	**1.1**
Fridge	99.1	97.2	96.6	**97.7**
Freezer	6.5	2.9	3.0	**4.3**

Source: RECS, EDRC, 2015

Table 27 summarizes the estimates of average daily use durations for the abovementioned main appliances. Stoves are used mostly 1-4 hours, while ovens – up to 1 hour.

Electric kettles are used up to 1 hour in majority of HHs. In HHs with dishwashers, the latter are used up to 1 hour in 52% of such HHs and 1-4 hours in 48% of such HHs.

Fridges and freezers are switched on for more than 12 hours a day.

Table 27. Duration of use of main kitchen appliance per day, %

	Up to 1 hour	1-4 hours	More than 4 hours	More than 12 hours
Kitchen stoves				
Electric	28	60.8	11.2	-
Natural or liquid gas	25.9	64.5	9.7	-
Combined: electricity and gas	19.8	74.2	6	-
Ovens				
Electric	82	17.1	1	-
Natural or liquid gas	81.8	18.2	0	-
Microwave oven	94.4	5.6	0	-
Electric kettle	87.8	12.2	0	-
Dishwasher	51.9	48.1	0	-
Fridge	0	0.3	0.6	99
Freezer	0	0	1.9	98.1

Source: RECS, EDRC, 2015

6.2. Other Home Appliances

Irons, vacuum cleaners and washing machines are the most frequent home appliances used by HHs. 98% of HHs have irons, while 93% of HHs have some type of washing machine. 77% of HHs have vacuum cleaners: their share is smaller in villages – 67% of HHs.

The Table below summarizes the average durations for iron, vacuum cleaner and washing machine uses per week.

Table 28. Home appliances and frequency of use, %

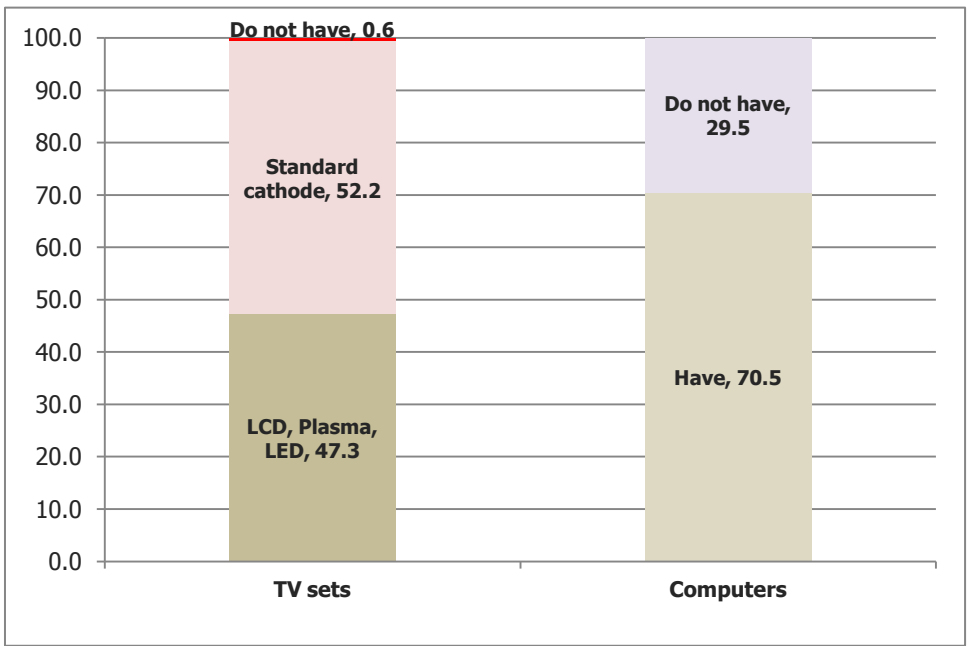
	HHs having home appliances per communities, %				Use per week		
	Yerevan	Other cities and towns	Villages	Total	Less than once	2 - 4 times	5 - 9 times
Washing machine	96.3	92.8	90.2	93.3	14.4	46.5	39.1
Vacuum cleaner	84.4	80.3	66.6	77.3	24.1	48.0	27.9
Iron	98.5	97.4	98.5	98.2	25.4	49.7	24.9

Source: RECS, EDRC, 2015

According to the Survey findings, almost all HHs have TV sets. Notably, 47% of them are produced with technology used in recent years, while 52% are cathode TVs.

Use of computers also became widespread in recent years. In 70% of HHs, there is at least 1 computer.

Figure 10. TVs and computers in HHs, %



Source: RECS, EDRC, 2015

The number of HHs having more than one TV set is quite large. 21% of HHs have 2, while 6% - have 3 and mote TV sets. The share of HHs with 2 and more TVs is higher in Yerevan than in other cities and towns.

65% of HHs have 1 computer, while 6% of HHs have 2 and more computers. Thus, 8% of HHs having computers have more than 1.

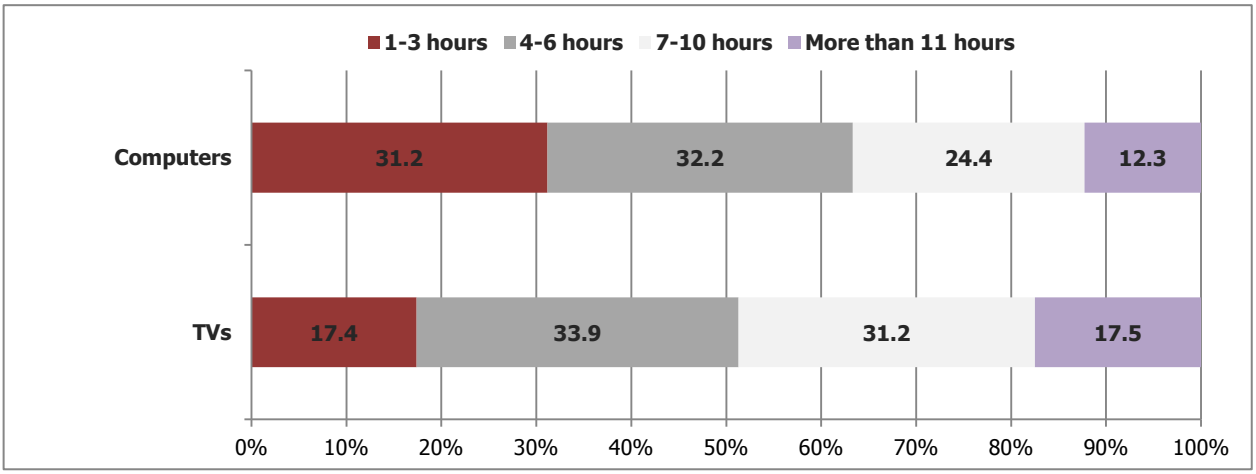
Table 29. TV sets and computers per community types, %

	Yerevan	Other cities and towns	Villages	Total
TV sets				
1	63.8	75.5	79.7	72.6
2	26.7	20.5	16.3	21.4
3	7.3	3.7	2.9	4.8
4 and above	2.1	0.3	1.0	1.2
Total	100	100	100	100
Computers				
1	65.9	66.7	61.1	64.6
2	7.8	3.9	2.6	4.9
3 and above	1.9	0.7	0.4	1.0
Do not have	24.4	28.7	35.9	29.5
Total	100	100	100	100

Source: RECS, EDRC, 2015

Average daily duration of a TV use is longer than that of computers. TV is used for than 7 hours per day in 49% of HHs, while computers – in 37% of HHs. For more details, see the Figure below.

