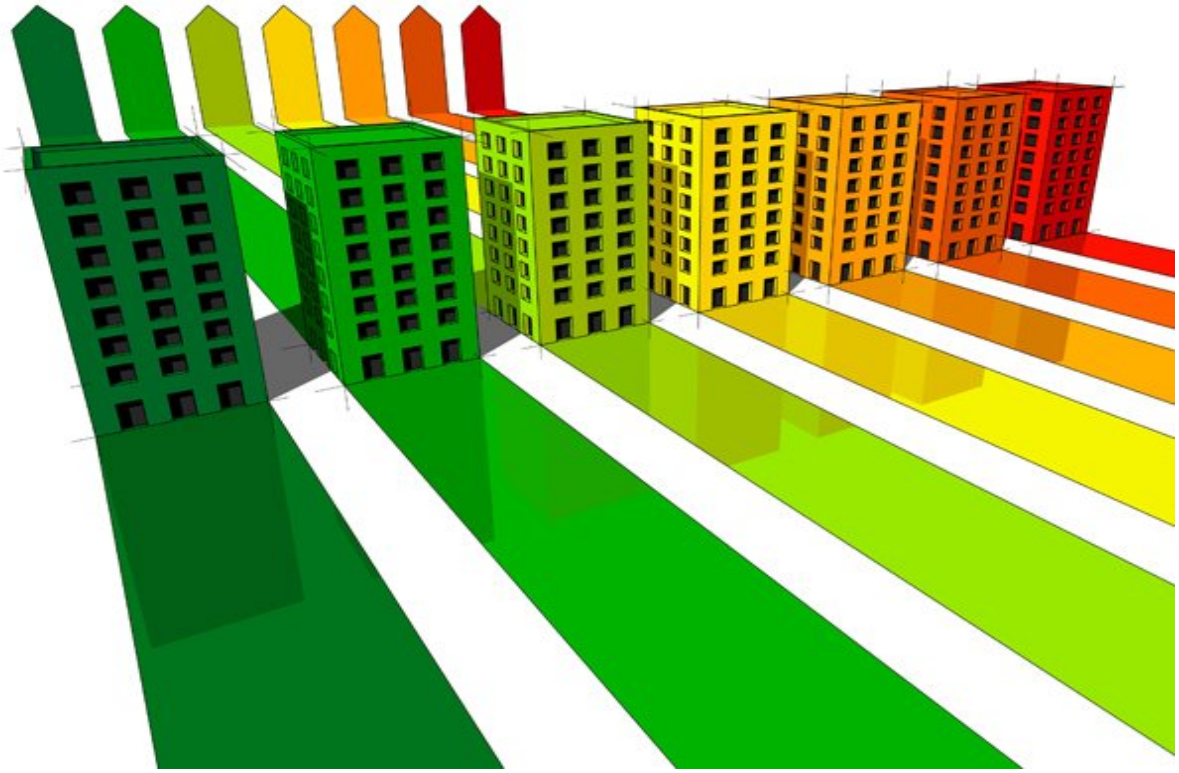
National study and detailed gap analysis between the performance objectives of the Framework Guidelines for Energy Efficiency Standards in Buildings and implementation of current building energy efficiency standards in Armenia



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AFD	Agence Française de Développement (French Development Agency)
CEPA	Comprehensive and Enhanced Partnership Agreement
CIF	Climate Investment Fund
CIS	Commonwealth of Independent States
DHW	Domestic hot water
E5P	Eastern European Energy Efficiency and Environmental Partnership
EAEU	EurAsian Economic Union
EBRD	European Bank for Reconstruction and Development
EE	Energy efficiency
EEM	Energy Efficiency Measures
EIB	European Investment Bank
EN	European Norm
ENA	Electric Networks of Armenia
EPB	Energy Performance in Buildings
EPBD	Energy Performance in Buildings Directive
EPC	Energy Performance Contracting
EPTATF	Eastern Partnership Technical Assistance Trust Fund
ESCO	Energy Service Company
EU	European Union
GCF	Green Climate Fund
GEF	Global Environmental Fund
GGF	Green for Growth Fund
GHG	Greenhouse gas
GOA	Government of Armenia
HDD	Heating Degree Days
HOA	Home Owner Association (Condominium)
HVAC	Heating, Ventilation, Air Conditioning
IFI	International Financial Institution
ISO	International Organization for Standardization
KfW	KfW Development Bank (KfW Entwicklungsbank)
LSG	Local self-government body
MAB	Multi-apartment building
MEINR	Ministry of Energy Infrastructures and Natural Resources (as of 8 February 2019 merged with Ministry of Territorial Administration and Infrastructures)
MPSF	Municipal Project Support Facility

MSN	Interstate Construction Norms (in Russian – Межправительственные строительные нормы)
MoTAI	Ministry of Territorial Administration and Infrastructures
NEEAP	National Energy Efficiency Action Plan
NGO	Non-governmental organization
NIP	Neighbourhood Investment Platform
PSRC	Public Services Regulatory Commission
PV	Photovoltaic
R2E2	Renewable Resources and Energy Efficiency Fund
RA	Republic of Armenia
RACN	Republic of Armenia Construction Norms (СНиП)
RE	Renewable Energy
RES	Renewable energy sources
SME	Small and medium enterprise
SREP	Scaling up Renewable Energy Program
TA	Technical assistance
TPES	Total primary energy supply
UNDP	United Nations Development Program

Signs and Measures

CO_2	Carbon dioxide
$CO_{2\ eq.}$	Carbon dioxide equivalent
GWh	Gigawatt hour
ktoe	kilotonnes of oil equivalent
kW	Kilowatt
kWh	Kilowatt hour
kWh/m^2	Kilowatt-hours per square meter
MWh	Megawatt hour
PJ	Peta Joule (10^{15} joules)
TWh	Terawatt hour

Currency

AMD	Armenian Dram
EUR	Euro
USD	United States Dollar

Executive Summary

Energy efficiency is one of the most effective tools to support an economy, while contributing to the global fight for climate change. On a national scale, energy efficiency helps strengthening energy security, reducing energy expenditures and freeing up funds for expenditures in other sectors, slowing down energy demand growth, eliminating the needs for investments in new generation capacities, creating green jobs, enhancing satisfaction with the public services' quality, helping meet the climate mitigation goals and improving the competitiveness of the economy. On a building scale, energy efficiency improves the utility affordability, extends building lifetime, and boosts indoor comfort.

Ambitious legal-regulatory documents have been recently adopted in Armenia. The legal-regulatory framework of Armenia clearly assigns roles and responsibilities for different aspects of EE development to the corresponding institutions.

Armenia joined the international standard system on thermal performance of buildings in 2004, which took into account the requirements of the EU-relevant documents. In 2016, Armenia introduced a mandatory building energy code with the adoption of a new regulation on thermal protection of buildings (RACN 24-01-2016), which was developed based on the Building Energy Code of the Russian Federation from 2003 (updated in 2012) with application of some methodologies and approaches of the EU standards, such as EN 15217:2007; EN15316-1:2007; EN15603-1:2007; ISO 16818:2008; and ISO 23045-2008. It linked building envelope components and heat losses with established energy limits, considering differences in climatic conditions. It also includes a requirement for issuing a building energy passport and an energy efficiency label/certificate with defined energy efficiency classes.

Standards are an effective instrument for addressing energy efficiency in buildings. Energy efficiency standards and labelling framework for buildings sector technology has made significant progress in Armenia, but some gaps remain.

The energy prices are at cost-recovery rates and energy prices are among the highest in the region. The incentives and investment framework are in place; however, investments remain limited, despite the fact that there is significant potential for EE improvement in both public and residential sectors. The gap analysis identifies the key barriers that hamper the scale-up of the energy efficient projects' implementations in the public sector, as well as commercialization of energy efficiency finance in multi-apartment residential buildings.

There is significant potential for energy performance improvement in Armenia, especially concerning the status of public and residential buildings. Persisting financial and institutional barriers have been limiting the possibility of affordable financing to exploit this potential, whereas IFI initiatives in so far have focused primarily on infrastructure development and, to a comparatively minor extent, on addressing directly the untapped energy savings potential.

As with many other countries, Armenia has a mixture of market barriers and other issues to address before it can make its buildings sector more efficient. These include general awareness about the benefits of efficiency investments and available options, data collection and quality, administrative and market capacity, and access to financing.

The energy efficiency legislation in force does not introduce the ESCO mechanism. According to the UN Economic Commission for Europe, there are no operating energy service companies in Armenia. To date, no information on its performance has been found.

In Armenia, there is low awareness about the multiple benefits of energy efficiency projects and lack of technical expertise and capacity to identify, evaluate and implement projects.

The methodology used for calculation of EPB within the energy auditing process is focused on the heat losses from the building envelope and the energy class is determined based on the heat load, instead of taking into account primary energy for heating, cooling, DHW, ventilation, lighting and other technical building systems as required in EPBD. The calculated specific energy consumption in kWh/(m^3.y) is the useful energy for heating, without taking into consideration the efficiency of the heat source (gas boiler, heat pump, etc.) and the type of heating system.

Based on the analysis of the barriers in Armenia, the gap analysis concludes that taking advantage of a significant untapped potential for EE improvement in Armenia demands the adjustment and tailoring of intervention mechanisms to current market needs.

1. General Information on EE in Buildings and Implementation of Current Building EE standards in Armenia

Buildings are primary components of every country's economy and society. In Armenia, past natural disasters have provoked a shortfall in adequate housing and damages to public buildings, which have significantly affected the provision of services. Public budgets are not sufficient to fully address the social and economic development needs related to the maintenance of existing and the construction of new buildings.

Due to the absence of domestic fossil fuel resources and the increasing energy demand from the public buildings and housing sectors, Armenia's dependence on imported primary energy sources strongly affects the country's economy. Increasing energy prices have further aggravated this dependency.

For these reasons, maximization of energy efficiency has become a main objective for Armenia. Improving energy efficiency, specifically regarding the building sector, has been assigned high priority in Armenia's climate, energy and housing strategies. In line with the expectations of higher electricity and natural gas costs, it is understandable that the profitability of energy efficiency in buildings will further increase with rising energy prices.

The Government has put efforts into effective enforcement of recently adopted legislations in the building sector. Some relevant technical regulations and standards are adopted in order to improve the effectiveness of the whole regulatory system in the building sector. Further strengthening of existing building legislations towards introducing requirements for near-zero consumption buildings should be considered.

The Government is committed to ensure that necessary conditions are put in place to allow local authorities to finance energy efficiency measures in the longer term. It should also further encourage energy efficiency improvement by providing innovative financial mechanisms and creating attractive conditions for application of energy performance contracting and ESCOs.

Armenia has made some progress towards developing a basic building-efficiency policy framework, and further efforts are underway, including as part of the Comprehensive Enhanced Partnership Agreement (CEPA) with the European Union. As part of CEPA, energy efficiency standards and norms are being aligned with the EU acquis communautaire established by laws, such as the Energy Performance of Buildings Directive (EPBD) and Ecodesign.

Nevertheless, Armenia must finish establishing a comprehensive regulatory framework for building efficiency that allows laws to be fully implemented and enforced. Building codes and other efficiency requirements for new construction and reforms related to managing multi-apartment buildings (MABs) are examples of areas in which policies may exist, but capacity constraints and other issues limit their practical effectiveness. In the absence of well-enforced rules, opportunities to improve the efficiency of buildings are likely to remain disregarded. Large-scale building retrofits, for example, are particularly challenging to achieve in Armenia, where the market for comprehensive, project-based building interventions remains nascent.

The mandatory requirements for buildings' energy performance in new multi-apartment residential buildings and buildings funded by state funds is the real step, acknowledging that the public authorities recognize the improvement of the Armenian building stock as a priority.

The following legal acts are clear indication that the process of improvement for building energy performance is on the way:

- Amendments in Law on Energy Saving and Renewable Energy in Al-67-N, dated 12 May 2016;
- Decision 1504-N of the Government of RA, dated 25 December 2014 on implementation of energy saving and energy efficiency improvement measures in facilities being constructed (reconstructed, renovated) under the state funding;
- Governmental Resolution No 426-N, dated 12 April 2018 on establishing the technical regulation for energy savings and energy efficiency in newly constructed multi-apartment buildings, as well as objects constructed (reconstructed/renovated) by state funds;
- Decree from the Minister of Economic Development and investments, No 342A, dated 30 May 2019 on establishing the rules of completing the compliance certificate form (energy performance certificate) and the template for newly constructed multi-apartment residential buildings, as well as objects constructed/reconstructed/renovated with state funds;
- During one of the recent Government meetings energy efficiency in buildings was discussed in deep details, highlighted as a top priority, as well as year 2020 was announced as a "year of energy efficiency". This will boost the interventions in residential and public buildings concerning application of energy efficiency measures (IEA, 2020).

According to the National Programme on Energy Saving and Renewable Energy, the potential for energy efficiency savings in Armenia is large, including 462 ktoe in the building sector (public and private sector) and 409 ktoe in industry (including 50.6 per cent for the chemical and metallurgy sector and 24 per cent for the food industry), while optimization of lighting in all sectors was estimated to save 475 GWh.

In 2011, the government adopted the First National Energy Efficiency Action Plan (NEEAP). This action plan was established to define concrete actions in order to fulfil the aims of the national policy to improve energy

efficiency and the usage of renewable energy sources. The action plan was elaborated for the period 2011–2014. The first NEEAP defined a set of policy and program measures for energy efficiency improvements in all relevant economic sectors.

The activities in the public building and transport sectors were most successful and for both sectors, savings have been achieved well beyond the target. At the same time, more efforts are still needed to unlock the potential for energy efficiency in the residential, industrial and agriculture sectors.

Recognizing the importance of raising building energy efficiency, several international organizations and lenders are working in Armenia alongside government officials, experts and other stakeholders to address persistent challenges and unlock the sector's potential. Successful building efficiency projects completed in the past decade provide demonstrable results and lessons for future efforts, and other countries' experiences and best-practice case studies can inform efforts in Armenia.

In this context, a roadmap development is an opportunity to take stock of the current situation and consider strategies for both the medium and long term (to 2040). This relatively brief document is therefore designed to provide an overview of Armenia's current buildings sector situation, with international case studies supplying the context and – when applicable – practicable insights. This roadmap is intended to support wider discussion among policy makers and experts working every day to advance building sector efficiency in Armenia.

The Ministry of Territorial Administration and Infrastructure (MoTAI) has overall responsibility for energy policy, including Armenia's transposition of the 2010 EU Energy Performance of Buildings Directive (EPBD) as part of the EU-Armenia CEPA implementation. MoTAI is supported in its EPBD transposition and other building policy issues by the Urban Development Committee, which is also involved in determining building codes for new constructions and housing policy. Other ministries, including Environment, Economy and Finance, also provide implementation or policy support related to building efficiency as required.

In addition, the Renewable Resources and Energy Efficiency Fund of Armenia (R2E2) was established by the Government of Armenia with support from the Global Environmental Facility (GEF) in 2006. Although the R2E2 in effect acts as an energy agency in Armenia and plays a leading role in developing impactful efficiency projects as well as energy efficiency markets and capacity, it lacks the official power to be the overarching authority for energy efficiency policymaking. Instead, several ministries and institutions share responsibility for energy efficiency policy pertaining to buildings.

Institutional arrangements and energy efficiency policy governance is a key issue in most countries. International experience, notably within EU member states, suggests that establishing a dedicated agency can be instrumental to create capacity for energy efficiency (as well as renewable energy) products and services in local markets.

Low awareness of the benefits of energy efficiency improvements, combined with insufficient capacity to secure financing for efficiency upgrades, is limiting the availability of financing for the residential housing efficiency improvements in Armenia. Raising awareness is critical to create demand for energy-efficient products and services, which would in turn stimulate policy maker, consumer, and market activity.

Greater awareness is also important to raise financing for energy efficiency projects. Making the decision to invest in a more efficient (but potentially more expensive) technology – such as a condensing boiler, a highly efficient air-conditioning (AC) unit or a double-glazed window – is not always straightforward even for wealthy and middle-income families, not to mention low-income households. Consumers and other market participants

need accurate and accessible information about the benefits of energy efficiency, technologies, and financing options – and about the cost of inaction.

2. Policies on Energy Efficiency in Buildings

2.1 Building codes requirements and EE legislation

In 2004, Armenia voted for the interstate building code, “Thermal performance of buildings”, which takes into account the requirements of EU codes and standards/methodologies. A corresponding document was developed in 2008 under the UNDP-GEF project. In 2009, proposals for energy audits and the certification of residential buildings were developed under the same project. In 2013, legal and institutional measures were drafted looking to improve energy efficiency in urban development (legislation improvements are currently under discussion).

- EE building Code - “Thermal Protection of Buildings" 24-01-2016 RACN, and “Building thermophysics of building envelope” II-7.02-95 RACN

The code refers directly to all residential, industrial, public buildings, and indirectly, to the construction industry including building materials and assemblies. These building codes apply to the design of thermal protection of the buildings and structures under the construction and reconstruction with more than 50 m2 of residential, public, industrial, agricultural and storage areas, where certain thermal and moisture conditions are required.

These building codes:

- Define requirements to heat transfer specific resistance of the constructions, energy efficiency indicator of the buildings, as well as to energy efficiency class and energy passports of the buildings.
- Dedicate the implementation of new energy efficiency indicators of the buildings (in particular, specific energy demand for the buildings heating),
- Envisage the evaluation and classification of energy efficiency of the buildings either in design and construction or in future use.