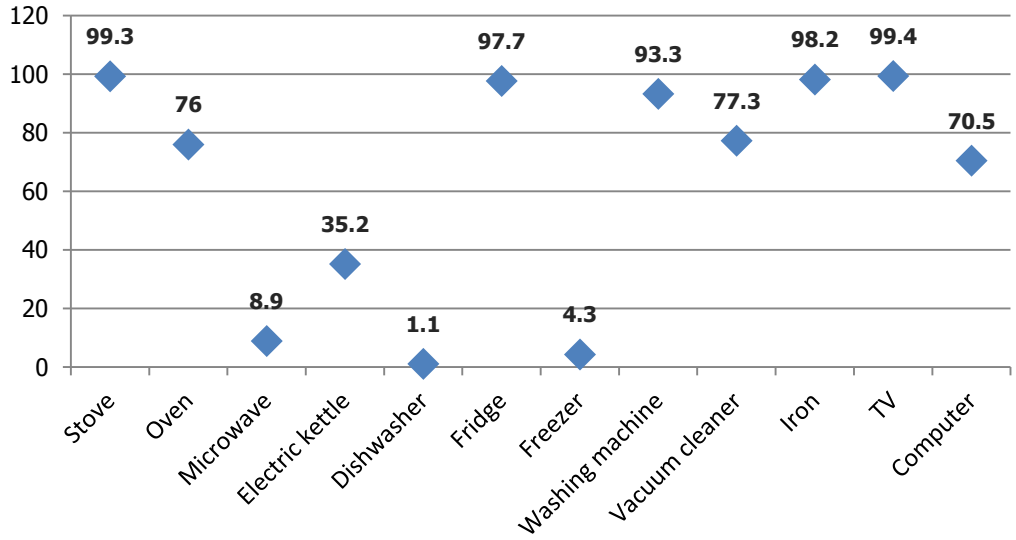
Figure 11. Average daily duration of use of TVs and computers in HHs, %



Source: RECS, EDRC, 2015

The Figure below summarizes the existence of various home appliances in HHs.

Figure 12. Main home appliances and equipment in HHs, % (shares of HHs having such appliances in the total



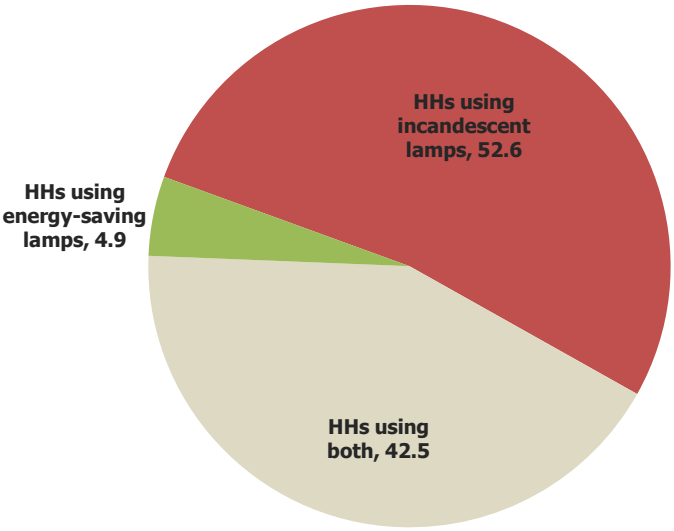
Source: RECS, EDRC, 2015

7. Lighting

7.1. Used Options and Energy Consumption

In Armenia, mostly incandescent lamps are used for lighting. Nevertheless, energy-saving lighting became quite widespread. 53% of HHs use only incandescent lamps for lighting, while 43% combine various options (energy-saving and non-energy-saving); while 5% use only energy-saving lamps.

Figure 13. Lighting options used by Armenian HHs, %



Source: RECS, EDRC, 2015

Table 30 presents the options of lighting per types of communities. As one can see from the Table, energy-saving lighting is used relatively more frequently in Yerevan and small villages: 6.6% and 2.6% respectively.

Table 30. Lighting options used by HHs, %

	Yerevan	Other cities and towns	Villages	Total
		In the total for the group		
HHs using incandescent lamps	93.4	94.6	97.4	95.1
HHs using only incandescent lamps	50.8	50.6	56.4	52.6
HHs using both	42.6	44.0	40.9	42.5
HHs using only energy-saving lamps	6.6	5.4	2.6	4.9

Source: RECS, EDRC, 2015

Although 53% of HHs use only incandescent lamps for lighting, such lamps are used in overwhelming majority of HHs – 95% of total. 20% of HHs also use halogen incandescent lamps. The most widespread type of energy-saving lamps is compact luminescent lamps, which is used in 32% of HHs. Luminescent lamps are used in 5% of HHs, while LED – in 3% of HHs. The use of the latter is higher in HHs in Yerevan – 6% (see Table 31).

Table 31. Main types of lamps used, HH numbers, %

	Yerevan	Other cities and towns	Villages	Total
1. Incandescent	93.4	94.6	97.4	95.1
2. Halogen incandescent	21.1	21.0	17.8	20.0
3. Luminescent	4.7	4.5	6.4	5.2
4. Compact luminescent	32.8	36.2	28.2	32.3
5. LED	6.4	1.9	1.4	3.4

Source: RECS, EDRC, 2015

In all HHs using combined options for lighting, there are incandescent lamps. Meanwhile, there are halogen incandescent lamps among 42% of HHs using combined options and luminescent lamps – in 10% of HHs. 67% of such HHs also use compact luminescent lamps and 6% - LED lamps.

Among HHs not using incandescent lamps, HHs using luminescent lighting constitutes the highest share – 82%, followed by HHs using halogen incandescent lamps (45%). The shares of HHs using Luminescent and LED lamps are almost the same – 16% (see Table 32).

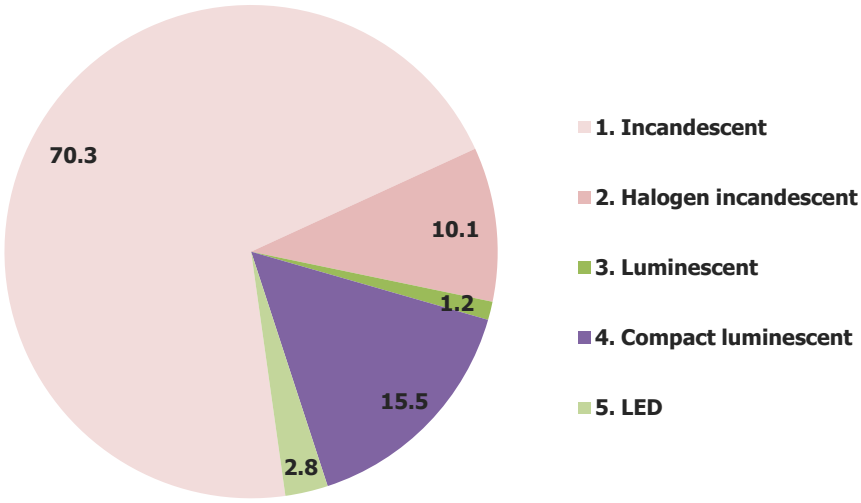
Table 32. Use of lamps per lighting options, % of HHs

	Total HHs	HHs using both		HHs using only energy-saving lamps	
	Share in total HHs	Share in the group	Share in total HHs	Share in the group	Share in total HHs
1. Incandescent	95.1	100.0	42.5	0.0	0.0
2. Halogen incandescent	20.0	41.9	17.8	44.5	2.2
3. Luminescent	5.2	10.4	4.4	16.0	0.8
4. Compact luminescent	32.3	66.6	28.3	81.5	4.0
5. LED	3.4	6.1	2.6	16.0	0.8
Total HHs	**100.0**	**100.0**	**42.5**	**100.0**	**4.9**

Source: RECS, EDRC, 2015

Figure 15 presents the breakdown of HHs per uses of various types of lamps. 70% of all lamps used in HHs are incandescent lamps, while 15.5% - compact luminescent and 10% - halogen incandescent lamps. LED lamps constitute 2.8% of all lamps used in HHs, while luminescent lamps – 1.2%.

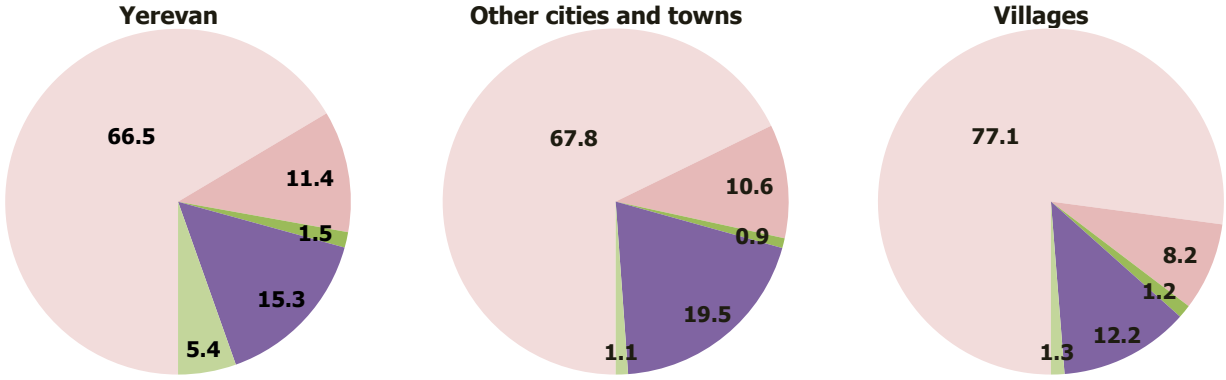
Figure 14. Breakdown of all lamps per types, %



Source: RECS, EDRC, 2015

The overall picture does not change much depending on the type of community. LED lamps are used more frequently in Yerevan (5.4%), while compact luminescent lamps – in other cities and towns (19.5%) and incandescent lamps – in villages (77%).

Figure 15. Breakdown of lamp types per community types, %



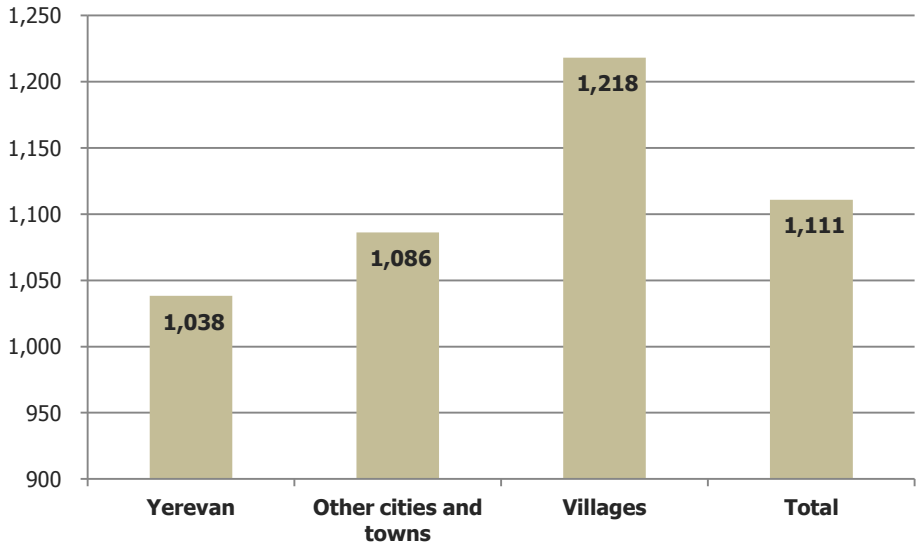
1.Incandescent, 2. Halogen incandescent, 3. Luminescent 4. Compact luminescent, 5. LED

Source: RECS, EDRC, 2015

Based on RECS data, energy consumption for lighting was calculated. According to that estimates, 1.1 kWt.h is consumed on average by 1 HH per day for lighting in summer months (see Figure 16 and Table 33).

Average energy consumption for lighting is the lowest in Yerevan and the highest in villages. This, first of all, is determined by the types of lamps used for lighting (energy-saving lamps are used more frequently in Yerevan).

Figure 16. Estimates of energy consumption by an average HH on lighting per day broken down per community types, Wt.h

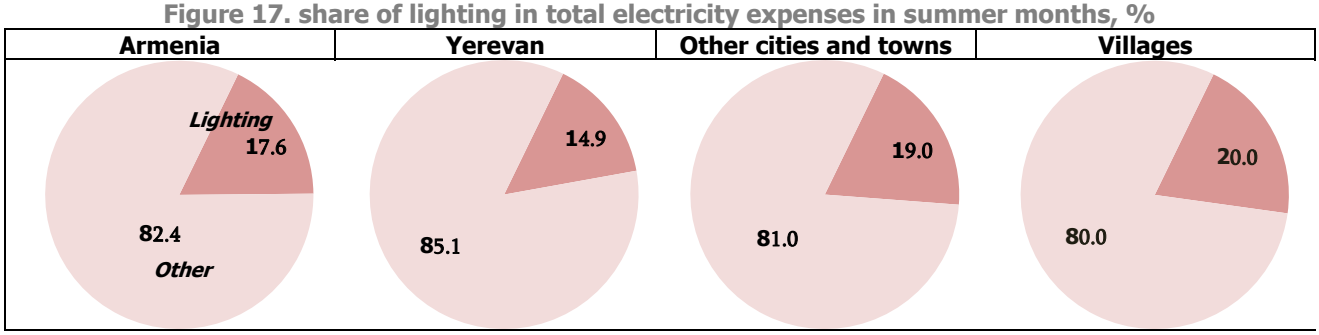


Source: RECS, EDRC, 2015 and authors' estimates

As a result, overall energy consumption of HHs for lighting was calculated as share in total electricity consumption. Thus, energy consumption for lighting of an average HHs in Armenia is 18% of total energy consumption in summer months.

The share of energy consumption for lighting in the total is lower in Yerevan – 15%, while it is higher in rural areas – about 20% of total electricity consumption.

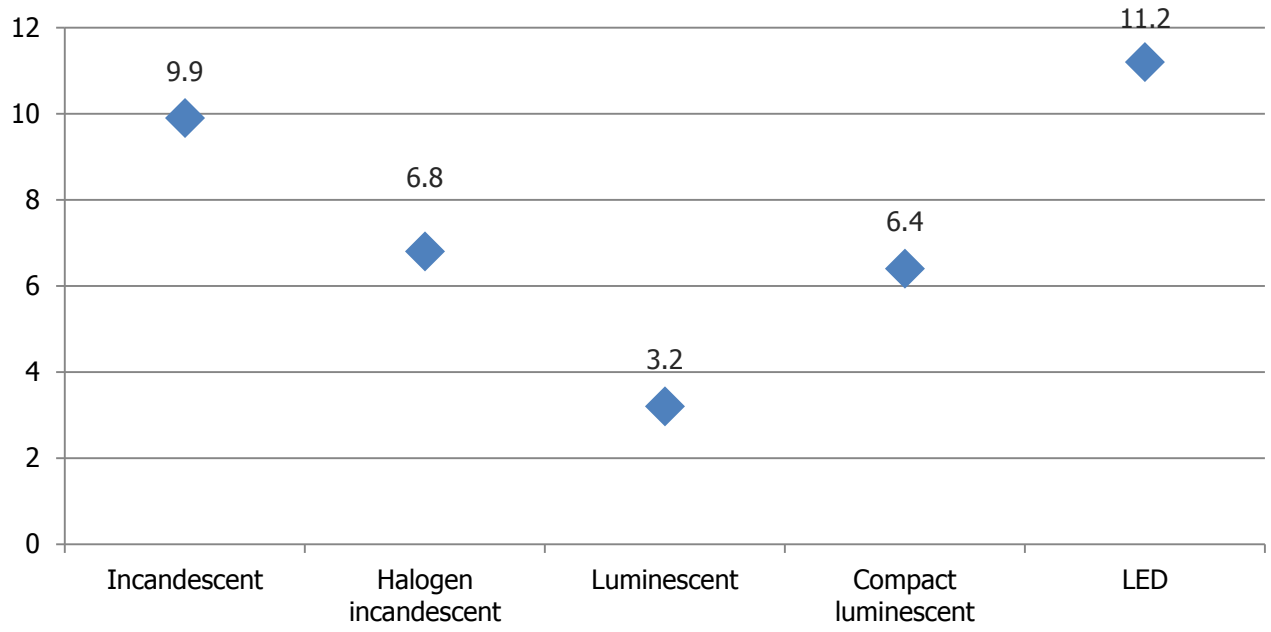
Figure 17. share of lighting in total electricity expenses in summer months, %



Source: RECS, EDRC, 2015 and authors' estimates

Figure 18 presents the number of lamps in and average HH, broken down per types of lamps. According to that presentation, there are on average 11.2 lamps in HHs using LED and 9.9 lamps in HHs using incandescent lamps. The number of luminescent lamps is the lowest - 3.2 lamps.

Figure 18. Average number of lamps in a reference HH



Source: RECS, EDRC, 2015

More details on energy consumption per types of lamps are presented in Table below.