The following building codes are currently into force:

- RACN 24-01-2016 “Thermal Protection of Buildings"
- RACN II-7.02-95 “Building thermophysics of building envelope”
- RACN II-7.01-2011 “Construction Climatology”
- RACN 22-03-2017 “Artificial and Natural Lighting”

Government agencies with an energy efficiency policy mandate

The Urban Development Committee (previously the Ministry of Urban Development) is the main government agency responsible for energy efficiency policy in the buildings sector. National institutions responsible for energy conservation and energy efficiency are as follows:

- The national government is responsible for the enforcement of legislation, including energy saving and energy efficiency regulations.
- The Ministry of Territorial Administration and Infrastructure (previously the Ministry of Energy Infrastructures and Natural Resources (MEINR)) addresses a wide range of strategic goals, including

energy efficiency, through the implementation of national projects, programs and draft legislation. The Ministry is responsible for the following investment programs: district heating sector – rehabilitation and renovation of existing thermal plants, construction of a new system on the base of cogeneration plants; renewable sector – development of economically viable projects in wind, solar and geothermal energy.

- The Urban Development Committee regulates construction activities, including insulation and building energy efficiency standards.
- The Statistics Committee (previously National Statistical Service) is in charge of statistical information, including data on fuel and energy consumption, tariffs, floor space, etc.
- The Public Services Regulation Commission (PSRC) was established in 1997 by Decree of the President of Armenia. PSRC is an autonomous regulatory agency; government entities cannot interfere with its decisions. It is a multi-member body responsible for electricity, natural gas, water and telecommunications. PSRC, in particular, regulates production, consumption as well as transmission and distribution tariffs for natural gas, electricity, and heat.
- The R2E2 Fund is established in accordance with Government Resolution No. 799-N dated April 28, 2005. The Armenian Prime Minister presides over the Board of Trustees. The World Bank through GEF provided a USD 20 million loan and a USD 1 million grant; EBRD provided a USD 7 million loan; and the Cafesjian Family Foundation provided a USD 3 million loan. The key objectives of the Fund are to facilitate investment in the energy efficiency and renewable energy sectors, as well as to foster market development in the sphere of Armenia's energy efficiency and renewable resources.

Energy efficiency legislation

Law No. 3-P-148 "On Energy", dated March 21, 2001, sets out a basis for the regulation of the energy sector, including tariff setting, licensing, and contracts for electricity, heat and natural gas supply. The Law "On Energy Saving and Renewable Energy", dated November 9, 2004, specifies the principles and mechanisms for the implementation of the national policy on energy conservation and renewable energy. The basic goal of the National Programme of energy conservation and renewable energy is to generate 30 per cent of electricity production from renewable sources by 2020.

The National Programme also defines the energy saving potential and the measures, projections and institutional mechanisms needed to attain the specified targets.

The National Energy Strategy examines energy efficiency improvements, among other priorities. The Action Plan of the Government of the Republic of Armenia aims at implementing the National Programme of energy conservation and renewable energy.

The Action Plan is to be implemented in three stages: 2011-2013, 2014-2016 and 2017-2020. In the first stage, the Plan includes: development of integrated fuel and energy balance (IFEB); development of short- and long-term investment programs in energy efficiency; information campaigns; training in energy saving and energy efficiency; development of energy efficiency standards; certification of energy auditors; and development of a methodology to assess the economic feasibility of energy saving and energy efficiency measures.

In the second stage, the aim is to amend the building codes relating to the energy performance of space heating, hot water and ventilation systems to specify the maximum permitted energy consumption in buildings. The

intention is to issue a building permit only if this requirement is met. In order to achieve this objective, it was decided to develop a methodology to assess the specific energy consumption of buildings, and to set up laboratories to test building materials, structures and power equipment (windows, insulation, boilers, etc.) used in the construction of new buildings that will help ensure their good quality and compliance with national standards.

The Action Plan of the former Ministry of Energy and Natural Resources (currently included in the Ministry of Territorial Administration and Infrastructure) specifies the steps to be taken by the Ministry to implement the specified tasks, including energy saving and efficiency.

The legal act that regulates energy audits in Armenia is the "Procedure for Energy Audit" approved by Armenian Government Decree 1399-N on August 31, 2006 and revised by Decree 1105-N on August 4, 2011 and Decree 1026-N on September 10, 2015.

2.2 Energy prices, principles of setting regulated tariffs

Energy tariffs of energy (primarily natural gas and electricity) consumed in newly constructed buildings may have significant role for the choice of end uses of energy, type for major use of energy for heating, consequently primary energy determination and GHG emissions calculation.

The PSRC regulates producer, consumer as well as transmission and distribution prices for natural gas and electricity.

For natural gas, this arrangement is a way to address and mitigate any risk from Armenia's heavy reliance on imports from the Russian Federation and from Iran. Consumer prices for natural gas are set higher than import prices. Large consumers pay less than smaller ones. At present, Armenia's import of natural gas from the Russian Federation is channeled through the sale of gas from Gazprom to its subsidiary - Gazprom-Armenia.

Both Armenia and the Russian Federation are members of the Eurasian Economic Union and the Customs Union. For this reason, the Russian Federation does not impose export duties on fuels sold to Armenia and Belarus. Nevertheless, natural gas tariffs for consumers in Armenia, though lower than in European countries, are considerably higher than in the neighboring countries. "Gazprom-Armenia" is also the largest taxpayer in Armenia. Natural gas tariffs are defined by PSRC Decision N221-N 19.06.2020.

Principles of Setting Regulated Tariffs

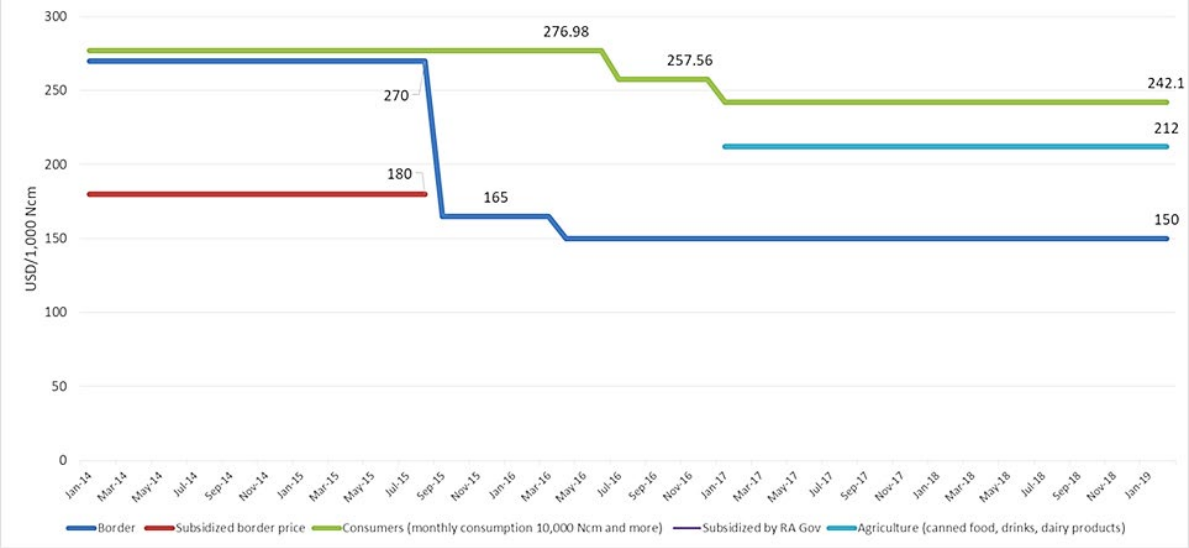
According to the Energy Law, the PSRC can either set the specific monetary value of the tariff or establish a clear formula for calculating the tariff based on parameters defined in the Energy Law. The basic principles of setting tariffs for electric and thermal energy and natural gas, as well as sizes of payments for rendered services are as follows:

- Providing for compensation of justified operation and maintenance costs as well as the depreciation allocations of the fixed assets and non-material assets essential for the conduct of the Licensed Operation in compliance with the License provisions;
- Providing an opportunity for reasonable profit;
- Inclusion of justified loan service costs;

- Establishment of differentiated tariffs for customers dependent on the consumption volume, requested capacity, season, time of use, connection terms, type of service;
- Inclusion of justified and essential insurance costs;
- Inclusion of justified costs related to compliance with environmental norms;
- Inclusion of justified technical and commercial losses;
- Inclusion of other justified and necessary costs as provided by the legislation.

A detailed evolution of natural gas tariffs in 2014-2019 is shown in Fig. 1 and Fig. 2 (latest tariffs are in force at moment of the current report development):

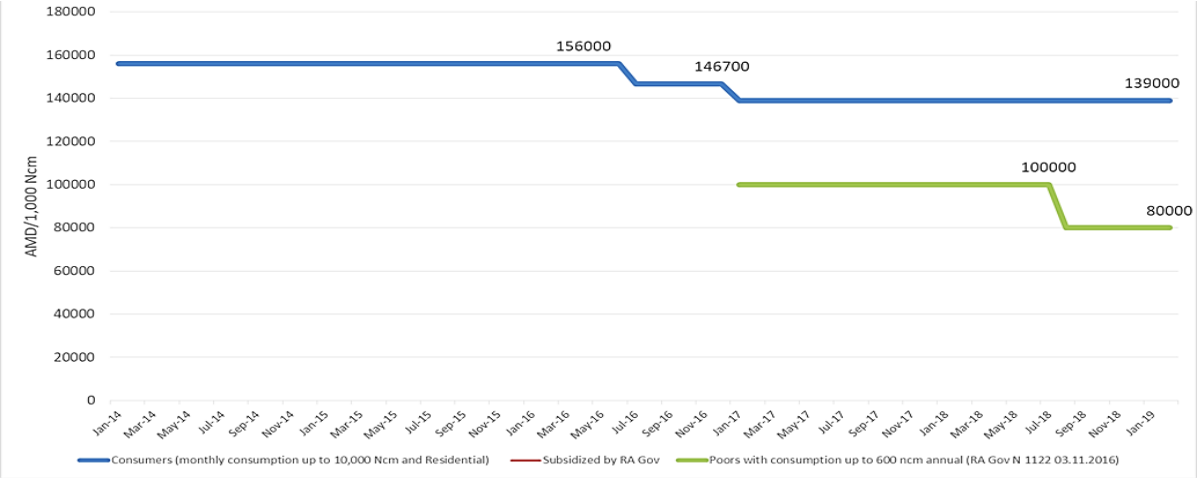
Figure 1: Natural Gas Tariffs on the Border and For Over 10,000 Cubic Meters of Monthly Consumption for Consumers



Purple line Subsidized by the RA Gov. is absent due to absence of subsidies in the mentioned period

Source: Public Services Commission of the Republic of Armenia

Figure 2: Natural gas tariffs for up to 10,000 cubic meters of monthly consumption for consumers
Red line Subsidized by the government is absent due to absence of subsidies in the mentioned period

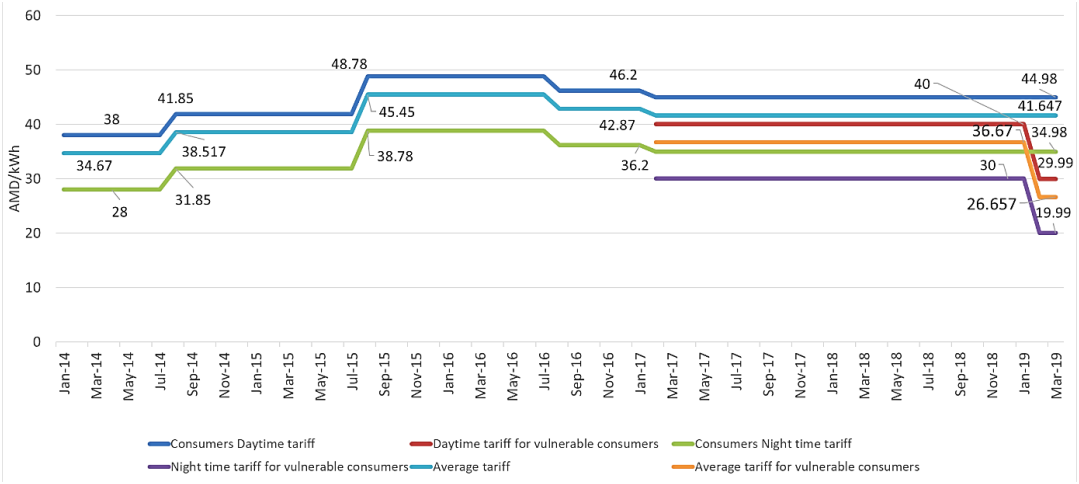


Natural gas tariffs for end-users are set by the PSRC. For customers whose monthly consumption is below 10 thousand m^3, the tariffs are fixed; for customers whose monthly consumption is above 10 thousand m^3, tariffs are calculated by a formula that takes into account the exchange rate determined by the Central Bank of Armenia. The government does not subsidize natural gas tariffs.

Armenia's electricity sector is a well-known example of a drastic tariff reform following the collapse of the Soviet Union and the ensuing energy crisis of the early 1990s. Electricity tariffs for industrial, commercial, and household customers were set at equal levels, beginning a process of tariff rebalancing and removal of cross-subsidies. Electricity tariffs are defined by PSRC Decision N422- N 23.12.2016; N772-N 27.12.2017.

Armenia embarked on a path towards privatization of the electricity sector in 1997. The distribution company ENA has not only been privatized, but also changed owners over the years. A detailed evolution of electricity tariffs in 2014-2019 is shown in Fig. 3:

Figure 3: Electricity tariffs for.38 kV-powered consumers



At present, consumer prices are higher or lower for end consumer groups with lower or higher voltage connections, respectively. Household consumers pay the highest price. This price structure reflects the increasing cost of distribution at lower voltages (due to losses). Thus, there are no cross-subsidies from industrial to household consumers in Armenia, unlike in several other countries in Central Asia.

The PSRC sets electricity tariffs for end-users. They are differentiated by time of use - day (07:00 - 23:00) and night (23:00 - 07:00) - and depend on the voltage level and the type of connection to the power supply (direct or indirect feed).

Based on the current tariffs of energy it should be noted that 1 kWh of useful heating energy converted from natural gas (heating device efficiency considered 90 per cent, and net calorific value 9.6 kWh/m^3) is around 2.5 times cheaper than 1 kWh of useful thermal energy transformed from electricity (considering night time tariff).

Usage of diesel or LPG for heating are very rare cases. Diesel and LPG prices in Armenia are not regulated. However, the State Commission for the Protection of Economic Competition monitors LPG, gasoline and diesel prices and ensures that there should be no cartel pricing and super profits in any market segment.

Table 1: Current electricity tariffs in Armenia

PSRC Decision N488-N 29.12.2020, in force since 01.02.2021

N	Final consumer group	Tariff (VAT included)	
		USD cents/kWh	AMD/kWh
1.	110 kV voltage-fed consumers		
	Daytime tariff	**6.95**	36.48
	Nighttime tariff	**6.19**	32.48
2.	35 kV voltage-fed consumers		
	Daytime tariff	**7.42**	38.98
	Nighttime tariff	**6.66**	34.98
3.	6(10) kV voltage-fed consumers		
	Daytime tariff	**8.57**	44.98
	Nighttime tariff	**6.66**	34.98
4.	0.38 kV voltage-fed consumers with monthly consumption more than 400 kWh (excluding those mentioned in point 6)		
	Daytime tariff	**9.14**	47.98
	Nighttime tariff	**7.23**	37.98
5.	0.38 kV voltage-fed consumers with monthly consumption less than 400 kWh (excluding those mentioned in point 6)		
	Daytime tariff	**8.57**	44.98
	Nighttime tariff	**6.66**	34.98
6.	0.38 kV voltage-fed consumers (Socially vulnerable consumers based on RA Government decision N 1122 03.11.2016)		
	Daytime tariff	**5.71**	29.99
	Nighttime tariff	**3.81**	19.99

Armenia is in the category of countries where fuel prices are taxed rather than subsidized. At the same time, compressed natural gas (CNG) accounted up to 70 per cent of fuels used in road transport in 2017.Manure and firewood is largely used as fuel (for heating, hot water and food preparation) in rural areas of Armenia and accounted for 2.6 per cent of the Total Primary Energy Supply (TPES) in 2017. Remarkably, coal is totally absent from Armenia's energy mix (0.04 per cent).

The PSRC also sets tariffs for electricity generated from renewable sources. In accordance with the law "On energy", all electricity produced from renewable sources is subject to mandatory purchase during the twenty years of the plant's commissioning (with exemption for Small HPP).

Armenia is pursuing a tariff policy to support the creation of favorable conditions for developing RE and attracting investment. There are purchase guarantees and feed in tariffs set for power generated by small HPPs, wind turbines, biogas, and solar PVs.

2.3 ESCO market, current status in Armenia

The energy efficiency legislation in force **does not introduce the ESCO mechanism**. According to the UN Economic Commission for Europe, there are no operating energy service companies in Armenia, although the Armenian ESCO Association was mentioned in the past.

To date, no information on its performance has been found. The Armenian ESCO market is not yet developed, particularly with regard to legislation, market demand, practices, state support, and affordable financial resources.

In 2012, the GoA approved an EE project under the World Bank financing implemented by the R2E2 fund. The project is targeted at implementing energy-saving activities in public facilities to reduce the level of energy consumption by social and other public facilities. The cost of the project is estimated to be about USD 10.7 mln.

The R2E2 Fund has been using a quasi-ESCO approach under this project. In this specific IFI project, the R2E2 Fund was able to disburse almost USD 10 million for EE/RE measures in municipalities. Project-financed facilities included educational and medical institutions, penitentiary institutions, municipal street lighting, kindergartens, and theatres. The EEMs included primarily: insulation of walls, basements, and attics; repair or replacement of external doors and windows; window optimization; reflective surfacing of walls behind radiators; improvement or replacement of boilers and heating systems; replacement of mercury vapor lamps with high-pressure sodium vapor lamps (or light-emitting diodes) and replacement of incandescent bulbs with compact fluorescent lamps.

For 64 Energy Service Agreements, the R2E2 hired 22 companies that gained experience necessary for energy audit, engineering design, new technologies for improvement of EE in buildings and street lighting systems, as well as for measurement and verification of savings.

They are in fact ESCOs experienced in working with energy performance contracts under R2E2-catered Energy Saving Agreements (ESA). In any case though, there is need to continue development of ESCO market through creation of demand. This is possible through supplementary public procurement regulatory improvement.

The existence of R2E2 as the “honest broker” allowed the creation of a value chain through which the financier, the beneficiary and the ESCO can work with minimal possible risks, with professional support in design, supervision and verification of results, which can also ensure that the funds serve their purpose, and the energy savings are delivered with loan repayment funds being generated through savings in due term.

Armenia has developed a comprehensive legislation system supporting energy efficiency and renewable energy development. For some of the laws, however, secondary legislation and implementation mechanisms will need to be developed. Nevertheless, there are still significant legislative and regulatory gaps that prevent the rapid growth of the energy services market.

The law on home-owners associations does not incentivize energy efficiency improvements such as insulation or centralized heating in buildings. Furthermore, the lack of regulation on building temperatures creates a barrier for implementing energy efficiency in residential buildings. There is no ESCO-specific legislation.

Specifically, the Law on Procurement (2016) does not include a provision for performance-based contracts, which may create a barrier to ESCO market development. There is a need to develop energy service-supporting mechanisms such as subsidies, government guarantee programs, and tax incentives.

ESCOs and Energy Performance Contractors (EPCs) represent a significant and growing business in developed countries, where they were invented, and where they commonly serve industry, commercial buildings, and public institutions (The potential for Improving energy Efficiency in Armenia, the World Bank, 2008).

ESCO market developments, international cooperation, financing energy efficiency are the main topics that may influence on the actual certification system developments and unique calculation methodology formation can be based on the best European practice.

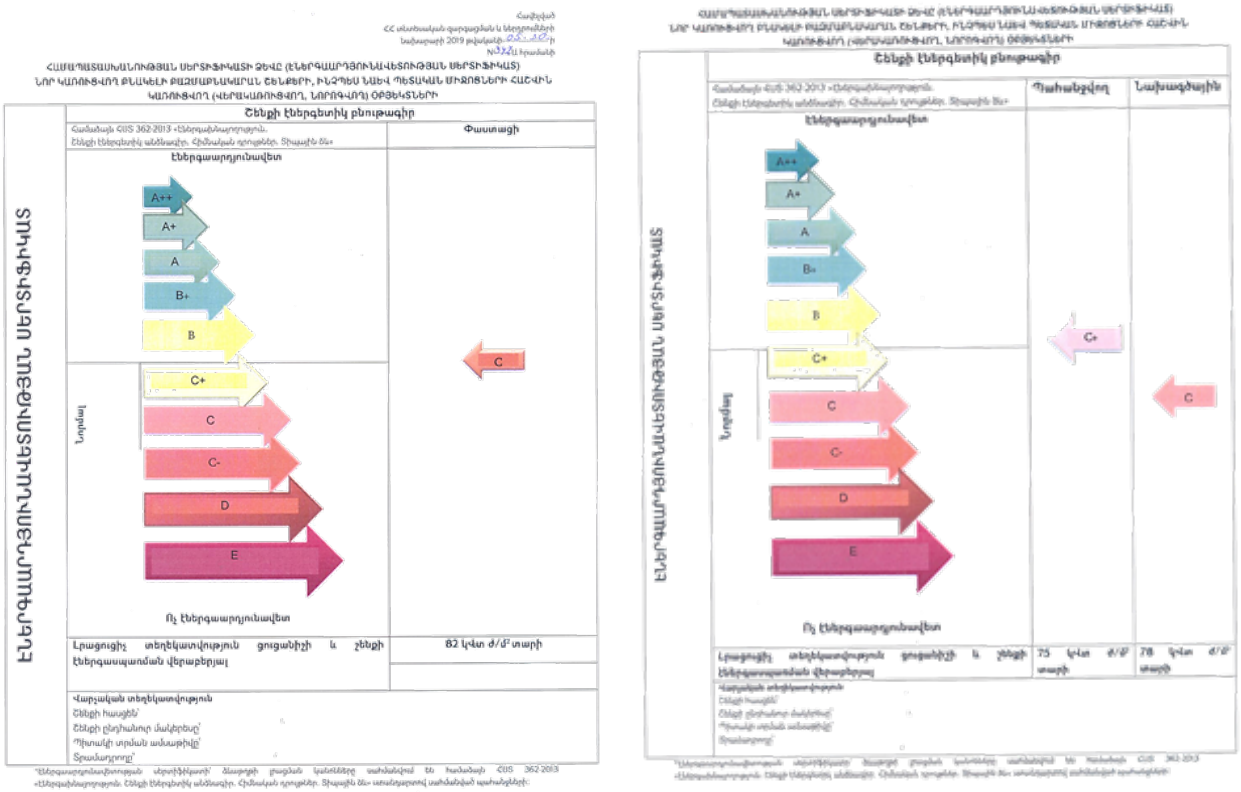
Government should encourage public agencies to enter into multi-year contracts with the private sector. In order to reap the benefit of energy efficiency investments, public agencies need to be able to enter into multi-year contracts. ESCOs are private firms that provide financing, technical consulting, installation, and management services to customers needing efficiency improvements.

2.4 Existing certification system for buildings' energy performance

During the last years, Armenian Government demonstrates its engagement towards energy efficiency in the building sector through series of changes in the regulatory framework (In-Depth Review of the Energy Efficiency Policy of Armenia, Energy Charter, 2017). Furthermore, based on the Comprehensive and Enhanced Partnership Agreement (CEPA) signed in 2017, Armenia commits to transpose the EU policies in the energy sector (including Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings (EPBD) and Commission Delegated Regulation (EU) No 244/2012 of 16 January 2012 supplementing EPBD by establishing a comparative methodology framework for calculating cost-optimal levels of minimum energy performance requirements for buildings and building elements).

The amendments in Law on Energy Saving and Renewable Energy in 2016, as well as Decision 1504-N of the Government of RA, dated 25.12.2014 on implementation of energy saving and energy efficiency improvement measures in facilities being constructed (reconstructed, renovated) under the state funding, Governmental Resolution No. 426-N, dated 12.04.2018 on establishing the technical regulation for energy savings and energy efficiency in newly constructed multi-apartment buildings, as well as objects constructed (reconstructed/renovated) by state funds and Decree from the Minister of Economic Development and Investments, No. 342A, dated 30.05.2019 on establishing the rules of completing the compliance certificate form (energy performance certificate- Fig.4) and the template for newly constructed multi-apartment residential buildings, as well as objects constructed (reconstructed/renovated) by state funds are clear indication that the process of improvement for building energy performance is on the way.

Figure 4: The energy performance certificate template for newly constructed multi-apartment residential buildings, approved by the Decree of the Minister of Economic Development and Investments (presently Minister of Economy), No. 342A, dated 30 May 2019



The template is the actual approved version by the Minister of Economic Development and Investments.

The mandatory requirements for buildings' energy performance in new multi-apartment residential buildings and buildings funded by state funds is the first practical step, acknowledging that the public authorities recognize the improvement of the Armenian building stock as a priority. The rules of completing and the template of the compliance certificate form (energy performance certificate) for newly constructed multi-apartment residential buildings, as well as objects constructed (reconstructed/renovated) by state funds is approved pursuant to the Governmental Resolution No 426-N (Governmental Resolution No 426-N, dated 12.04.2018, on establishing the technical regulation for energy savings and energy efficiency in newly constructed multi-apartment buildings, as well as objects constructed reconstructed/renovated) by state funds).

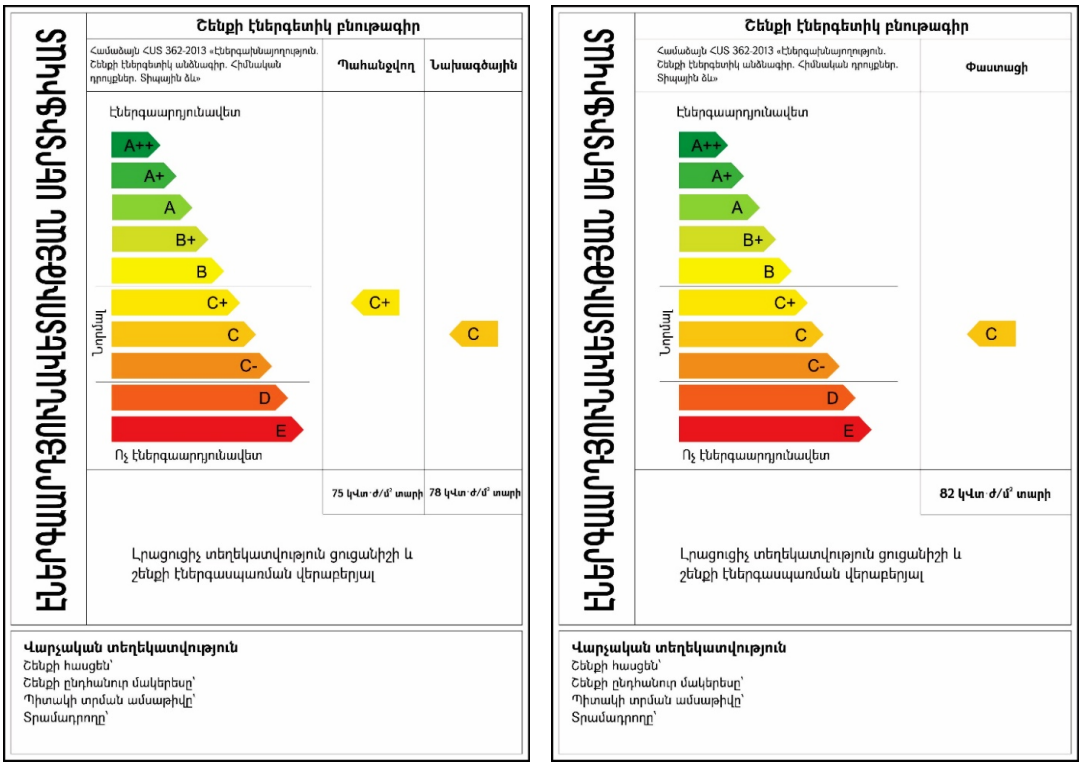
In the period 2013–2016, two National Standards were developed to support the improvement of buildings energy performance, enabling the implementation of important instruments as the building energy passports and energy audits:

- AST 362-2013 "Energy conservation. Building energy passport. Basic rules. Standard form";
- AST 371-2016 "Methodology for performing energy audit in residential and public buildings".

The building code "RACN 24-01-2016 Thermal Protection of the Buildings" (mandatory building code based on Russian norms), approved in 2016, also tightens the requirements for energy efficiency through requirements for the heat transfer resistance of building structures, the characteristics of energy efficiency of buildings, the class of energy efficiency of buildings and the energy passport of a building.

AST 362-2013 "Energy conservation. Building energy passport Basic rules. Standard form" refers to the classification and building energy performance certificates (Fig. 5 shows the forms approved for use in Armenia).

Figure 5: A building certificate form specified in Armenia standard AST 362-2013 "Energy conservation. Building energy passport Basic rules. Standard form."



The template is the original version from AST 362-2013.

The standard is introducing the Building Energy Passport form, methodology to fill it in as well as the Building Energy Efficiency Certificate with classification of the buildings' energy performance.

As illustrated above, the "normal" class of the building should at least be "**C-**", as the "normal" zoning ranges from "**C-**" to "**C+**", and starting from "**B**" class, the building is considered energy efficient (exceeding the code minimal requirements).

2.5 Financing energy efficiency

So far, most investments in energy efficiency improvements in Armenia have been based on grants and loans from IFIs, with international organizations such as United Nations (UN) agencies or non-governmental organizations (NGOs) such as Habitat for Humanity (HFH) playing a central role in project delivery.

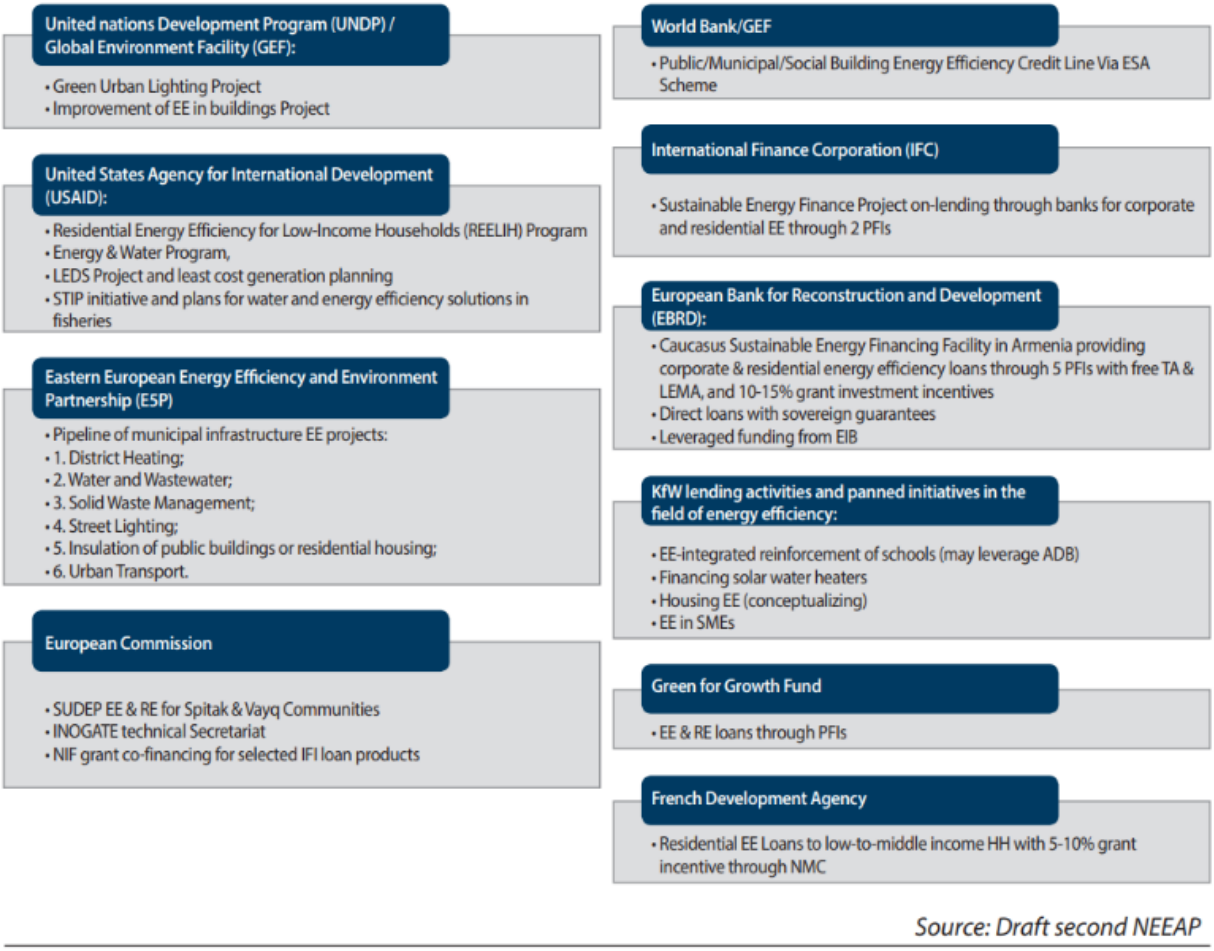
During 2010-2015, for example, IFIs committed an estimated USD 86 million to energy efficiency-related projects in Armenia, with the European Bank for Reconstruction and Development (EBRD) and the International Finance Corporation (IFC) providing the majority (nearly 90 per cent) of funding, which leveraged over USD 23 million in additional financing from the private sector. These investments have had a notable impact on the country's banking sector, as local financial institutions (LFIs) have not only administered funds but also invested significant additional funds through a variety of loans. However, only a small portion of these significant sums – about 0.3 per cent – was invested in improving building energy efficiency, mainly in public buildings rather than residential dwellings. Industry received the largest share at over 35 per cent, the power sector garnered approximately 22 per cent, small and medium-sized enterprises (SMEs) 18 per cent, and municipal infrastructure projects 14 per cent. While these investments have created a market for energy efficiency financial services targeting industries and SMEs, for example, many LFIs in Armenia still do not offer financial products aimed at residential housing efficiency. In addition, central and local government budgets to implement and enforce building efficiency policy measures have been limited.

Some credit lines for energy efficiency improvements have already been deployed in Armenia, and policy makers are now working to further unlock residential building efficiency financing as part of a Neighborhood Investment Platform (NIP) being developed with the European Union under the CEPA initiative. The NIP "will aim at supporting low-income households and MABs with piloting innovative financing schemes which could be scaled up in the future".