Table 33. Indicators of lighting lamps use per community types

	Yerevan	Other cities and towns	Villages	Total
1. Incandescent lamps				
Reference number of HHs	837	688	773	2298
Total number of lamps in 1 HH, average	9.90	9.20	10.47	9.88
Capacity per 1 lamp, Wt	68.88	72.82	76.85	72.8
Duration of use per lamp per day, hours	1.986	2.214	2.030	2.069
Electricity consumption in 1 HH per day, Wt.h *	1,354.2	1,483.1	1,632.6	1,488.6
2. Halogen incandescent lamps				
Reference number of HHs	189	153	141	483
Total number of lamps in 1 HH, average	7.50	6.49	6.12	6.78
Capacity per 1 lamp, Wt	37.66	31.36	33.51	34.66
Duration of use per lamp per day, hours	4.22	3.97	3.81	4.02
Electricity consumption in 1 HH per day, Wt.h *	1,192.0	807.5	781.9	944.5
3. Luminescent lamps				
Reference number of HHs	42	33	51	126
Total number of lamps in 1 HH, average	4.31	2.61	2.57	3.16
Capacity per 1 lamp, Wt	37.50	25.21	36.19	34.41
Duration of use per lamp per day, hours	2.73	2.99	3.23	3.00
Electricity consumption in 1 HH per day, Wt.h *	440.6	196.1	300.0	325.8
4. Compact luminescent lamps				
Reference number of HHs	294	263	224	781
Total number of lamps in 1 HH, average	6.49	6.93	5.70	6.41
Capacity per 1 lamp, Wt	15.92	16.58	16.47	16.30
Duration of use per lamp per day, hours	2.70	3.22	3.33	3.05
Electricity consumption in 1 HH per day, Wt.h *	278.5	370.3	312.5	319.2
5. LED				
Reference number of HHs	57	14	11	82
Total number of lamps in 1 HH, average	11.88	7.64	12.00	11.17
Capacity per 1 lamp, Wt	6.80	7.64	10.01	7.36
Duration of use per lamp per day, hours	3.08	2.84	3.13	3.04
Electricity consumption in 1 HH per day, Wt.h *	248.7	166.2	375.3	250.4
Total electricity consumption in 1 reference HH per day, Wt.h*	**1,038**	**1,086**	**1,218**	**1,111**
Estimate of monetary cost of electricity for lighting in 1 reference HH per month, AMD**	**1,294**	**1,354**	**1,518**	**1,385**

**Calculated for each type of lamp as a weighted average for average number, capacity and average daily use.*

*** Estimates were based on assumptions of 30.5 days per month and AMD 40.5 tariff per 1 kWt.h as average daily reference tariff.*

Source: RECS, EDRC, 2015 and authors' estimates

7.2. Awareness on Energy-Saving Lamps

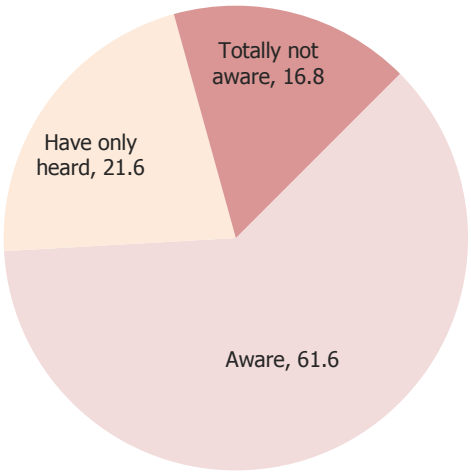
The level of awareness on energy-saving lamps among the population is not low. 62% of HHs mentioned that they were aware of such lamps, while 22% - "heard of" such lamps.

Table 34. Awareness on energy-saving lamps per types of communities, %

	Yerevan	Other cities and towns	Villages	Total
Aware	61.8	64.1	59.2	61.6
Have only heard	20.0	21.6	23.3	21.6
Totally not aware	18.2	14.3	17.5	16.8
Total	**100.0**	**100.0**	**100.0**	**100.0**

Source: RECS, EDRC, 2015

Figure 19. Awareness on energy-saving lamps in Armenia, %



Source: RECS, EDRC, 2015

41% of HHs agreed that energy-saving lamps are "more efficient", while 48% - that such lamps have "longer life". 26% of HHs did not specify any of the suggested advantages.

Table 35. Advantages of energy-saving lamps, %

	Yerevan	Other cities and towns	Villages	Total
1. High efficiency	44.1	39.0	38.2	40.6
2. Brightness	16.9	13.8	13.0	14.7
3. Longer life/operation	49.1	48.0	47.2	48.1
4. Other	0.3	0.5	0.9	0.5
5. No answer	23.7	27.3	28.5	26.4
Total	**100**	**100**	**100**	**100**

Source: RECS, EDRC, 2015

32% of HHs did not have any answer on disadvantages of energy-saving lamps. 47% mentioned that they were expensive and not affordable. 20% of HHs mentioned they do not like the color of the light from energy-saving lamps. 6.3% of HHs believed that such lamps are not healthy, while 5.6% believe those are of low quality.

Table 36. Disadvantages of energy-saving lamps, %

	Yerevan	Other cities and towns	Villages	Total
Expensive (not affordable)	40.4	51.4	49.0	46.6
The light is not pleasant	16.1	20.4	23.5	19.8
Do not match to lighting appliances	6.3	6.6	5.2	6.0
Contains mercury and not healthy	8.0	6.4	4.1	6.3
Low quality	4.5	5.5	7.0	5.6
No answer	37.9	28.3	29.8	32.3
Total	**100**	**100**	**100**	**100**

Source: RECS, EDRC, 2015

The main source of information on energy-saving lamps are relatives, friends and acquaintances (62%), shops (34%), as well as TV (42%).

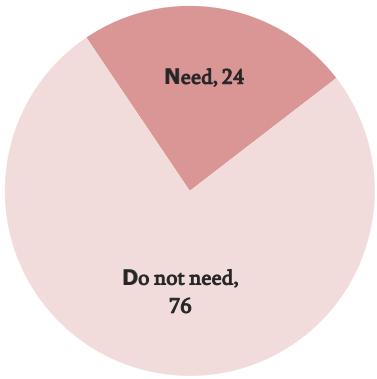
Table 37. Main sources of information on energy-saving lamps, %

	Yerevan	Other cities and towns	Villages	Total
TV	36.0	46.1	45.3	42.2
Newspapers, magazines	2.5	5.9	1.8	3.3
Internet	12.3	17.3	9.0	12.8
Radio	0.8	0.5	0.6	0.6
Friends, relatives, colleagues, neighbors etc	60.4	64.2	62.0	62.1
Billboards/external ads	4.4	2.2	2.6	3.1
Shops	38.2	31.3	31.5	33.9
Total	**100**	**100**	**100**	**100**

Source: RECS, EDRC, 2015

Number of those who would prefer to get additional information is not large. 24% of HHs mentioned they needed more information, while 76% - did not.

Figure 20. HHs that needed additional information on energy-saving lamps, %



Source: RECS, EDRC, 2015

The share of HHs that wanted more information is slightly higher in other cities and towns as compared to Yerevan and rural areas (see Table 38).

Table 38. HHs that needed additional information, %

	Yerevan	Other cities and towns	Villages	Total
Need additional info	22.8	27.0	22.4	24.0
Do not need additional info	77.2	73.0	77.6	76.0
Total	**100**	**100**	**100**	**100**

Source: RECS, EDRC, 2015

37% of HHs prefer receiving information from relatives and friends. 29% of HHs mentioned TV, while 15% - shops. Preference of other sources of information is very small.

Overall, confidence towards formal (institutional) sources is low: 6.7% of HHs does not trust any source, while 5.4% trusts only their own experience.

Table 39. Reliable and preferred sources of information, %

	Yerevan	Other cities and towns	Villages	Total
TV	22.0	32.7	33.0	28.9
Newspapers, magazines	1.5	3.9	1.1	2.1
Internet	13.2	11.2	8.2	11.0
Radio	0.7	0.2	0.3	0.4
Friends, relatives, colleagues, neighbors etc	38.2	35.3	35.7	36.5
Billboards/external ads	1.4	1.3	2.4	1.7
Shops	21.3	12.8	10.4	15.1
Do not trust any source	4.9	4.8	10.4	6.7
Trust only their own experience	5.9	4.7	5.6	5.4
Total	**100**	**100**	**100**	**100**

Source: RECS, EDRC, 2015

7.3. Reasons for Not Using Energy-Saving Lamps

Reasons for not using energy-saving lamps and energy-efficient lighting options are various. Nevertheless, the main reason is financial affordability.

Among responses of HHs about reasons for not using energy-efficient lighting options, the prevailing response is "high price/expensive" mentioned by 35% of HHs.

Although 17% of HHs responded that they were not aware of advantages, however responses to other questions prove that the level of awareness is low.

There were numerous responses noting the negative attitude towards such lamps and their quality.