There are numerous donors in Armenia with significant flows of grants and loans in energy efficiency (Table 2).

The Government of Armenia is supportive of developing the energy efficiency–enabling environment, but in the implementation of energy efficiency, it relies on significant funding from donors and international financial institutions. This is also evidenced in NEEAP-2 stating that significant additional funding necessary for the implementation of the energy efficiency investments will be required from donors and international financial institutions. International donors largely set and implement Armenia's energy efficiency agenda.

Table 2: Overview of main donors and IFI funds available for energy efficiency in Armenia



Source: Draft second NEEAP

According to IEA, many countries have developed a considerable number of building efficiency financing instruments to generate financing for energy efficiency in recent decades. Lessons from their efforts could offer helpful insights for policy makers in Armenia working on roadmap focus areas. While approaches may differ according to local context, instruments are generally accompanied by enabling measures – from collateral development and training programs for auditors, installers and local lenders, to the creation of dedicated organizations to lead implementation.

Energy efficiency financing instruments and enabling measures are presented in Table 3.

EBRD, AFD, IFC, GGF and KfW are implementing or planning credit facilities for the residential sector, predominantly through participating banks/credit institutions and offering energy efficiency loans for household energy-efficient retrofits, however none of them offer residential EE financing for building-level solutions.

Table 3: Energy efficiency financing instruments and enabling measures

FINANCING INSTRUMENT	SECTOR FOCUS	ENABLING MEASURES (CAPACITY)
Grant, preferential loan or line of credit	Residential	Finance ministry resources; supply chain and LFI training sessions; awareness-raising campaigns targeting households
Revolving fund	Residential and public, including municipal	Creation of a special-purpose vehicle (SPV) to coordinate/oversee financial flows across the fund
EPC/ESA (ESCOs)	Primarily public/commercial	Standard contracts; pre-approved pools of suppliers; technical assistance; training for energy auditors
Bulk procurement	Public and residential	Super-ESCOs to deploy technologies, along with market promotion measures through collaboration with energy providers
On-bill financing (efficiency loan paid back through monthly utility bill)	Public and residential	System elaborated between energy regulators and utilities, whereby government institutions can be facilitators and beneficiaires for financing public building retrofits

L'Agence Française de Développement (AFD): In 2014, the French Development Agency (AFD) launched the Social and Energy Efficiency Housing Finance Programme (SEEHFP). The programme targets low- and medium-income households, especially in rural areas to enable them to renovate their habitation, improve living conditions, reduce residential energy expenses, as well as promote the development of energy-efficient housing stock in towns and villages of Armenia. For the second phase of the technical assistance, AFD commissioned the consulting company to support the National Mortgage Company (NMC) with the implementation of the recommended changes. The main objective of this project is to increase the disbursement of loans under SEEHFP and set up a sustainable financing landscape for energy efficiency in Armenia. The AFD works with national mortgage companies and 14 PFIs on household energy efficiency loans and EE mortgage loans with an overall EUR 10 million credit line and a target of 3,000 households to be reached within the first year of the Programme.

KfW Development Bank: In compliance with the request of the Armenian Government, among the bilateral and multilateral actors KfW, as the agency in charge of German Financial Cooperation, was commissioned to take a lead role in the creation of a sustainable market for housing finance. The support in this market segment was intended to be long-term and was designed to make a significant contribution to creating a solid housing finance market and, in the medium term, to creating donor-independent sources of funding as well. The overall objective was to contribute to improving the housing conditions of the population and to deepening and broadening the financial system. The "Housing V" – is a fifth phase of the project implementing under the umbrella of the German-Armenian Financial Cooperation. In addition, funds are provided by the German Federal Ministry for Economic Cooperation and Development (BMZ) for an Accompanying Measure as grant funds under the umbrella of the German-Armenian Financial Cooperation.

KfW and the Republic of Armenia have signed an Inter-Governmental Agreement on three new loans aimed at:

- EE integrated reinforcement of schools;
- EE credit line for SME; and
- Housing EE credit line.

Habitat for Humanity: In partnership with universal credit organizations, Habitat Armenia implements housing microfinance projects that help low- and middle-income families receive loans from financial institutions to improve their living conditions. These families use the loans to renovate and repair their homes, improve energy

efficiency, water and sanitation conditions, and create access to renewable energy. The projects also aim to revitalize war-affected urban and rural communities. Through its housing microfinance projects, Habitat Armenia also provides technical assistance to families and partner financial institutions through training programs, construction technical advice and informational brochures. Other programs involve renovation of common areas of residential buildings, residential energy efficiency for low-income households and access to renewable and efficient energy in the municipalities of Vayk and Spitak.

UNDP-GEF Project "Improving Energy Efficiency in Buildings: Project was implemented from 2010 to 2016. The objective of the project was to reverse the existing trends and reduce consumption of electrical and thermal energy and associated greenhouse gas emissions in new, restored and primarily residential buildings in Armenia, creating an enabling regulatory environment, skills and capacity among industry professionals to introduce the principles of integrated building design approach in Armenian construction practices from the stage of building design through construction to maintenance of the buildings, developing new energy efficiency (EE) building codes and standards, and stimulating manufacturing and certifying of new EE materials and equipment.

EU4civil society: Energy Efficiency in Armenian Communities Project: The National Social Housing Association Foundation, ASBA Foundation, in partnership with German "Housing Initiative for Eastern Europe" (IWO), Czech "SEVEn, the Energy Efficiency Center z.u" , (SEVEn) and Dutch "Energie-U" Cooperative (Energie-U) organizations, is implementing a project funded by the European Union Delegation to Armenia to address this important issue in rural communities by increasing awareness and implementing practical measures to improve energy utilization pattern, increase quality of life and reduce energy bills. The overarching goal of the project is to provide opportunities for the citizens of Armenia to participate in decision-making to improve their governance and quality of life. The project contributes to this goal by building capacities of local non-governmental organizations NGOs and regional media outlets to engage local communities and active citizens in addressing social issues, in particular fighting energy poverty. This two-year project started on December 24th, 2017, and was implemented in Lori, Tavush, Gegharkunik, Kotayk, Ararat regions of Armenia.

European Bank for Reconstruction and Development (EBRD): The Armenia Sustainable Energy Financing Facility has set up the Energo Credit facility, which provides energy efficiency loans for residential and business clients. In addition, it has been working with MUD to assess the market for residential energy efficiency lending, which would target the energy-saving potential in existing residential buildings. Energo Credit provides free technical assistance and advice on which technologies are eligible for financing (eligibility check).

UNDP-GCF Project "De-risking and Scaling-up Investment in Energy Efficient Building Retrofits": This Project (implementation period 2017-2023), being the 10th GCF financed project in the world and the first one on EE in buildings, seeks to systematically de-carbonize the existing building stock in Armenia to reduce greenhouse gas (GHG) emissions while achieving sustainable development benefits. To do so, the Project focuses on reducing the overall investment risk profile of energy efficiency retrofits in the building sector – one of the major energy consumers in Armenia. Creating a favorable market environment and scalable business model for investment in energy efficiency retrofits will lead to sizeable energy savings, GHG emissions reductions, green job creation and poverty reduction.

The Project addresses market barriers to energy efficient building renovation via a combination of policy and financial de-risking instruments and targeted financial incentives to key market players. By targeting policy, financial, market, technical and capacity barriers, the Project will significantly reduce the overall investment risk profile of energy efficiency building retrofits to encourage private sector investment and thereby scale-up investment in energy efficiency building retrofits in the country. The Project's four components each address a

specific risk area: (i) building sector monitoring, report and verification (MRV) and knowledge management; (ii) policy de-risking; (iii) financial de-risking; and (iv) financial incentives.

The total budget of the project is USD 116.070 million. This is financed through a GCF grant of USD 20 million, USD 420 thousand in cash co-financing and USD 1 million parallel co-financing to be administered by UNDP, USD 8 million from the Yerevan Municipality, USD 400 thousand from the Government of Armenia along with USD 86.250 million in parallel co-financing from EIB, as well as other funding sources available in the market.

The UNDP Armenia, within the framework of this Project, is cooperating with the Ministry of Territorial Administration and Infrastructure of the RA on implementation of Energy Efficient (EE) Building Retrofits under the State Subvention Program (since 2019). Within this cooperation, the Project provides technical assistance to communities in understanding the benefits for EE retrofitting in MABs, selecting relevant buildings, preparing applications, estimating costs and later in design development with objective to co-finance the EE retrofits (up to 25 per cent for full and up to 20 per cent for partial retrofit works). As of December 2020, 32 multi-apartment buildings in six communities have undergone EE retrofits and co-financed by UNDP (with derived CO2 emission savings of around 1,900 tons/year).

Yerevan Energy Efficiency Project (EIB loan, with Yerevan Municipality co-financing, GCF and E5P grant): The Yerevan Energy Efficiency project targeting full and deep retrofit of 50 and improvements of 100 kindergartens started in 2016 with the EU Municipal Project Support Facility (MPSF) grant to prepare the project and financings from the EIB and from the E5P (EUR 15 mln., 2016-2019, SUB-SOVEREIGN).

"EU for Yerevan: Solar Community" Project (2018 – 2020): In the scope of the project, support to the multi-apartment building management bodies (condominiums) is offered in managing the energy use through introduction of energy efficiency measures and installing rooftop photovoltaic (PV) systems to cover the energy consumption used for common areas. The Project includes 90 multi-apartment buildings, on the roofs of which it is planned to install photovoltaic systems which will provide generation of energy required for energy supply of common use premises (lighting of staircases and backyard areas, as well as elevators). Total Project Budget is EUR 1.25 million, of which EU Contribution (grant) accounts for EUR 1 million.

3. Energy Performance of Buildings

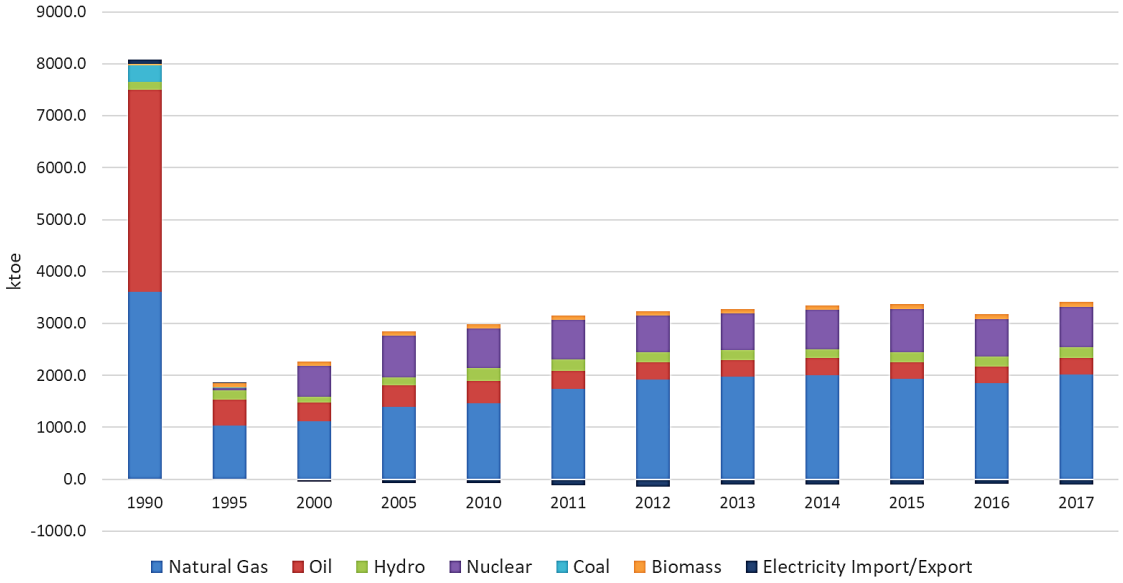
3.1 Overview of building sector emissions assessment

In Armenia's urban economy, buildings are one of the major sources of greenhouse gas emissions (GHG).

18 per cent of the total GHG emissions is from the fuel combustion in the residential buildings, and 7 per cent of the total GHG emissions is from the fuel combustion in the commercial institutional buildings. Based on IPCC methodology, this mentioned figures do not include GHG emissions generated for electricity energy consumption in the buildings. Final energy consumption (FEC) in the residential buildings amounts up to 38 per cent of total FEC, and up to 20 per cent sums FEC in commercial and institutional subcategory. There is no any available study implemented in Armenia considering GHG and FEC investigations on the type of buildings, breakdowns for end uses. At the same time, the building sector presents a significant energy saving potential, which is possible to realize through the effective use of modern energy efficient technologies and practices, reinforce of energy efficient building robust certification system and energy efficiency lending through international and local financial institutions, etc.

Armenia has no domestic resources of fossil fuel and imports all of its oil and gas. Vast majority of natural gas come from Russia - nearly 83.4 per cent in 2016. Armenia also imports some natural gas from Iran in exchange for Armenia's supply of electricity to Iran. Oil is imported from a range of countries. Therefore, it is the urgent need for Armenia to increase its indigenous energy production, improve transmission infrastructure and reduce its dependence upon external suppliers.

Figure 6: Total primary energy supply in Armenia, 1990 - 2017



Source: Armenia's Second Biennial Update Report on Climate Change

Armenia relies on electricity and gas to meet the majority of its energy consumption needs. 82.8 per cent of CO2 emissions from fuel combustion in 2016 originates from natural gas. This is due to a very high gas deliverability level in the country – 95 per cent and widespread use of natural gas for heating and cooking purposes, which is less expensive than electricity, as well as widespread use of natural gas in transport as it is less expensive than petrol or diesel.

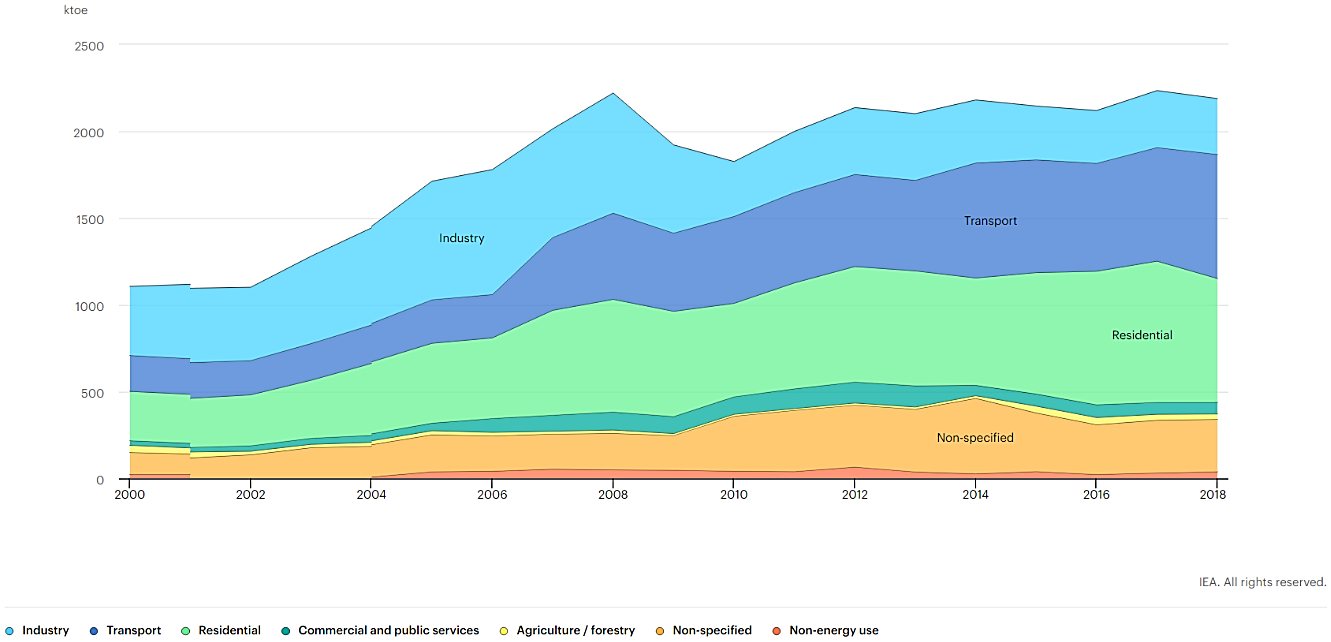
Energy sector GHG emissions in 2017 decreased by 3.2 times compared to 1990. At the same time, the total primary energy supply decreased 2.4 times, the import of natural gas - 1.8 times, the production of electricity - 1.3 times.

These changes are due to the collapse of the USSR and the structural changes in the economy after the energy and economic crisis. As well as a number of factors: termination of centralized heat supply, in the energy sector (energy production and transport subcategories) large-scale use of environmentally friendly fuels i.e. natural gas (the use of coal and fuel oil is negligible), with reopening of the nuclear power plant and the rapid growth of small hydropower.

The main power generation capacities in Armenia are nuclear power plant, natural gas consumed thermal power plants (including small cogeneration units), large hydropower plants as well as small renewables (small hydro, a biogas plant, a wind power plant), which provided 32.5 per cent, 19.1 per cent, 35.3 per cent and 13.1 per cent of total electricity generation in 2016.

In Armenia, there is a single buyer distribution grid. Total final energy consumption in Armenia is shown in Fig. 7:

Figure 7: Total final energy consumption (FEC) by sector, Armenia 2000-2018

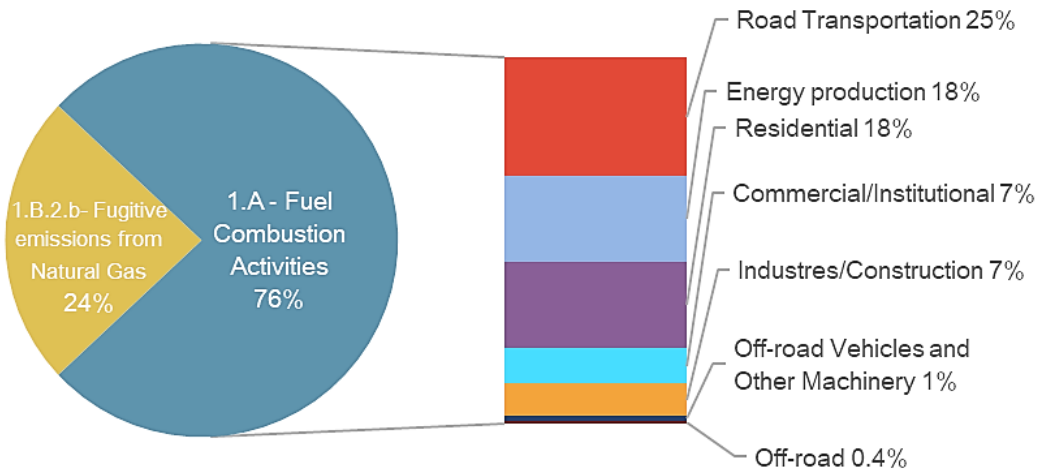


Source: IEA

Armenia has interconnections with neighboring countries – Iran and Georgia, allowing for power exchange in both directions.

The energy sector is by far the biggest source of GHG emissions in the country. Emissions from the energy sector consist of two main categories: fossil fuel combustion and fugitive emissions from natural gas. The majority of the sector's emission (76 per cent) results from fossil fuel combustion (Fig.8).

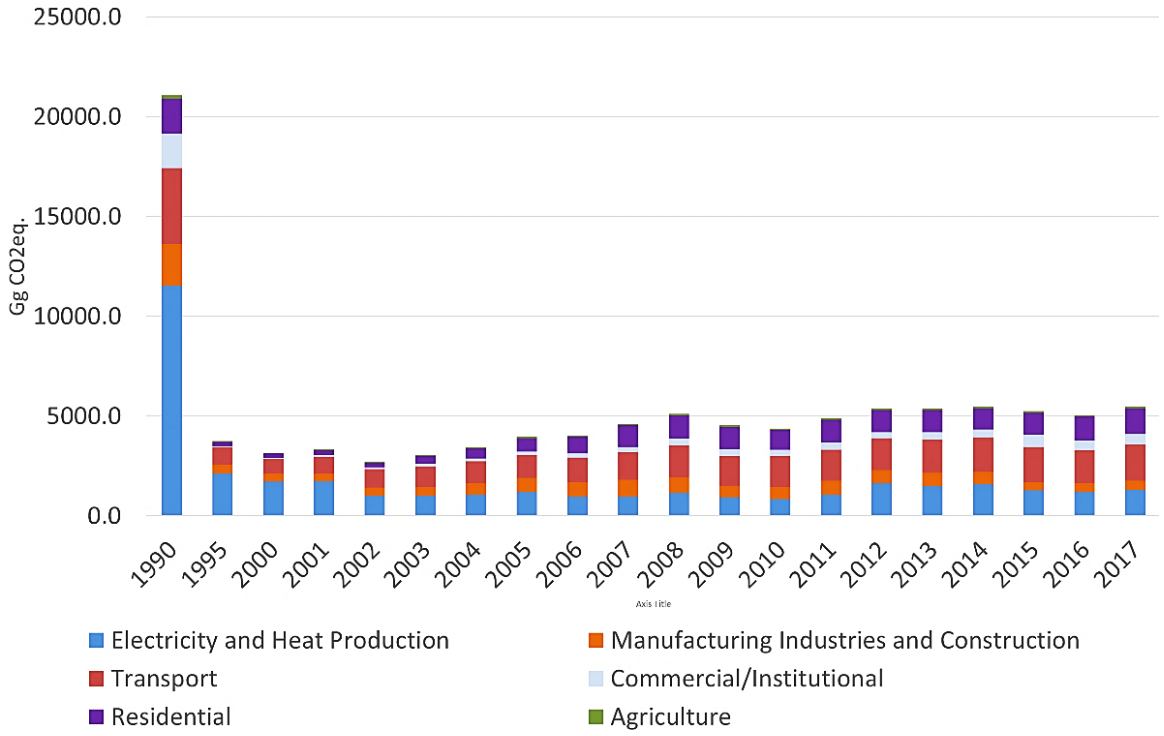
Figure 8: Greenhouse gas emissions by sources in Energy Sector in 2016 (Gg CO2eq.)



Source: National Greenhouse Gas Inventory Report of Armenia, 1990-2017

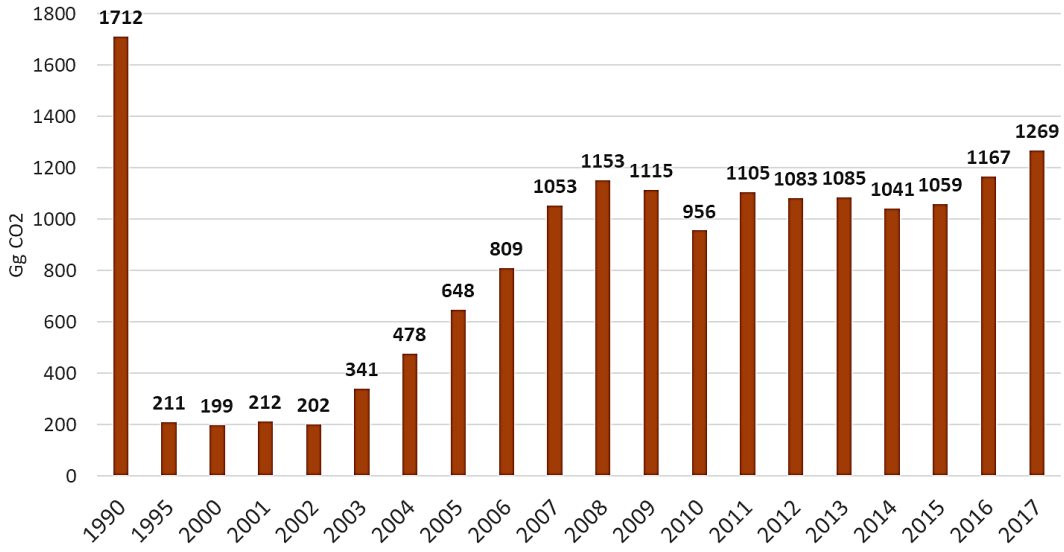
In 2016, its share of the total greenhouse emissions was 64 per cent (6,594.5 Gg CO2eq). The energy sector emissions in 2014 made 29.0 per cent of 1990 emissions level and were 4.6 per cent higher than those in 2012 (Fig.9 and Fig.10).

Figure 9: CO2 emissions by sector, Armenia 1990-2017



Source: National Greenhouse Gas Inventory Report of Armenia, 1990-2017

Figure 10: Emissions from Residential Sector, 1990 – 2017



Source: National Greenhouse Gas Inventory Report of Armenia, 1990-2017

3.1.1 Residential sector and specific energy consumption per square meter of residential floor space (energy intensity in residential buildings)

The building sector is recognized as the most significant energy consumer in Armenia. The officially issued energy balances show the households are the main and largest final consumers of energy (33-38 per cent; 2015-2018), mainly including the natural gas and electricity.

According to the data of the State Committee of the Real Estate Cadaster, the total area of the housing stock of the Republic of Armenia in 2017 is 94.9 million m^2, including 53.7 million m^2 in urban communities (56.6 per cent) and 41.2 million m^2 (43.4 per cent) in rural communities.

Natural gas is the main fuel consumed by households, making up to 86 per cent of the total fuel consumption.

Total number of housing stock is presented in Table 4:

Table 4: Total number of housing stock in Armenia, as of 2017

Multi-apartment buildings			Single family houses		Dormitory and temporary dwellings, thousand m^2	Total area per resident, m^2
Number	Number of apartments	Total area, thousand m^2	Number	Total area, thousand m^2		
19,195	443,023	28,280,813	396,948	66,305,298	273,507	31.9

The total space of the multi apartment buildings amounted to 28,280.8 thousand m^2 or 29.9 per cent of the total space of the housing stock. About 70 per cent of the multi-apartment buildings are made of stone (Fig. 11 and Fig. 12).

Figure 11: Percentage distribution of multi-apartment buildings by exterior wall materials

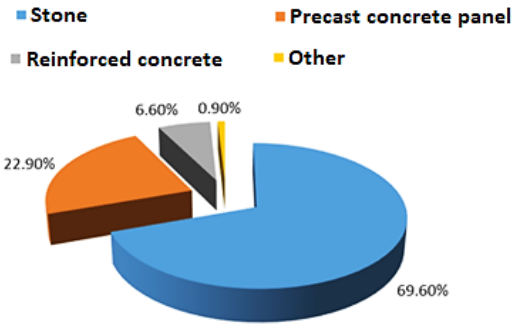
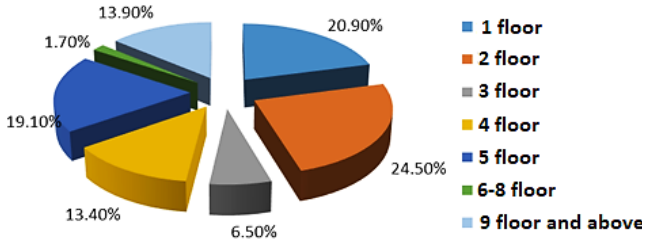


Figure 12: Multi-apartment buildings by number of floors



Most of Armenia's 19,000 buildings were built during the Soviet era, 35 to 60 years ago, without any energy efficiency in mind, especially not having any embedded energy efficiency measures (thermal insulation) in the construction phases, nor enforced code requirements. Many of these buildings are in a dilapidated condition and do not provide the minimum hygienic and comfortable living conditions.

According to preliminary studies conducted by different donor-funded projects and local assessments, energy consumption for heating can be reduced by at least 40 per cent through efficient thermal insulation of residential and public buildings.

According to some energy audits conducted by R2E2 Fund, AE Consulting, Energy Saving Foundation, as well as those carried out by international stakeholders such as World Bank, UNDP, Habitat for Humanity Armenia Foundation and similar entities, average specific residential energy consumption is 185 kWh/m^2 per year and varies between 171 kWh/m^2 per year and 218 kWh/m^2 per year for stand-alone buildings.

These findings are contrary to the indicators estimated on the basis of statistical data (collected from different sources such as Statistical Committee of the Republic of Armenia (ARMSTAT), R2E2 and UNDP Armenia) for residential buildings and energy consumption. According to the Integrated Fuel and Energy Balance (IFEB), residential energy consumption amounted to 664 ktoe, translating into 7,723 million kWh. With around 95 million square meters of total housing area, specific energy consumption would be just about 83 kWh/m^2 per year, which is unrealistically low.

Most likely, the energy balance of the International Energy Agency does not take complete account of total residential fuel and energy consumption. Possible explanation is under consumption (under heating, suppressed comfort levels) and/or unrecorded consumption of other energy resources.

The residential buildings have a higher heat energy demand due to poor insulation and building aging. The results of documented and monitored pilot projects implemented by UNDP-GEF Building Energy Efficiency Improvement project estimated that the average heating energy demand in typical multi-apartment residential buildings is 185 kWh/m^2 per year and with cost-effective energy efficiency improvements the energy use can be cut by 38-40 per cent and the demand can go down to 111 kWh/m^2 per year.

The heavy heating demands due to low efficiencies and large heat losses place major financial burden on household disposable incomes, leading them to fuel poverty (spending over 15 per cent of household income on energy bills). Many families chose to save by under heating or partially heating their homes. This provides a very low baseline energy consumption, which does not create possibilities for economically justified EE improvements. It is common to expect that EE improvements do not result in reduction in energy bills, but they do deliver significant comfort improvements. The EE improvements must be calculated with normalized (corrected for comfort) energy consumption as baseline, corrected for comfort sacrifice.

While energy prices in Armenia are among the highest in the CIS region but still quite lower than prices in EU countries. Armenian population has pronounced fuel poverty (usually defined as use of over 15-20 per cent of disposable income on energy in heating months) among 7-12 per cent of rural households.

In addition to controlling and protecting forests on the supply side, much can be done to address the issues of fuel poverty and excessive fuelwood use on the demand side. Some tools that have proved effective worldwide include enabling access to financing for rural households and introducing low-income energy efficiency programs to improve the efficiency of household heating stoves, building envelopes, hot-water preparation equipment, lighting, household appliances, etc. Due to the high poverty levels among rural population, as well

as high level of indebtedness among rural population due to agricultural farming investments, their ability to borrow large funds or offer securities is limited. Despite the multi-million credit lines available at local financial institutions, the rural households cannot afford to borrow to improve their households' energy performance and reduce their utility bills to remain within their affordability limits. The unsecured loan accessibility for rural households is limited, commonly, to monthly income.

The solution of the multitude of problems related to deforestation, ecosystem damage, fuel poverty, energy waste, unhealthy fuel use, women's empowerment and others could only be done in a holistic approach tackling all areas from policies to finance.

In parallel with the improvement of energy efficiency of the mentioned equipment, the efficient behavior of the consumer will have a greater saving potential in this field (up to 60 per cent).

In Armenia, around 70 per cent of all existing apartment buildings are stone buildings (tuff walls or double layer stone with concrete filling). All of these buildings were constructed in urban areas during the 40's, 50's and partly 60's. That is why they are popularly called "Stalinki", "Khrushchovki" (i.e. built during the Stalin's and Khrushchov's rule) and "Czech design". Brick apartment buildings usually have two to six upper floors and a basement. That type of apartment buildings is made from masonry of classical metric perforated stones (usually local stones like tuff or basalt). The standard thickness of the outdoor wall is 40 - 50 cm, depending on the level of the floor. The walls have exterior lime-cement render with paint finish or exposed masonry. Additional, thermal insulation is not practiced at all. The heat energy consumption of that type of residential buildings varies from 150 to 180 kWh/m^2 per year (OeEB 2013).

Around 23 per cent of the overall number of apartment buildings in Armenia is built with concrete prefabricated panels. All of these buildings were constructed in urban areas during the 60's, 70's and 80's. About 8 per cent of all panel buildings are a "tower" type with about 10 to 16 floors. The remaining 92 per cent of panel buildings are a "line-type", which have between five and 12 floors. During the 60's and 70's mostly "line-type" buildings with a number of floors from six to eight were built. Later constructions built during the 70's and 80's have eight to 12 floors.

Major problems of panel apartment buildings are related to the sticks and joints of panels. Most of these buildings were raised quickly under low construction quality and with the use of cheap materials. Nowadays, the cover of the panel joints is in obsolete condition and needs rehabilitation. Other problems are related to the state of windows and transparent constructions. These have high rate of infiltration and poor thermal resistance values in building shell components, which increases the energy demand of panel buildings. The heat energy consumption of that type of residential buildings varies from 140 to 210 kWh/m^2 per year (OeEB 2013).

6.6 per cent of the overall number of apartment buildings in Armenia is built with monolithic concrete or concrete frame. All of these buildings have been constructed in urban areas from the 70's up to now. Those constructed from the 90's up to now have a skeleton structure with block wall filling.

About 60 per cent of all monolith buildings are a "tower" type with about ten to 14 floors. The remaining 40 per cent are a "line-type" with eight to 12 floors. Outdoor walls have a thickness of approximately 35 cm. Major problems of monolithic concrete apartment buildings are related to the low insulation value of different building shell components, which results in a thermal property lower than initially designed. Energy audits of multiple residential buildings proposed a standard set of measures which can bring to as much as 65 per cent energy consumption reduction:

- Insulation of external walls;
- Replacement of windows and entrance doors;
- Windows replacement by walls (reduction of window area);
- Roof insulation;
- Installation of gas boilers with high efficiency (≥ 92 per cent) for space heating, with possibility to demand side management (thermostat control, consumption-based billing).

New buildings, which make up about 10 to 12 per cent of all buildings, are mostly private and are often built with limited funding, leading to inadequate use of building materials. The average cost of one unit of energy saved in buildings is 1 to 4 US cents per 1 kWh, while the average cost of energy produced by the Armenian energy system is 5 US cents, and the cost of new products is more than 8 US cents.

Building heating, domestic hot water and the use of various equipment are the biggest consumers in buildings. The private sector has been delivering substantial new housing construction, which has reduced during the financial crises, but recovering steadily. Most of these new buildings are consisted of 12-16 floors, with reinforced concrete structure typology, where exterior walls are made with hollow core blocks (varying from 200 to 400 mm), with small (expanded polystyrene (EPS), or extruded polystyrene (XPS), varying from 20 mm to 50 mm) or no insulation layer and covered with a stone cladding (typically with locally tuff stone with a thickness of 30-35 mm). Heating in these buildings is mainly carried out by individual gas boilers (combi boilers) and in some cases through main central heating system (often rooftop boilers).

In new buildings, because apartments are being sold in unfinished conditions, and the selling happens gradually within 1-2 year range, most of the real estate developers do not install centralized heat supply systems, leaving the heating system installation to be done by the apartment owners at a later stage, which is always the individual boiler scheme.