Table 40. Reasons for not using energy-saving lamps, %

	Yerevan	Other cities and towns	Villages	Total
Expensive	29.1	38.4	38.7	35.0
Already use (entirely or partially)	30.0	30.5	23.4	28.0
Not aware of advantages	13.4	17.3	21.9	17.4
No need, not necessary	14.8	14.4	15.4	14.9
Not sure on possible savings	9.3	9.9	8.3	9.1
Do not trust the quality	7.4	7.2	7.1	7.2
Overall attitude is negative	4.1	8.4	6.2	6.1
Light is not pleasant	1.8	1.2	1.6	1.6
Prefer to switch to	1.5	1.1	1.5	1.4
Does not match the existing lighting appliances	1.6	1.5	0.9	1.3
Affects health and eyes	1.1	0.96	0.4	0.8
Not sold in shops nearby	0.0	0.4	0.6	0.3
Total	**100**	**100**	**100**	**100**

Source: RECS, EDRC, 2015

69% of HHs that mentioned the price as the reason for not switching to energy-efficient options is willing to pay AMD 500 per one energy-saving lamp. 17% of such HHs is willing to pay AMD 500-800, while 4% - up to AMD 1500.

Table 41. Estimates of possible price per 1 energy-saving lamp, %

	Yerevan	Other cities and towns	Villages	Total
Below AMD 500	63.6	71.9	70.3	68.8
AMD 500 – 800	16.6	15.3	18.2	16.8
AMD 800 – 1,500	6.7	2.9	2.7	4.0
AMD 1,500 – 2,500	0.8	0.7	0.3	0.6
No answer	12.3	9.1	8.4	9.8
Total	**100**	**100**	**100**	**100**

* Only those HHs answered that mentioned the high price as the reason for not using energy-saving lamps.

Source: RECS, EDRC, 2015

Current duration of lighting and intensity may change when switched to energy-efficient options. 51% of HHs mentioned that duration of lighting will not changed if energy-efficient options are used, while 19% mentioned that it will increase. 30% of HHs did not have an answer to that.

Table 42. Estimates of possible changes in lighting duration is switched to energy-saving options, %

	Yerevan	Other cities and towns	Villages	Total
Will not change	60.6	43.0	48.9	50.9
Will increase	11.6	24.6	20.1	18.8
No answer	27.8	32.4	31.0	30.4
Total	**100**	**100**	**100**	**100**

Source: RECS, EDRC, 2015

8. Consumption of Fuel and Expenses

8.1. Consumption of Main Fuel Types and Payments

This section discusses the consumption of mail fuel types by HHs and payments for them. According to RECS Survey, an average HH in Armenia consumed about 194 kWt.h electricity in summer months with total monthly payment of AMD 7,700[4]. In winter months, electricity consumption increases by about 75% with average monthly payment of AMD 14000. Electricity consumption is higher in Yerevan: AMD 8500 in summer and about AMD 17 thousand – in winter.

Electricity consumption varies depending on the type of HH and is quite uneven. For the lowest 10% of HHs consuming electricity, average monthly payment in summer is about AMD 2,500 which is 6 times lower than the payment of an average HH in the highest 10% of HHs. In winter months, the difference between the lowest and highest 10% of HHs is even larger – more than 12 times.

Table 43. Data on average electricity consumption by HHs, AMD per month

	Yerevan	Other cities and towns	Villages	Total
Average for summer months (July)	**8,557**	**7,046**	**7,506**	**7,757**
Median	8,000	7,000	7,000	8,000
Lowest 10%, average	2,780	2,300	2,239	2,517
Highest 10%, average	16,698	13,746	15,430	15,540
Average for winter months (January)	**16,879**	**12,768**	**10,816**	**13,651**
Median	14,000	10,000	8,750	11,000
Lowest 10%, average	4,456	3,132	2,409	3,102
Highest 10%, average	44,959	36,145	31,227	38,827

Source: RECS, EDRC, 2015

HHs consuming natural gas in any form consume on average 38 c.m. in summer months with total payment of AMD 5,900. In winter, their consumption increases 4.7 times, reaching AMD 28,000.

The difference between gas consumption in lowest and highest deciles is very large – about 30 times. The lowest decile on average pays AMD 3 thousand per month, while the highest – on average AMD 82 thousand.

Table 44. Average data on consumption of natural gas by HHs, AMD per months

	Yerevan	Other cities and towns	Villages	Total
Average for summer months	**6,081**	**5,938**	**5,796**	**5,953**
Median	5,441	5,134	5,097	5,259
Lowest 10%, average	1,608	1,817	2,173	1,808
Highest 10%, average	12,950	12,453	12,401	12,647
Average for winter months	**32,360**	**29,321**	**20,371**	**27,911**
Median	30,000	25,000	10,000	24,000
Lowest 10%, average	3,332	3,179	2,528	2,919
Highest 10%, average	79,488	82,089	84,548	82,203

Source: RECS, EDRC, 2015

Use of wood for household purposes in summer months is negligent. In winter, HHs on average consume 1.8 c.m. wood per month with monthly expenses of about AMD 31 thousand. The data does

[4] Weighted average data are presented. Actual average effective tariff for a day equals AMD 40.

not take into account the cases of provision of subsidized or free-of-charge wood to HHs living in areas near forests.

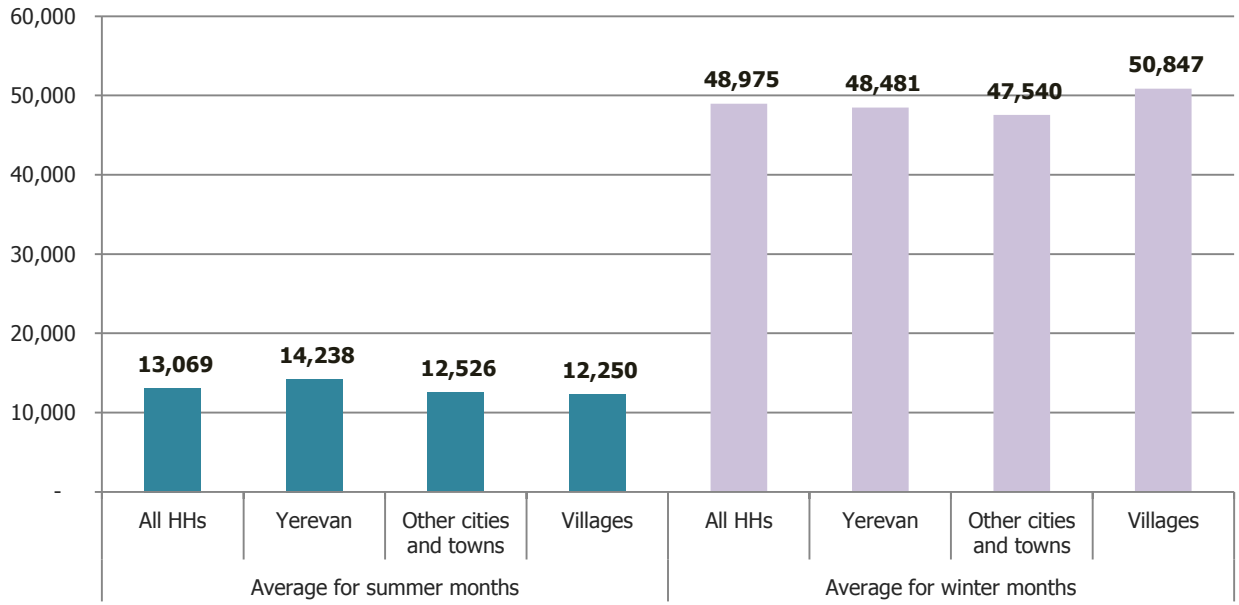
Table 45. Wood consumption data by HHs in winter months

	Yerevan	Other cities and towns	Villages	Total
Average monthly quantity, c.m.	1.3	1.6	1.9	1.8
Average monthly cost, for all HHs using wood	26,310	27,776	32,046	30,692
Average monthly cost, for HHs mostly using wood for heating	27,936	28,283	32,854	31,463

Source: RECS, EDRC, 2015

Thus, payments for the main 3 types of fuel (natural gas, electricity, wood) total to AMD 13 thousands for an average HH in summer months and AMD 49 thousands – in winter. Average for payments for fuel in summer months is the highest is Yerevan, while in winter – in villages.

Figure 21. Average monthly payments for the main three energy types, AMD



Source: RECS, EDRC, 2015

Consumption volumes and payments for fuel in winter months are mostly determined by the choice of heating option. Table 46 presents expenditures for fuel broken down per heating options.

HHs that use electricity for heating pay AMD 36 thousands for all fuel types, including AMD 28 thousands for electricity and AMD 9,700 – for natural gas (if applicable). Among these HHs, number of HHs using wood is very small.