If projecting the current trend in new residential building construction and estimating the expected energy consumption at the commonly assessed current heating energy demand, energy efficiency can bring down energy consumption in these new buildings by about 40 per cent as a minimum. The increased energy tariffs and gradually growing market for green lending for individual household and private businesses will support the spillover effect of the energy efficient construction and renovation in the private sector.

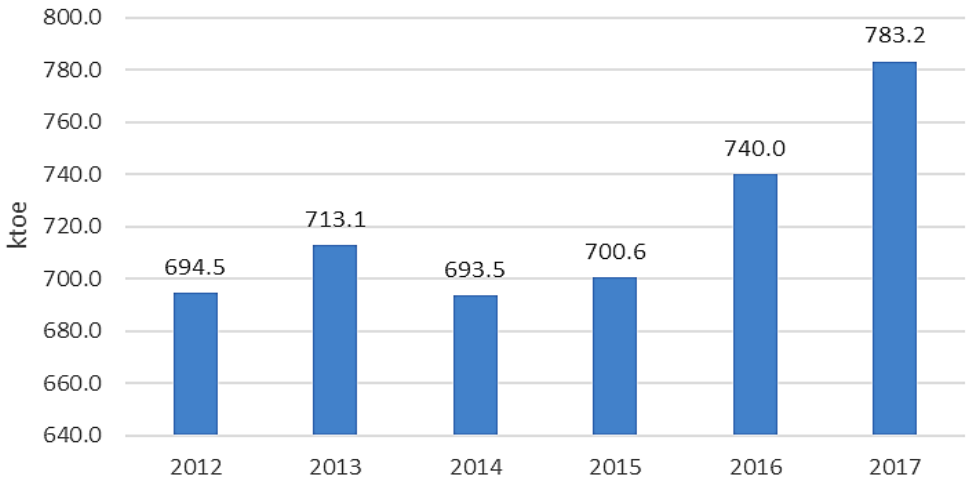
Fig. 13 illustrates the housing construction based on current trends indicating a steady annual growth rate of 1.6-1.8 per cent, the private housing stock will be growing at almost 500 thousand square meters per year:

Figure 13: Housing stock construction trends

Source: National Statistics (https://www.armstat.am/en/)

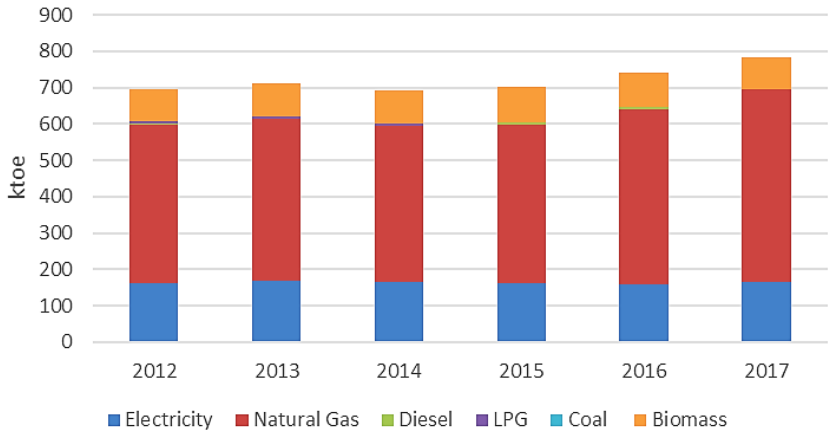
Final Energy consumption in residential sector is presented in Fig. 14 and Fig.15:

Figure 14: Final energy consumption for households, 2012 – 2017



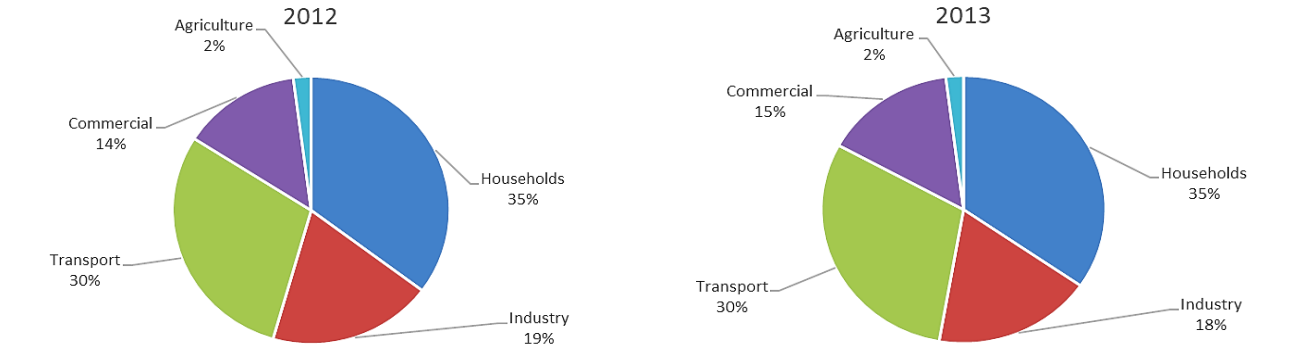
Source: IEA online energy statistics

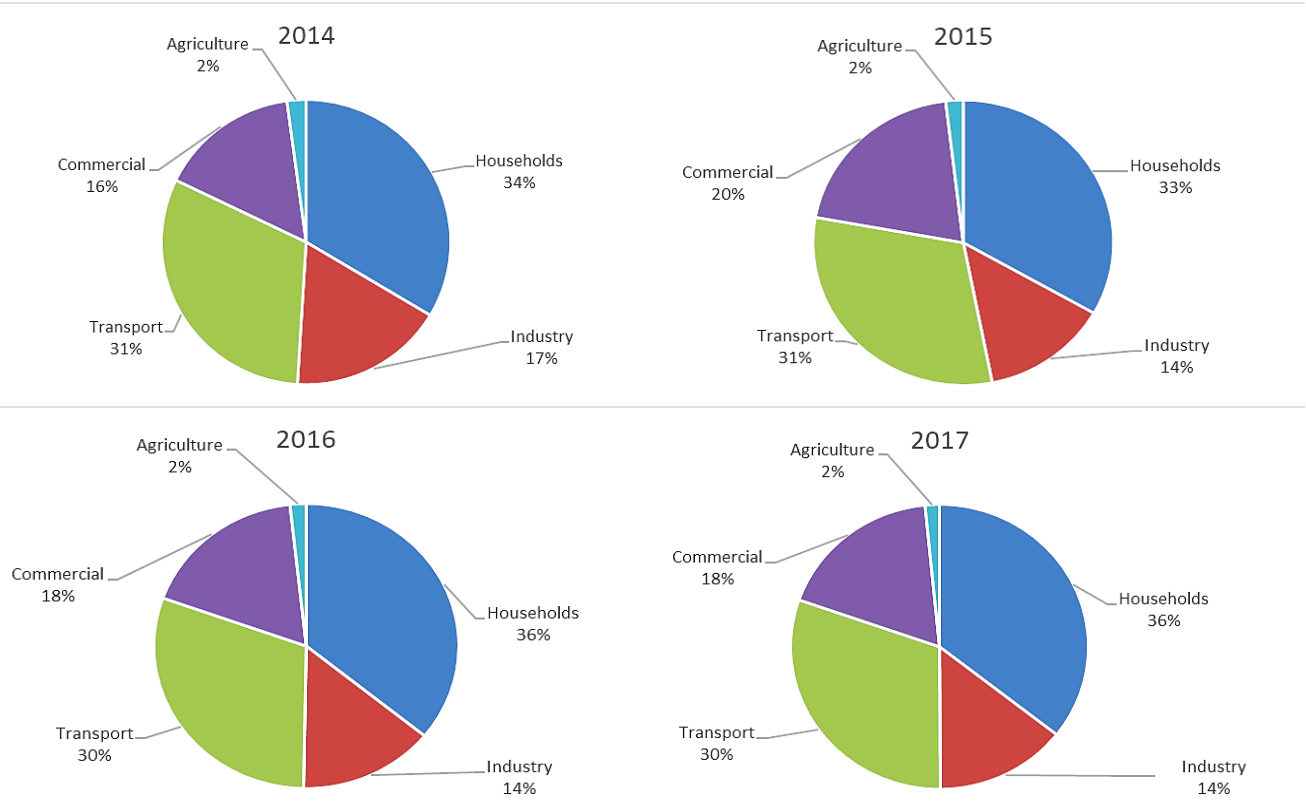
Figure 15: Final energy consumption for households by fuel types, 2012 - 2017



Final Energy Consumption (FEC) breakdowns in Armenia for years 2012 – 2017 is shown in Figure 16:

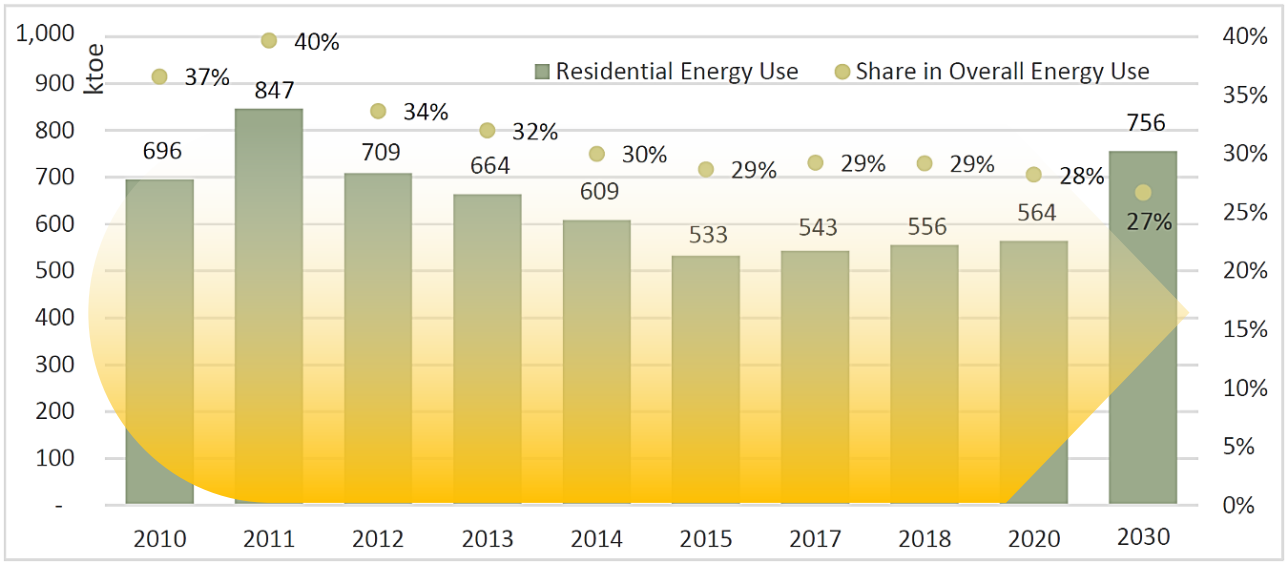
Figure 16: Final Energy Consumption (FEC) breakdowns in Armenia for years 2012 – 2017





As illustrated in Table 4, the Final Energy Consumption for Households is 33-36 per cent (around 690 – 780 ktoe per year). Final Energy Consumption of Commercial sector accounts of 310-430 ktoe per year (14-18 per cent). It can be mentioned that mainly this energy consumption is in the Buildings. Fig. 17 illustrates residential energy consumption and share in overall energy use in Armenia for years 2010 – 2030 (projected):

Figure 16: Residential Energy Consumption and share in overall energy use in Armenia



As it can be seen from the graph above, there is a clear tendency in new residential buildings' construction, and the overall energy use will be raised due to the increase in indoor comfort levels and real estate developments.

Based on GDP projections and economic growth indexes, the development tendency in other sectors such as industry, transport, commercial, agriculture is subject to rise on a steeper slope. On the opposite side, with the enforcement of codes and National Energy Efficiency Action Plans and setting targets to meet EPBD, the energy consumption share of residential sector in total final energy consumption will be lightly reduced.

3.1.2 Specific energy consumption per square meter of public floor area

Public buildings are used for the following activities focusing on not-for-profit services in the public's interest:

- Educational facilities (including universities, schools, kindergartens, art and athletic schools)
- Health (including hospitals, clinics, ambulatories, policlinics)
- Social buildings (nursing homes, orphanages)
- Judicial buildings (courts, prisons)
- Cultural and multipurpose public facilities (museums, archives, libraries, theatres, concert halls, etc.)
- Offices/administrative buildings (including offices for national, regional and local authorities).

New construction, reconstruction and capital renovations are mainly financed by the state budget, regional or municipal budgets, IFI loans or charities/benefactors. Currently, accurate statistics on the number of public buildings, floorage, typology and use is not available. As a rule of thumb, public buildings comprise about 25 per cent (in surface area) of the total area of the building sector.

This sector faces persistent budget limitations. Moreover, the financing is assigned in the public sector from the public budgets per person (e.g. per pupil in schools, per patient – in hospitals, etc.), without consideration of low occupancy, seasonal flows, resulting in forced compressed energy demand and poor state of repair. Schools, universities, colleges, kindergartens, medical institutions, and sports facilities comprise 92 per cent of all public buildings. Over 40 per cent of all public buildings are located in the capital of Armenia. Total Area of public buildings in Armenia is around 13.8 million m^2. The total energy consumption (based on the 56 projects implemented by R2E2 Fund) in public buildings has been estimated at around 1.76 million MWh/a, with annual saving potential of around 0.9 million MWh/a.

The majority of public buildings are under governmental ownership and direct financing. Most have very low energy performance, largely due to the age, the poor condition of the building envelope and the lack of adequate energy management. On average, such buildings have a big range of 10–70 per cent potential for energy saving, which is due to the occupancy rates, functionality, building typology and characteristics. Most of the public buildings, however, are under heated with heating ensuring only 40–50 per cent of the comfort level.

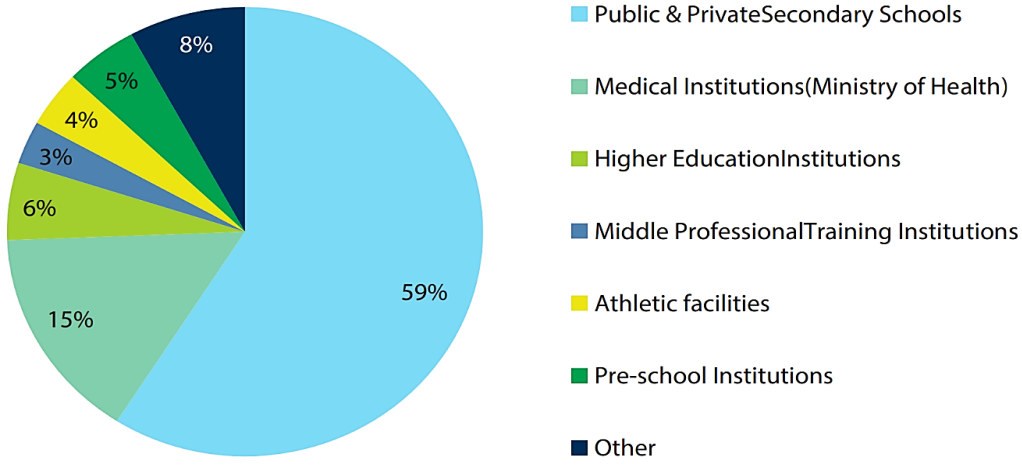
The integrated fuel and energy balance of the International Energy Agency is also a source of energy consumption data for the public sector. Energy costs constitute a large share of the annual expenses incurred by public buildings. In a survey of educational, municipal, and healthcare buildings, 35 per cent of those surveyed admitted that electricity bills amounted to 11-20 per cent of their total annual spending.

According to Energy Consumer Survey in Armenia for Residential, Commercial, Public and Industrial Sectors, conducted by Advanced Engineering Associates International (September 2006), electricity costs were particularly high for educational buildings, where 38 per cent of respondents reported their electricity bills at 11-20 per cent of total annual spending, whereas 27 per cent of respondents reported the share of electricity costs as above 20 per cent. Many schools close down in winter because they cannot provide adequate space heating. When they do operate, they often maintain indoor air temperatures way below adequate levels (most

residents agree that “adequate heating” provides at least 16 °C indoor air temperature; however, schools often operate at less than 8 °C).

The number and area of public buildings in Armenia is shown in Fig. 18:

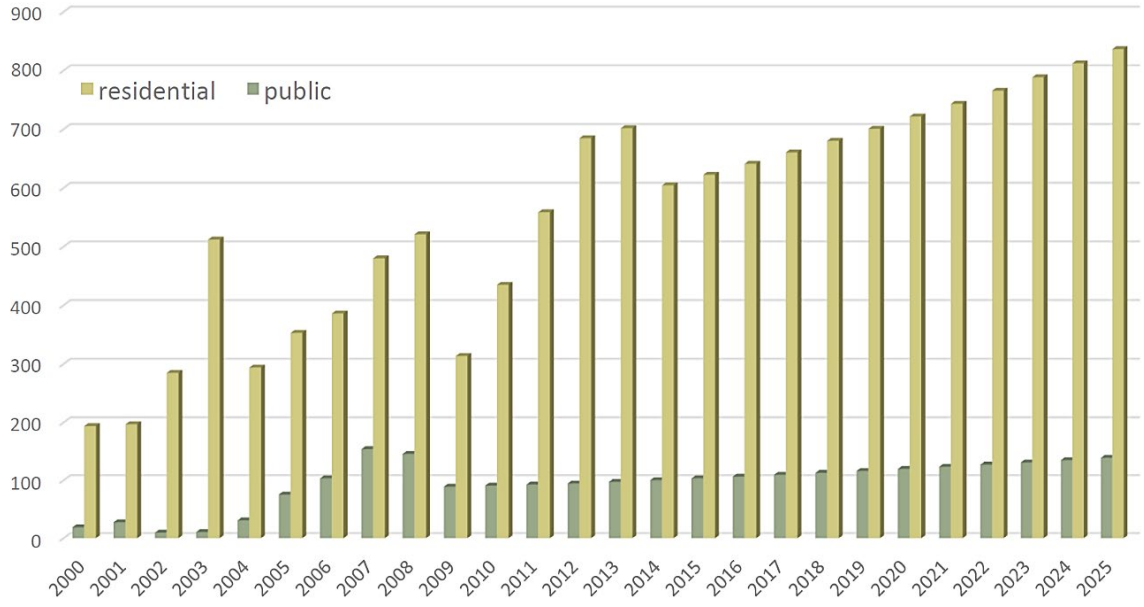
Figure 18: The number and area of public buildings in Armenia, 2013



Source: Energy Charter, 2017

Growth dynamics and forecast for residential and public building stock (thousand m^2) in Armenia is illustrated in Fig. 19:

Figure 19: Growth dynamics for residential and public building stock (projected)



According to the National Programme on Energy Saving and Renewable Energy of Republic of Armenia, 40 per cent of the total energy saving potential can be achieved in the building sector. Thermal insulation can help

reducing space heating demand by 30 per cent, which is equivalent to 3.89 TWh in residential and 0.78 TWh in public buildings per annum.

3.1.3 Specific hot water consumption with access to centralized domestic hot water (DHW) supply

In rural areas, during the heating season, 62 per cent of households heat water with natural gas, 22 per cent – with wood, and 10 per cent – using electricity.

The Armenia Integrated Living Conditions Survey (2017) found that among all – urban and rural – the households relied on the following types of fuel for heating: natural gas – 40.2 per cent (as compared to 57.1 per cent in 2010), wood – 35.9 per cent (as compared to 25.8 per cent in 2010), electricity – 18.5 per cent (as compared to 11.7 per cent in 2010).

It can be summarized that, with negligible exceptions, centralized DHW supply systems **are not in operation in Armenia** since early 2000's.

3.1.4 Centralized space heating and cooling, ventilation

Heating is a central issue in Armenia's building efficiency discussions. Due to the length of the heating season and the severity of winter, particularly in certain rural parts of the country, heating (for space heating and hot water) accounts for the majority of energy consumption in Armenia's buildings (see Fig. 2). Heating also has important fuel poverty, health and wellbeing implications. Of 2,500 households surveyed across Armenia in 2015, less than 40 per cent claimed to be "comfortable" in winter, while nearly half are merely "close to comfortable" and more than 9 per cent said they "hardly cope". The survey results indicate that discomfort due to insufficiently heated homes is more prevalent in villages, and in cities and towns other than Yerevan.

Heating is therefore likely to remain a central topic for Armenia's policy makers during NEEAP deliberations and for the implementation of standards and labels for key technologies such as boilers and heat pumps.

Unlike heating, cooling is still responsible for only a relatively small portion of overall energy demand in Armenia. Only 5 per cent of Armenian households have an AC unit, although the figure is higher in Yerevan at just over 10 per cent. However, cooling is one of the fastest-growing sources of Armenian energy demand, mirroring a global trend resulting from climate change-induced average temperatures increases.

Average annual temperatures in Armenia are expected to rise by up to 2.2°C by 2050 (USAID, 2017). In addition, most Armenian cities are in the country's "moderate" and "warm" climate areas (EDRC, 2015). With greater population density in cities and urban heat-island effects, it is likely that demand for AC units and other cooling technologies such as fans will increase further, particularly among Armenia's city dwellers during summer heat waves.

While currently accounting for a relatively small share of overall demand, cooling-related energy use in Armenia is projected to quadruple from 0.36 PJ in 2020 to 1.61 PJ in 2036, overtaking energy demand for lighting.

Globally, "space cooling accounted for around 13 per cent of the overall growth in electricity demand between 1990 and 2016 and 22 per cent of the increase in electricity use in buildings alone". These trends are particularly visible in the United States and the People's Republic of China (China hereafter), as well as in emerging economies in the hottest parts of the world, where an expanding middle class and rising income levels have created unprecedented increases in energy demand for cooling. While China leads AC manufacturing and sales,

yearly installations are rising by up to 15 per cent in India and other hot emerging economies. This demand is driving up energy use and GHG emissions (both energy- and refrigerant-related) while creating significant pressure on already-strained electrical grids, especially during peak times.

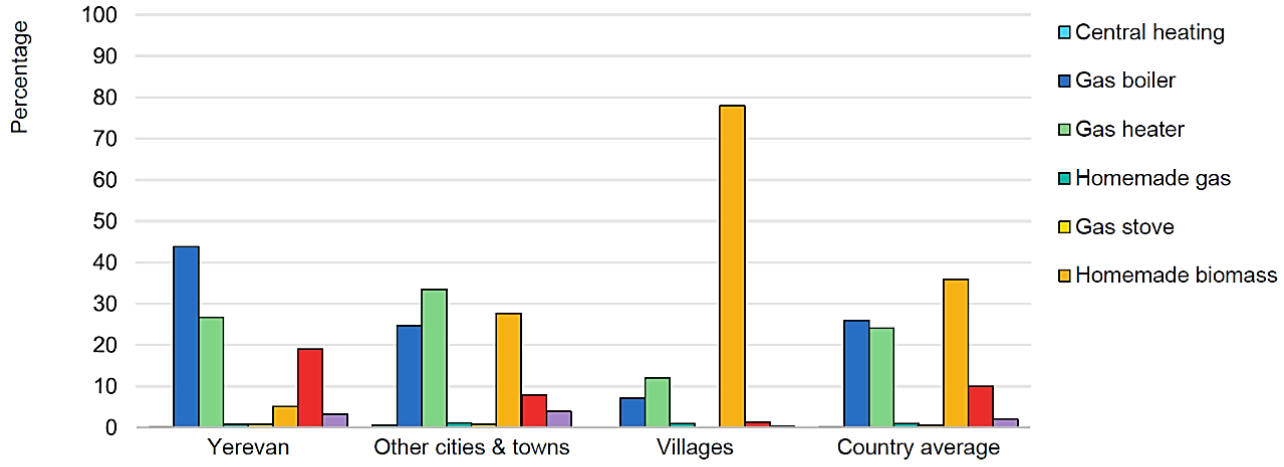
With minor exceptions in conventional office buildings, centralized space heating and cooling does not exist in residential or municipal buildings in Armenia. Centralized heating and cooling systems do exist in hospitals and newly built office/commercial buildings, but these cannot be grouped in a unified scheme, as the systems and typologies differ case by case, hence a standardized scheme cannot be considered.

Mechanical (forced) ventilation is almost non-available in multi-apartment buildings in Armenia. In a few newly built office and public buildings, centralized ventilation systems (with or without heat recovery units) have been executed.

3.1.5 District heating

While 90 per cent of MABs and public buildings relied on district heating during the Soviet era, after its collapse the central systems were almost entirely replaced by individual installations such as gas-fired boilers and heaters, particularly in MABs. Meanwhile, households in villages continue to heat their homes primarily with homemade stoves that burn wood or other forms of biomass. Strong reliance on individual heating systems that combust fossil fuels or biomass means Armenians are highly exposed to the risks associated with gas price fluctuations, and with biomass cost and availability (Fig.20).

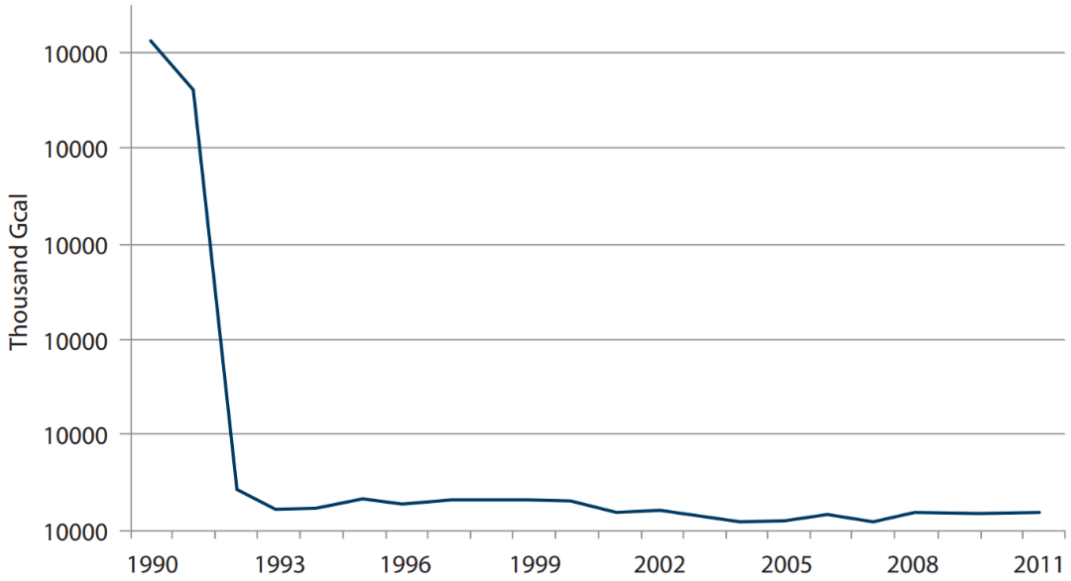
Figure 20: Main heating technologies used in Armenian households



Note: Based on a 2015 survey of 2 500 households.
Source: EDRC (2015), *Residential Energy Consumption Survey: Analytic Report*.

Until the early 90s, district heating provided heat for 64 per cent of the country's residential space (and more than 90 per cent of residential space in multi-apartment buildings); however, it collapsed in Armenia after the dissolution of the Soviet Union. Heat generation by district heating systems in 2005 fell to about 2.5 per cent of that in 1990 (Fig.21).

Figure 21: Heat Energy Production by District Heating Systems in Armenia, 1990-2011



As part of a UNDP-funded project, 76 MABs in Yerevan (Avan district) have been connected to a modern co-generation facility since 2010. The initiative has proven successful, as it provides better heating for residents while cutting average heating costs by 20 per cent compared with individual gas heaters.

According to the energy balance in 2017, centralized production of thermal energy (and delivery to other consumers) was carried out only by “ArmRosCogeneration” CJSC CHP plant, comprising only 8.5 million kWh (or 0.1 per cent of electricity generation in the country).

3.1.6 Lighting

Armenia has made considerable progress in converting to LED lighting. However, precise data for level of LED penetration – or, conversely, the number of remaining inefficient incandescent lamps still in use – is currently not available. There are currently no restrictions on the wattage of household lamps in Armenia. Regulations on lighting design and installation in the Republic of Armenia are integrated into building codes and health codes.

The building code on natural and artificial lighting regulates the amount of light delivered into given indoor or outdoor spaces, with very limited requirements for energy efficiency. “Artificial and Natural Lighting" RACN 22-03-2017 construction norms have been adopted in 2017, which enforce mandatory requirements for buildings and structures of various purposes (as well as outdoor working sites, outdoor sites of industrial and agricultural organizations, railroads within the working sites, outdoor/street lighting of cities and urban and rural settlements, design, reconstruction, capital renovation and operation of road tunnels).

According to RA government decision No. 77 (21.01.2021), for obtaining the energy consuming supplies (products) for the state needs, minimum requirements and technical specifications for luminaires are set as follows (Table 5):

Table 2: Minimum requirements specifications for luminaires

#	Type of product	Nominal Power of the product (W)	Luminous efficacy (lm/W)	Power factor (cos ϕ)	Color Rendering Index (CRI, %)	Lifetime (hours)
1	Luminaires and lamps (with embedded operating and regulating device or power supply), which are used for indoor lighting	2 ≤ P < 20	≥ 80	> 0.5	≥ 80	≥ 20,000
2	Luminaires and lamps (with embedded operating and regulating device or power supply), which are used for outdoor lighting	2 ≤ P < 20	≥ 100	> 0.5	≥ 70	≥ 20,000
3	Luminaires and lamps (with embedded operating and regulating device or power supply), which are used for indoor lighting	P ≥ 20	≥ 90	> 0.9	≥ 80	≥ 30,000
4	Luminaires and lamps (with embedded operating and regulating device or power supply), which are used for outdoor lighting	P ≥ 20	≥ 110	> 0.9	≥ 70	≥ 30,000
5	Lamps (without embedded operating and regulating device or power supply) with E14, E27, G13 and G5 threads	2 ≤ P < 60	≥ 75	-	≥ 80	≥ 20,000
6	Lamps (without embedded operating and regulating device or power supply) with E27, E40, and R7 threads	P ≥ 60	≥ 80	-	≥ 20	≥ 20,000

Due to the decrease in costs of new LED lighting systems and increase in public awareness, energy efficient indoor lighting technologies and solutions have become available and widely accessible in Armenia. Modern light sources are now vastly implemented, meeting the satisfactions on the energy efficiency levels, as well as increasing comfort and performance patterns. Lighting source efficacies of the luminaries available in the market to be installed in buildings are in the range of 90-100 lm/W, resulting in reduced environmental impacts and GHG emissions. Hence, as new LED lighting system has become common practice, potential savings through lighting system upgrades do not seem to be applicable.

3.1.7 Appliances

Armenia has introduced energy labels in line with – sometimes quite old - EU regulations, however, only for refrigerators/freezers, washing machines and air conditioners. Armenia has committed to a schedule of further EU-based energy labels in coming years, however, has also agreed to introduce energy labels as defined by the EurAsian Economic Union (EAEU). Fortunately, those new EEU energy labels are (for household appliances) all aligned with current EU energy labels, as also used in other countries in which the GGF is active. Armenia has virtually no domestic production of appliances and imports these from a variety of countries.

The mandate for the introduction and implementation of energy labelling in Armenia rested with the former Ministry of Energy Infrastructures and Natural Resources. The national market surveillance authority is in charge of enforcement of energy labelling. As far as could be established, however, there has been limited implementation activity around energy labels apart from drafting and adopting the necessary legislation.

In practice, it is common to find Armenian, EU, Turkish and/or Russian energy labels (and sometimes Ukrainian and Kyrgyz labels as well) on products, and sometimes several labels on the same product, in particular for refrigerators/freezers, washing machines and dishwashers. Usually, those labels all indicate the same information, in different styles and languages. Air conditioners and ovens are rarely labelled and, if so, typically carry only one label (no Armenian label for ovens, as that one does not exist). Energy labels used and the information provided on them are generally reliable and can be used to establish the energy performance of appliances. It should be noted, however, that the various versions of labels around present a challenge, as it might make labels harder to recognize.

Armenia's situation is somewhat unusual since it has cooperation agreements around regulatory alignment with both the EU and the EAEU. Armenia became an observer of the Energy Community in 2011. Armenia does not have obligations to implement EU acquis in the field of energy. However, the EU-Armenia Comprehensive and Enhanced Partnership Agreement (CEPA) and other technical assistance initiatives such as EU4Energy incentivizes the country to gradually approximate its legislation to that of the EU in certain areas including eco-design and energy labelling.

Armenia's national energy policy and strategy for energy efficiency and renewable energy is based on a number of policy documents, including its "National Programme on Energy Saving and Renewable Energy of Armenia", adopted in 2007 and National Energy Efficiency Action Plans (NEEAPs). These, however, do not include binding targets for energy efficiency and CO2 emissions. Legislative changes adopted in 2016 make it mandatory to fulfil energy efficiency and energy saving standards for newly constructed apartment buildings.

According to the 2017 policy recommendations report of the Energy Community Secretariat, Armenia's energy efficiency legislation is progressing towards the implementation of the Energy Community energy efficiency acquis, including recent progress in the development of the second NEEAP, adoption of secondary legislation on energy efficiency information, labelling of appliances and energy performance of buildings.

Government Resolution "About the approval of the form of the energy labelling and application procedures for energy consuming appliances and equipment" № 1492-N dated 17.12.2015 introduced the general framework for energy labelling in Armenia in line with the EU Directive 2010/30/EU (note that this EU directive was since superseded by regulation (EU) 2017/1369).

Regulations for these appliance types specify requirements and design similar to the EU labels, however, Armenian labels followed the examples of first-generation EU labels that had then already been replaced in the EU. This, nevertheless, was a step forward as it introduced the concept of energy labelling in Armenia.

Energy labels currently in use in Armenia, according to market studies, are listed in the summary overview below (Table 6). This overview further shows the upcoming energy labels based on EEU technical requirements. For both Armenian and EEU technical requirements, comparable EU energy labels are indicated. Note that these EU energy labels are from different iterations of EU labelling requirements.