HHs that use natural gas for heating pay AMD 55 thousand, including AMD 13 thousand – for electricity and AMD 41 thousand – for natural gas.

Those who heat with wood pay AMD 49 thousand, including AMD 9,700 for electricity, AMD 11,000 – for natural gas (if applicable) and AMD 31 thousand – for wood.

Table 46. Total expenditures on energy for HHs per primary heating options, AMD

		Total expenses for energy in winter months			
		Expenditures on electricity	**Expenditures on natural gas**	**Expenditures on wood**	**Total Expenditures**
Primary heating option	Electricity	**28,081** (N=303)	9,735 (N=237)	22,000 (N=4)	**36,012** (N=303)
	Natural gas	13,031 (N=1239)	**40,674** (N=1239)	23,743 (N=47)	**54,687** (N=1239)
	Wood	9,747 (N=759)	10,643 (N=562)	**31,463** (N=759)	**49,090** (N=759)
	Biofuel	7,685 (N=81)	6,074 (N=58)	20,349 (N=39)	**22,998** (N=81)
	Other	9,707 (N=30)	6,000 (N=22)	17,200 (N=4)	**17,433** (N=30)
	Not heated	5,600 (N=5)	10,167 (N=3)	- (N=0)	**11,700** (N=5)
	Total HHs	**13,508** (N=2417)	**27,911** (N=303)	**30,445** (N=853)	**48,975** (N=2417)

Source: RECS, EDRC, 2015

Thus, payments for fuel in winter months are the highest among HHs that use natural gas for heating. Amounts of payments of HHs that use electricity as primary heating option are quite small as compared to both HHs using natural gas and, even, HH using wood. This, however, does not speak about affordability of heating with electricity.

8.2. Comparative Analyses of Heating Options

Below average monthly payments for fuel per heating options are presented together with calculation of payments per 1 sq.m. of actually heated area (see Table 47). According to the findings, HHs using electricity for heating, on average paid AMD 28 thousands (AMD 66 thousands in the top decile and AMD 11 thousand in the lowest decile). This makes up on average AMD 868 per 1 sq.m. of actual heated areas (AMD 2,035 – in the highest decile and AMD 271 – in the lowest).

Average monthly expenditures of HHs using natural gas for heating (AMD 41 thousand) make up AMD 646 per 1 sq.m. For wood, average monthly expenditures per 1 sq.m. was AMD 681.

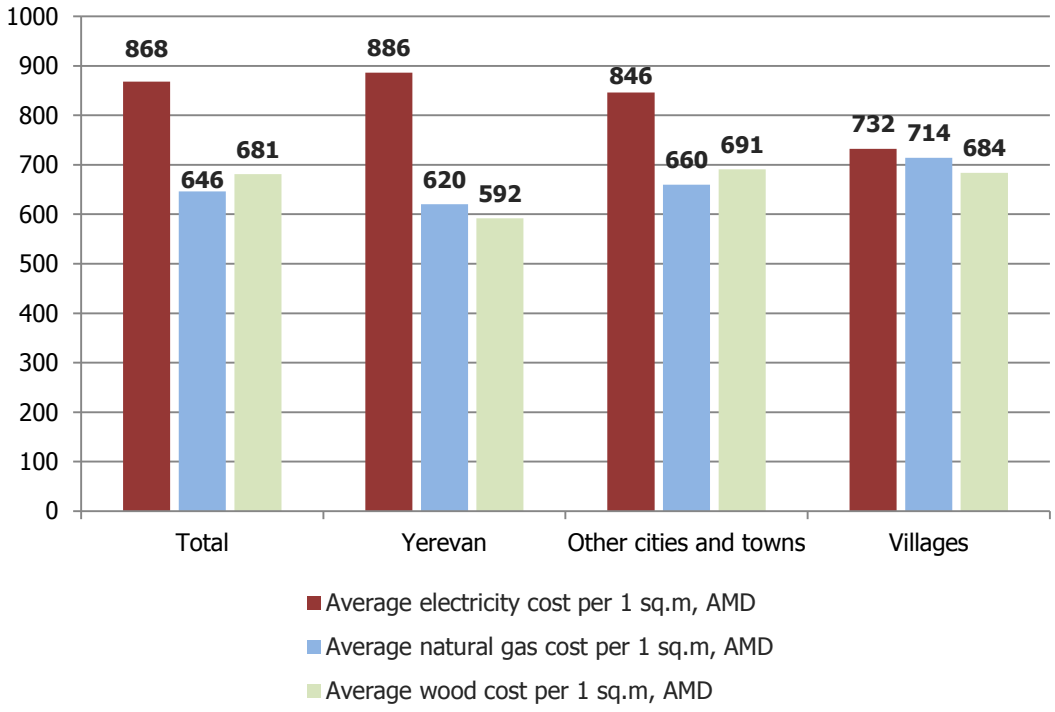
Table 47. Total expenditures on energy for HHs per primary heating options

	Total HHs	**Highest 10%**	**Lowest 10%**	**Yerevan**	**Other cities and towns**	**Villages**
Average monthly payments for respective energy sources, AMD						
Electricity	28,081	65,933	10,824	28,019	26,689	38,154
Natural gas	40,674	95,195	12,800	39,303	39,129	50,259
Wood	31,463	63,118	11,704	27,936	28,283	32,854
Average monthly payments for respective energy sources per 1 actually heated sq.m., AMD						
Electricity	868	2,035	271	886	846	732
Natural gas	646	1,491	203	620	660	714
Wood	681	1,912	178	592	691	684

Source: RECS, EDRC, 2015

Average cost of heating per actually heated area is considerably higher in HHs that use electricity in all communities compared to costs of per sq.m. heating with other options. Actual cost of heating per 1 sq.m. varies in various communities, when heated with natural gas or wood. Average cost of natural gas per 1 sq.m. of heated area is higher compared to wood in Yerevan and rural areas. In other cities and towns, the situation is reverse: cost is lower when heated with natural gas compared to heating with wood (AMD 660 against AMD 691).

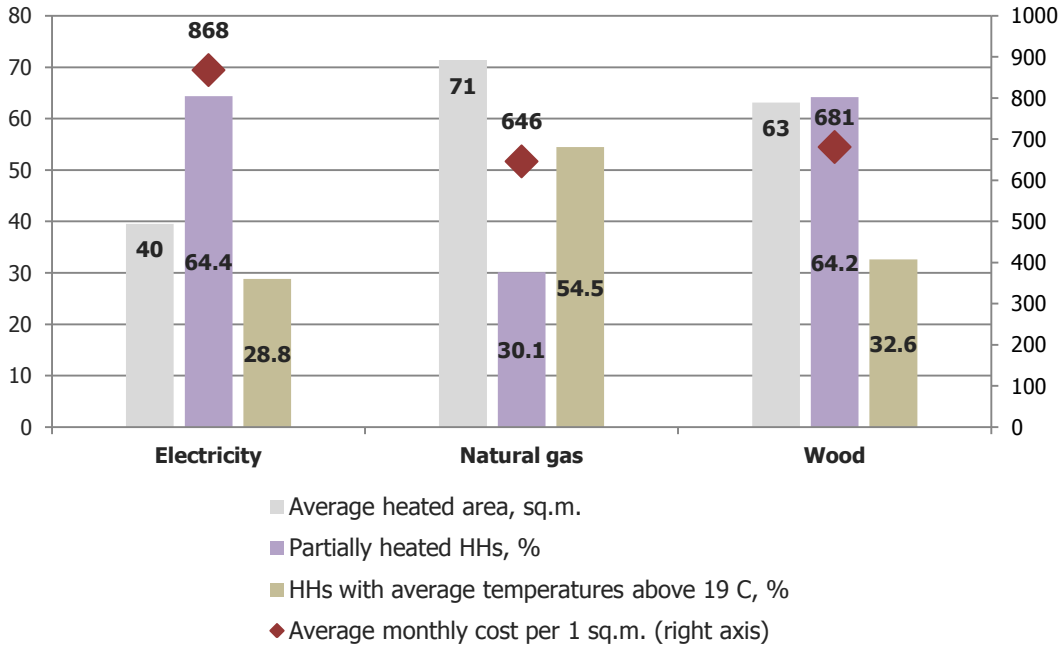
Figure 22. Monthly expenditures on primary energy source for HHs per unit of actually heated area, AMD



Source: RECS, EDRC, 2015

Thus, actual cost of heating per heated area is the highest in HHs that use electivity (AMD 868): it exceeds the cost of heating with natural gas by 34% and cost of heating with wood by 27%. On average, HHs that use electricity for heating, heat about 40 sq.m, while those using natural gas – 71 sq.m. and those using wood – 63 sq.m. For the case of heating with electricity, 64% of HHs heat part of the house/apartment, in case of natural gas, the share is 30% and wood – 64%. Average temperatures were above 19 degrees in 29% of HHs using electricity, 55% of HHs using natural gas and 33% of HHs using wood for heating.

Figure 23. Comparative indicators main heating options



Source: RECS, EDRC, 2015

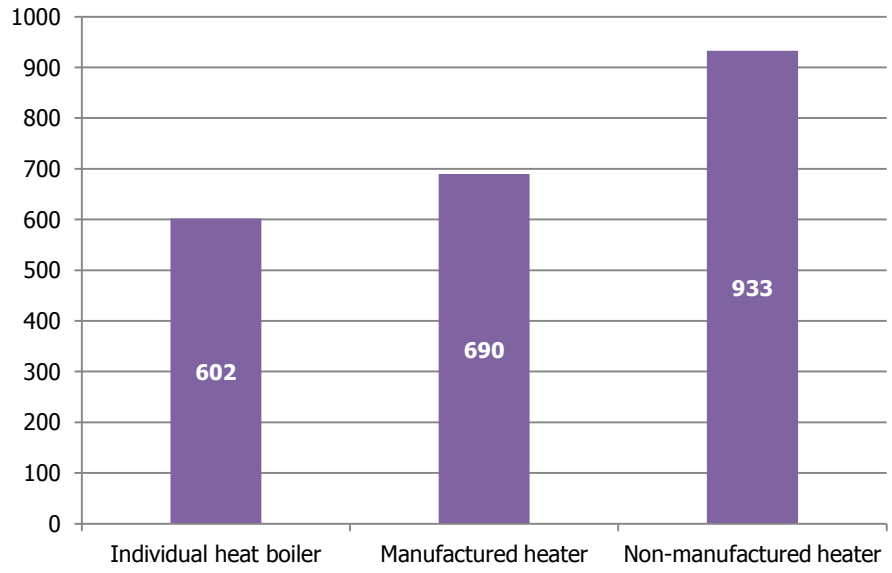
In order to assess the efficiency of heating options and fuel types, one should take into account a number of other factors and use compatible data. This issue is not the subject of our study. Nevertheless, the analyses carried out allow getting the overall picture with respect to quality of heating in Armenia and draw certain conclusions.

Small HHs opt for heating with electricity in Armenia: they heat smaller areas, heat partially and average temperatures are below comfortable levels in 70% of cases. Although the average monthly payments of such HHs are small, it is the highest per 1 sq.m. of heated area.

Actually heated areas are larger in HHs that use natural gas for heating; cases of partial heating are few and average temperatures are higher. Monthly expenditures are higher; however, cost per heated area is smaller. Depending on the type of heating equipment used, the actual cost per sq.m. may vary considerably (see Figure 24). In particular, average cost of heating per sq.m. with an individual heat boiler is about AMD 600/sq.m.

Many HHs, when deciding upon the heating option, prefer or are forced to choose the one with lowest expenditures per month, thus compromising in the heated area, cleanness and comfort or choosing to heat partially. There are possibilities to divert to natural gas from wood; however this requires substantial initial investment of money from HHs.

Figure 24. Heating cost per 1 sq.m. per various equipment when heated with natural gas, AMD



Source: RECS, EDRC, 2015

8.3. Estimates of Wood Consumption Volumes

Based on the Survey data, one can estimate average volumes of residential wood consumption in the country. According to RECS data, an average HH in Yerevan consumes 4.7 c.m. wood during the heating season, while the consumption reaches 7.1 c.m. in other cities and towns. Meanwhile, average consumption of wood per season is 8.1 c.m. in villages.

Table 48 presents wood consumption data broken down per climate areas. It is high in "cold" areas – 8.1. c.m., while in "moderate" areas it totals to 7.9 c.m. and 7.6 c.m. – in "warm" areas.

Table 48. Estimates of average volumes of wood use for heating by HHs

Per community types	
Yerevan	4.7 c.m.
Other cities and towns	7.1 c.m.
Villages	8.1 c.m.

Per climate areas	
Cold	8.1 c.m.
Moderate	7.9 c.m.
Warm	7.6 c.m.
Total average	**7.7 c.m.**

Source: RECS, EDRC, 2015

Based on the share of HHs using wood for heating in total number of HHs and estimates of wood consumption per 1 HH, we estimated the total volume of wood consumption in the country. The calculation based on the number of HHs equal to 750 thousand in the country, which is slightly lower than the official data.

Thus, it is estimated that about 2 mln c.m. wood was used by HHs during the previous winter season in Armenia. The calculation is presented in Table below.

Table 49. Estimates of wood use volumes for heating in Armenia during 2014-2015

Indicator	Yerevan	Other cities and towns	Villages	Total (Armenia)
Average consumption of wood by 1 HH, c.m.	4.7	7.1	8.1	7.7
Share of HHs using wood in total number of HHs in a community, %	5.4	28.1	74.2	34.8
Share of HHs using wood in total number of HHs, *% of total HHS*	2.0	8.4	24.4	34.8
Estimate of number of HHs using wood*, based on 750 thousand as total number of HHs*	14,894	63,302	182,768	260,964
Total consumption of wood in the country, *mln c.m.*	0.07	0.5	1.5	2.0

Source: RECS and authors" estimates

Appendix. The Methodology

The main study method is a sample-based statistical survey of HHs. Based on the requirement to the survey to be representative for the entire country; relevant methodology was developed on general population stratification and sample planning by applying a stratified proportional multi-stage random sampling model.

The general population was divided into the following clusters:

1. Type of community
2. Type of housing
3. Material of external walls
4. Climate area.

Each cluster was then divided into separate strata according to which the representativeness of the Survey was targeted, together with sample margin of error.

2011 official Census data was used for clusterization and stratification of general population. Table A1 presents the breakdown of Armenian HHs according to the NSS of RA data. Data is presented per 3 clusters. In order to form strata in each cluster, certain data were grouped and presented under *Grouped indicators, strata* column in the Table. In order to ensure quality of data obtained through the Survey and not to increase the sample inappropriately, grouping was carried out in such a manner so that it provides as large groups (strata) as possible.

Table A1. Number of HH per clusters (general population)

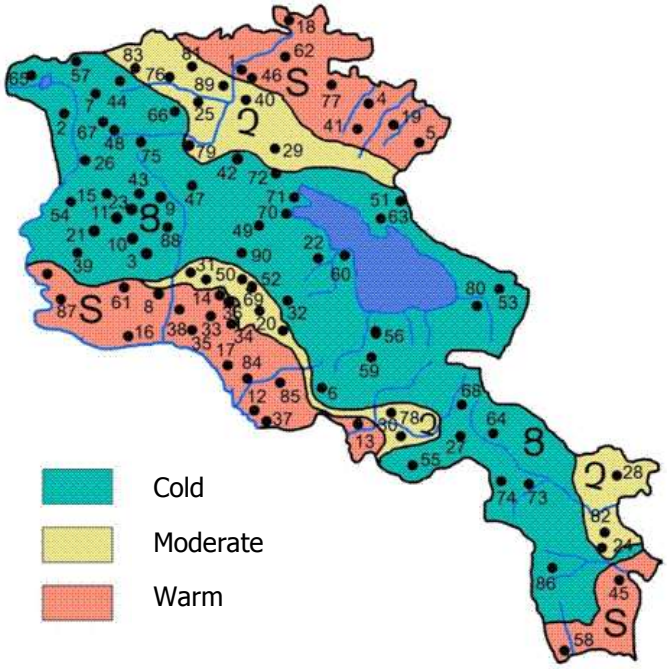
Indicators	Official information, 2011		Grouped indicators, strata	
	Number of HH (N)	Structure (%)	Number of HH (N)	Structure (%)
Total HH	**763,454**	**100**	**763,454**	**100**
Yerevan	285,097	37.3	285,097	37.3
Other urban areas	225,917	29.6	225,917	29.6
Rural areas	252,440	33.1	252,440	33.1
Main types of the residential buildings	**703,517**	**92.1**	**763,454**	**100.0**
Individual house	358,264	46.9	422,021	55.3
Multi-apartment blocks	341,433	44.7	341,433	44.7
Other types	26,205	3.4	-	0.0
Not clear	37,552	4.9	-	0.0
Material of external walls of residential buildings	**763,454**	**100.0**	**763,454**	**100.0**
Stone	526,153	68.9	526,153	68.9
Panel	157,796	20.7	237,301	31.1
Monolith	13,213	1.7	-	0.0
Wood	10,570	1.4	-	0.0
Mixed material	17,717	2.3	-	0.0
Other	38,005	5.0	-	0.0

*Homeless HHs are not included

Source: NSS of RA, 2011 Census data, EDRC calculations

In addition, the general population was first divided into warm, moderate and cold communities based on the climate area maps and temperature*days during the heating season. Yerevan was taken separately, in order to neutralize its dominant influence on other strata.

Picture 1. Climate area map of RA



RA Construction Norms II-7.01-2011 "Construction Climatology" and "RA Consultation Manual of Technical Solutions for Thermo-Isolation of External Cover Materials for Newly Constructed, Reconstructed Residential, Public and Industrial Buildings" (UNDP, Yerevan, 2013) were used as basis for the categorization of communities into climate areas. In cases, where temperature*day data was absent, altitude from the sea level was taken as proxy.

Thus, stratification model of the general population and distribution of HHs in it is presented in Table A2.

Table A2. Stratification of the general population

Cluster	Strata	Distribution
Cluster 1. Type of community	Stratum 1. Yerevan	37%
	Stratum 2. Other cities and towns	30%
	Stratum 3. Villages	33%
Cluster 2. Type of housing	Stratum 1. Individual houses	55%
	Stratum 2: MABs	45%
Cluster 3. Material of external walls	Stratum 1. Stone buildings	70%
	Stratum 2. Other (panel, monolith) buildings	30%
Cluster 4. Climate areas	Stratum 1. Yerevan	37%
	Stratum 2. Warm settlements	24%
	Stratum 3. Moderate settlements	23%
	Stratum 4. Cold settlements	16%

Source: EDRC calculations

Table A3 presents the distribution of the sample per strata and the maximum expected error margin. The target sample size was determined equal 2,400 which allows ensuring high reliability of the Survey results. I particular, the expected error of margin in the first cluster is 3.7%, while it is below 3% in strata of the second cluster, equals 3.7% in the third cluster and will be below 5% in the fourth cluster. As one can see from the Table, 95% confidence interval will yield in the highest expected margin of error in Stratum 4.4 (Cold communities) - 4.99%.

Table A3. Sample size and margin of error

Stratum	General population (thousand HHs)	Sample (HHs)	Distribution	Margin of error, %
Stratum 1.1 Yerevan	282.5	888	37%	+/- 3.28
Stratum 1.2 Other cities and towns	229.0	720	30%	+/- 3.65
Stratum 1.3 Villages	251.9	792	33%	+/- 3.48
Stratum 2.1 Private houses	419.9	1320	55%	+/- 2.69
Stratum 2.2 Apartment buildings	343.6	1080	45%	+/- 2.98
Stratum 3.1 Stone buildings	534.4	1680	70%	+/- 2.39
Stratum 3.2 Other (panel, monolith) buildings	229.0	720	30%	+/- 3.65
Stratum 4.1 Yerevan	282.5	888	37%	+/- 3.28
Stratum 4.2 Warm settlements	183.2	576	24%	+/- 4.08
Stratum 4.3 Moderate settlements	175.6	552	23%	+/- 4.16
Stratum 4.4 Cold settlements	122.2	384	16%	+/- 4.99
Total	**763.5**	**2400**	**100**	+/- **2.0**

Source: EDRC calculations

The actual sample size equaled to 2,417 HHs. Table A4 presents the target indicators of the sample and actual size and breakdown of surveyed HHs. As it can be seen from the Table, actual numbers deviated insignificantly from the target indicators.

Table A4. Target and actual indicators of the sample

	Target		Actual	
	(HH)	%	(HH)	%
Stratum 1.1 Yerevan	888	37%	896	37.1%
Stratum 1.2 Other cities and towns	720	30%	727	30.1%
Stratum 1.3 Villages	792	33%	794	32.9%
Stratum 2.1 Private houses	1320	55%	1331	55.1%
Stratum 2.2 Apartment buildings	1080	45%	1086	44.9%
Stratum 3.1 Stone buildings	1680	70%	1665	68.9%
Stratum 3.2 Other (panel, monolith) buildings	720	30%	752	31.1%
Stratum 4.1 Yerevan	888	37%	896	37.1%
Stratum 4.2 Warm settlements	576	24%	577	23.9%
Stratum 4.3 Moderate settlements	552	23%	558	23.1%
Stratum 4.4 Cold settlements	384	16%	386	16.0%
Total	**2400**	**100**	**2417**	**100**

Source: EDRC calculations

In Yerevan, the sample covered all administrative districts except Nubarashen. In each administrative district, building type and material data were proxied targeting full representation of housing in Yerevan in Clusters 2 and 3 to the general population.

Minimum sample (survey) size was determined for each survey unit for the selection of cities, town and villages in Marzes. In each climate area, first, the communities were selected in accordance with their high probabilistic weights, as well as the sample size in these communities exceeded the pre-determined minimum if the sample was proportionally distributed. The remaining communities and HHs were chosen from the list of remaining communities in the same area by random choice in proportion of the missing sample size. In certain cases, settlement maps were used for the selection of HHs in order to ensure target indicators in Clusters 1 and 2. In all cases, HH sample includes a double (reserve) sample in line with the determined target size. The latter was used when interviews were impossible in the address from the main sample list and it was necessary to change the address.

Table A5. Marz cities, towns and villages included in the sample broken down per climate areas

	Families in cities and towns, HH	Number of cities and towns	Families in villages, HH	Number of villages
Stratum 4.2 Warm settlements	226	8	351	28
Stratum 4.3 Moderate settlements	374	9	184	15
Stratum 4.4 Cold settlements	127	5	259	21
Total, Marzes	**727**	**22**	**794**	**64**

Source: EDRC

Thus, multi-stage stratified random and proportional sampling model was used. It ensures high representation of the general population at strata level and is scientifically justified. Table A6 presents the actual surveyed sampling proportions.

Table A6. Sample distribution, %

	Total	Stratum 1.1 Yerevan	Stratum 1.2 Other cities and towns	Stratum 1.3 Villages
Stratum 1.1 Yerevan	896	896		
Stratum 1.2 Other cities and towns	727		727	
Stratum 1.3 Villages	794			794
Stratum 2.1 Private houses	1331	259	325	747
Stratum 2.2 Apartment buildings	1086	637	402	47
Stratum 3.1 Stone buildings	1665	475	485	705
Stratum 3.2 Other (panel, monolith) buildings	752	421	242	89
Stratum 4.1 Yerevan	896	896		0
Stratum 4.2 Warm settlements	577		226	351
Stratum 4.3 Moderate settlements	558		374	184
Stratum 4.4 Cold settlements	386		127	259

Source: EDRC

The main Survey tool is the HH Questionnaire. It was drafted by the EDRC, thereafter – discussed with the Client. The Client proposed specific recommendations and amendments. The Questionnaire was adjusted slightly as a result of the pilot interviews.

The Questionnaire consists of 8 sections. It covers several dozens of data grouped under 35 questions.

Survey tools also include Interviewers training and instruction manual and manual on HH Selection in each community.

Field works were managed per Marzes. Verification and checking of field works took place during the field works and continued after the data entry stage for HHs where logical inconsistencies were identified. Data were input into the relevant database in SPSS software.

Table A7. Actual survey size per Marzes, HH

	Yerevan	Other cities and towns	Villages	Total
Aragatsotn		73	77	150
Ararat		79	86	165
Armavir		62	110	172
Gegharqunik		48	88	136
Kotayq		118	79	197
Lori		104	65	169
Shirak		134	86	220
Syunik		37	72	109
Tavush		48	47	95
Vayots Dzor		24	84	108
Yerevan	896			896
Total	**896**	**727**	**794**	**2417**

Source: EDRC

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Abbreviations

AMD	Armenian Dram
Bln	billion
C.m.	Cubic metre
EDRC	Economic Development and Research Center (EDRC)
FCCC	Framework Convention on Climate Change
GDP	Gross National Product
HH	Household
ILCS	Integrated Living Conditions Survey
LED	light-emitting diode
MAB	multi-apartment block
Mln	million
NSS	National Statistical Service
RA	Republic of Armenia
RECS	Residential Energy Consumption Survey
R2E2	Renewable Resource and Energy Saving Fund
Sq.m.	Square metre
TOR	Terms of References
UN	United Nations (Organization)
UNDP	UN Development Program
WB	World Bank
Wt	Watt