Table 3: Energy labels currently in use in Armenia

Appliance type	Armenia label in place	Armenia label scale	Comparable EU label	EEU TR in place	EEU regulation label scale	Comparable EU label
Household electric refrigerators and freezers	Yes	A to G	A to G EU label version 2010	Yes	A +++ to D	A +++ to G EU label version 2014
Household electric washing machines	Yes	A to G	A to G EU label version 1995	Yes	A +++ to D	A +++ to D EU label version 2010
Household dishwashers	N/A	N/A	N/A	Yes	A +++ to D	A +++ to D EU label version 2010
Air conditioners	Yes	A to G	A to G EU label version 2013	Yes	A +++ to G	A +++ to G EU label version 2013
Domestic ovens	(Domestic electric ovens are not covered by the EEU TR or national Armenian regulations).					
TVs	N/A	N/A	N/A	Yes	A +++ to G	A +++ to G EU label version 2010

The lack of effective enforcement mechanisms for energy efficiency standards and labels has been pointed out as a challenge that should be addressed, for example, by the EU4Energy project. Armenia also lacks well-equipped laboratories for conformity assessment and testing. This, however, is hardly unique to Armenia: many countries (including many EU countries) are lacking such laboratories, and there are effective ways to work around this issue. Now that the EAEU is introducing rules and requirements for conformity assessment and certification, further action will need to be undertaken by its member States to fulfil those obligations. There are ongoing efforts supported by some international donors to enhance the capacity for energy efficiency testing in Armenia.

The lack of verification and enforcement capacity for energy labels implies that there is no certainty about the reliability of labels in the Armenian market. This needs to be seen in perspective, however: in most markets, including many EU markets, there is limited to virtually no government compliance checking, without this being a big hurdle for the effectiveness of energy labels.

Energy labels for refrigerators/freezers, washing machines and dishwashers are widely used in Armenia. Air conditioners (for which there is a – little used – Armenian energy label as well as EU and Russian energy labels) and electric ovens (for which there are only the EU energy labels) are not commonly labelled.

Armenian, EU, Turkish and Russian energy labels can be accepted, as these all use the same label categories. The EU has recently adopted new energy labelling requirements for refrigeration, washing and dishwashing appliances, reverting to an A-G scale as well as introducing several important changes in test procedures and energy efficiency calculations. Those new labels are set to come into force from 2021 on and are not yet relevant for non-EU markets, however, the upcoming transition to those new labels needs to be considered for future years.

3.2. Existing calculation methodology and current practices

Building codes

The following building codes approved by Urban Development Committee are currently into force:

a) *RACN II-7.02-95 "Construction thermophysics of building envelope; construction norms"*

The norm is clarified in CNM II-7.102-98 "Manual on RACN II-70.2-95 Construction thermophysics of building envelope" and regulates the energy efficiency related parameters (minimum code requirements) to be addressed during building design and construction stages.

b) *RACN 24-01-2016 "Thermal Protection of Buildings"*

The norm (based on advanced development of CIS interstate building codes) regulates the minimum energy efficiency requirements in terms of useful heat energy demand for heating and ventilation in $W/(m^3 \cdot ^oC)$ for different types of buildings.

c) *RACN II-7.01-2011 "Construction Climatology"*

The norm specifies climatic conditions in various towns in Armenia, including data about temperature, relative humidity, precipitation, wind, solar irradiation, duration of heating season, climatic zones, etc.

d) *RACN 22-03-2017 "Artificial and Natural Lighting"*

The norm sets mandatory requirements for indoor and outdoor lighting.

As a major difference from the established European practices, in Armenia, the energy performance requirements in building norms **are only based on thermal resistance of the elements of the building envelope and the heating degree-days for the building, taking into account heat gains, infiltration and factors related to heating self-regulation.** This corresponds to Module 2 of the modular structure of CEN standards for calculation of EPBD described in the previous chapter.

Currently the efficiency of the building HVAC systems, type of energy (energy carriers) used for heating, the energy for cooling, DHW, lighting and the generated emissions are not part of the energy performance requirements. The recommended change of the minimum requirements for EPBD, which has to be reflected in the relevant construction norms (mainly a) & b)) will be strongly supported by the application of the ISO 52000 set of standards, presenting the necessary instruments to bridge this major inconsistency.

EPBD assessment methodology

The EPBD assessment in Armenia is based on the existing local standards. Based on local legislation, all standards are voluntary, unless they are referenced in the normative-regulatory acts.

a) *AST 362-2013 "Energy conservation. Building energy passport. Basic rules. Standard form"*

The standard regulates the basic principles of energy passports of buildings, defines the form of energy passports for residential and public buildings, and proposes a unified legal solution to the structure of the energy passports. The defined energy performance indicator (in $W/m^3 \cdot °C$) is the specific useful energy for heating and ventilation. AST 362-2013 is based on the harmonized and revised versions of the inter-governmental building code MSN 24-01-2011 "Thermal Protection of Buildings".

The following normative document is referred to in this Standard:

- GOST 31167-2009 Buildings and structures. Methods for determination of air permeability of structures under natural conditions.

b) AST 371-2016 "Methodology for performing energy audit in residential and public buildings".

The standard regulates the procedure for energy auditing of buildings, the process of drawing up a building energy passport and determining the energy efficiency class of the building in accordance with useful energy for heating and ventilation.

The standard also cites the following normative documents:

- AST 362-2013 Energy saving. Building energy passport. Key points: Typical forms;
- AST ISO 16818-2012 Building environment design. Energy Efficiency. Terminology;
- AST EN 15217-2012 Energy performance of buildings. Methods of Expression and Certification of Energy Efficiency of the Building;
- AST 15316-1-2012 Heating systems in buildings. Method for calculating system energy demand and efficiency. Part 1 General Provisions;
- AST EN 15603-2012 Energy performance of buildings. Common use of energy and determination of energy efficiency ratings;
- AST ISO 23045-2012 Building environment design. Energy Efficiency Guidelines for New Buildings;
- GOST 24940-96 Buildings and structures. Method for measuring illumination;
- GOST 30494-2011 Residential and public buildings. Microclimate settings in the premises.

The standard is developed in 2016 on the basis of legal acts and normative documents of the Republic of Armenia, taking into account applicable but currently outdated international practices in energy auditing as EN 15217 (replaced by ISO 52003), EN 15603 (replaced by ISO 52000-1), EN 15316-1-2012 (newer version available).

The full list of standards that ensure enforcement of the Technical Regulation of the Republic of Armenia Government Decree No 426-N, dated 12 April 2018, on establishing the technical regulation for energy saving and energy efficiency in newly constructed multi-apartment residential buildings, as well as in objects constructed (reconstructed, renovated) by state funds is presented in Annex 1.

These standards are applied on a voluntary basis and, based on experts' feedback, generally are weakly enforced in the mainstream construction practice, have a broader scope and not all are specifically addressed to EPB calculation methodology. The full list of standards is approved by the Decree from the Minister of Economic Development and Investments (presently Minister of Economy), No. 342A, dated 30 May 2019.

The list is a mixture of EU, ISO, GOST and national standards, but there is no clear guidance how and when the standards, or part of them, should be applied in regard to EPB calculation. Some of the standards, focused on insulation products or measuring equipment, are clearly not directly related to the EPB assessment.

There are also standards already withdrawn and superseded by new ones (i.e. EN 15242 is replaced by EN 16798-7) or updated (i.e. ISO 14683-2014 has a new version from 2018). Standards like ISO 14683 and ISO 10211 focusing on thermal bridges are mentioned in the list but are not directly applicable during the design or

auditing, as there is no explicit obligation to calculate the impact on thermal bridges (which in fact may be premature considering the current market development).

The presented Russian standards (GOST) consider thermal resistance (R-value) to describe the elements of the building envelope instead of thermal transmittance (U-value). Given these inconsistencies, it is recommended to apply the practical modular structure presented in ISO 52000 and introduce up-to-date standards as per the requirements of the Directive 2018/844 in order to optimize the process and enable the designers and energy auditors to apply the recognized standards during actual EPB assessment practice.

Current EPB assessment practice

The EPB assessment is based on the specific thermal load for heating and ventilation in $W/m^3/^oC$ (without taking into consideration the energy for cooling, DHW, lighting and other technical building systems).

The minimum R-values for different building shell components, as required by RACN 24-01-2016 "Thermal Protection of Buildings" code is regulated by the number of annual heating degree days (HDD) are presented in Table 7:

Table 4: The minimum R-values for different building shell components (RACN 24-01-2016 "Thermal Protection of Buildings")

Building Type	HDD	Required heat transfer resistance (R-value) of the building envelope ($m^2 \cdot °C$ /W)				
		external walls	flat roof and other isolating covers	covers of cold cellars, basements and attics	windows and outside doors (fenestration)	glazed skylights
Multifamily residential, schools, kindergartens	1000	1.80	2.70	2.40	0.30	0.28
	1500	2.00	2.95	2.65	0.33	0.29
	2000	2.20	3.20	2.90	0.35	0.30
	2500	2.40	3.45	3.15	0.38	0.31
	3000	2.60	3.70	3.40	0.40	0.33
	3500	2.80	3.95	3.65	0.43	0.34
	4000	3.00	4.20	3.90	0.45	0.35
	4500	3.20	4.45	4.15	0.48	0.36
	5000	3.40	4.60	4.40	0.49	0.38
Public, except those listed above, administrative, domestic, industrial in damp and wet conditions	1000	1.34	2.00	1.70	0.30	0.28
	1500	1.49	2.20	1.90	0.33	0.29
	2000	1.64	2.40	2.10	0.35	0.30
	2500	1.79	2.60	2.30	0.38	0.31
	3000	1.94	2.80	2.50	0.40	0.33
	3500	2.09	3.00	2.70	0.43	0.34
	4000	2.24	3.20	2.90	0.45	0.35
	4500	2.39	3.40	3.10	0.48	0.36
	5000	2.54	3.60	3.30	0.49	0.38
Industrial in dry and normal conditions	1000	1.20	1.80	1.20	0.23	0.18
	1500	1.30	1.95	1.30	0.24	0.19
	2000	1.40	2.10	1.40	0.25	0.20
	2500	1.50	2.25	1.50	0.26	0.21
	3000	1.60	2.41	1.60	0.28	0.23
	3500	1.70	2.55	1.70	0.29	0.24
	4000	1.80	2.70	1.80	0.30	0.25

	4500 5000	1.90 2.00	2.85 2.90	1.90 2.00	0.33 0.34	0.26 0.28
Note - at intermediate values are determined by linear interpolation.						

There is no zoning in relation to HDD in Armenia, and each particular location has its own indicator, which derives from the average temperature during heating season in degrees Celsius and duration of heating season in days. There are temperature recordings for 36 locations, defined in the RACN II-7.01-2011 "Construction Climatology", where HDDs can be calculated accordingly.

The number of degree-days during the heating period is used to select normative indices and make calculations (the indicator deduced from initial conditions of microclimate maintenance), which is calculated with the help of following formula:

$$HDD = (t_i - t_{a.t}) \cdot n$$

Where:

n – The duration of the heating period, days

t_i – the inside temperature of the building, ˚C

$t_{a.t}$ – the outside average temperature during the heating period, ˚C

Simultaneously, the same code sets specific thermal load values in W/m^3·°C unit.

The values depend on the typology of the building and the number of floors. Tables 8 and 9 shows the referent values for single family houses and other types of buildings.

Table 5: Specific thermal load for single family houses (RACN 24-01-2016 "Thermal Protection of Buildings")

Specific thermal load for single family houses in W/m^3·°C

Heated area of the building, m^2	Number of floors			
	1	2	3	4
50	0.579	-	-	-
100	0.517	0.558	-	-
150	0.455	0.496	0.538	-
250	0.414	0.434	0.455	0.476
400	0.372	0.372	0.393	0.414
600	0.359	0.359	0.359	0.372
1000 and more	0.336	0.336	0.336	0.336
Note: intermediate values of the heated area of the house in the interval 50-1000 m^2 specific thermal load values should be determined by linear interpolation.				

Table 6: Specific thermal load for buildings (RACN 24-01-2016 "Thermal Protection of Buildings")

Specific thermal load for buildings in W/m^3·°C

Type of building	**Number of floors**							
	1	**2**	**3**	**4, 5**	**6, 7**	**8, 9**	**10, 11**	**12+**
Residential (MFH), hotels, hostels	0.455	0.414	0.372	0.359	0.336	0.319	0.301	0.290
Public, except for the next rows	0.487	0.440	0.417	0.371	0.359	0.342	0.324	0.311
Polyclinics, health care, nursing homes	0.394	0.382	0.371	0.359	0.348	0.336	0.324	0.311
Kindergartens	0.521	0.521	0.521	-	-	-	-	-

Techno-parks, warehouses for services, cultural and leisure activities	0.266	0.225	0.243	0.232	0.232	-	-	-
Administrative (offices)	0.417	0.394	0.382	0.313	0.278	0.255	0.232	0.232

The energy class of the building is based on the deviation between the calculated specific energy consumption for heating and ventilation in kWh/(m^3.y) and the specific energy consumption determined by multiplying the thermal load from tables above by the heating degree-days for the specific building. The energy class of the building is determined as shown in Table 10:

Table 7: Energy classes for buildings in Armenia (RACN 24-01-2016 "Thermal Protection of Buildings")

Energy class	Energy efficiency	Deviation of the actual energy for heating and ventilation and the calculated referent value, %	Suggested events/measures
For new and reconstructed buildings to be designed and operated			
A++	Very high	**Less than -60**	Economic promotion
A+		**Between -50 and -60**	
A		**Between -40 and -50**	
B+	High	**Between -30 and -40**	Economic promotion
B		**Between -15 and -30**	
C+	Normal	**Between -5 and -15**	No actions required
C		**Between -5 and 5**	
C-		**Between 5 and 15**	
For existing buildings			
D	Low	**Between 15 and 50**	Refurbishment recommended
E	Very Low	**Over 50**	Refurbishment recommended

In particular, the **level "C"** refers to the "required level" of thermal protection of the building.

Levels "C+" and "C-" represent deviation from the required level of energy performance by +/- 5 to +/-15 per cent. **Level "B"** represents deviation from the required level of energy performance by - 15 to -30 per cent, which means "better than code requirements by 15-30 per cent. **Level "A"** represents deviation from the required level of energy performance by -40 to -50 per cent, which means "better than code requirements by 40-50 per cent.

Once the deviation from the specific thermal load has been resulted in the range applicable for required level (C), then the R-values of different building shell components can be reduced, as long as the required level C is still met.

Energy efficiency certificates for existing buildings should be issued based on energy audit (Governmental Resolution No 426-N, dated 12 April 2018). Energy audits in Armenia are implemented based on Law on Energy Saving and Renewable Energy. The norm-setting legal act that regulates energy audits in Armenia is the "Procedure for Energy Audit". This procedure has been approved by Armenian Government Decree 1399-N on August 31, 2006 and revised by Decree 1105-N on August 4, 2011 and Decree 1026-N on September 10, 2015.

It is multi-sector (intended primarily for production enterprises) and evaluates the use of fuel and energy resources in a building. Based on the Law on "Technical Regulation" the Building Certificate should be issued by accredited conformity assessment body. In addition, based on the Governmental Decision No 1399-N energy audit should be implemented by an energy auditor certified by an accredited conformity assessment body.

Hence, it is desirable to develop more robust mechanism to control and verify the auditing process that leads to a limited application of this regulation.

4. Maintenance of Multi-Apartment Housing

In 2002, the RA Laws "On the Management of Multi-Apartment Building" (No. 334 RA law, 07.05.2002) and “On Condominium” (ՀՕ-333 of 20.06.2002) were adopted. In accordance with Article 10 of the Law of the Republic of Armenia "On Management of Multi-Apartment Building", the Government of the Republic of Armenia adopted the decision No. 1161-N "On setting mandatory rules for the maintenance of common shared ownership of a multi-apartment building" dated 04.10.2007. The decision includes the compulsory norms on the maintenance of the common shared ownership of a multi-apartment building and the requirements and timing for their provision, the terms of the repair works and the visual inspection of technical condition of the building and the measures of technical conditions survey.

Maintenance and operation of multi-apartments buildings should be carried out on the basis of the results of visual inspection or technical investigations through the implementation of restoration works and preventive measures, which are aimed to ensuring the requirements of protection of the common shared property of the building by the decision of the Government of the Republic of Armenia No. 1161-N of October 4, 2007.

One of the obstacles to improving the maintenance and reliability of existing multi-apartment buildings is the lack of legal and technical facilities for the maintenance and operation of buildings. While a number of legal and normative documents are currently operating in Armenia, some issues have arisen regarding their application.

Particularly:

- There is no common, unified, and unambiguous concept of building maintenance standards,
- The owners and the building manager interpret in different ways the proper maintenance and exploitation of the property, the works and measures to be taken in that direction.

Among numerous other issues, the main reasons for the lack visual inspection of buildings and technical investigations are:

- existence of different legal requirements (voluntary and mandatory requirements for the inspection);
- lack or absence of technical, human and financial resources of the governing body;
- management of large number of buildings by one governing body;
- lack of legal awareness, responsibility and motivation both among the owners and the governing body;
- absence of control.

The stakeholders of maintenance and operating of the commonly shared ownership of MABs are the owners of the building, governing bodies, private organizations that maintain, operate and serve common shared property, Local Self Government bodies (in some cases building governance bodies), the organizations serving the engineering infrastructures (power and communication transmission lines, gas pipelines, water supply, sewage, heat supply systems).

Stakeholders in the field of maintenance and operation of buildings (including existing professional organizations), funding sources for adequate works and measures

The multi-apartment building is a multifunctional structure whose full maintenance and exploitation largely depends on the fulfillment of obligations under the legislation by the involved entities. The stakeholders of maintenance and operating of the common shared ownership of multi-apartment buildings are the owners of the building, governing bodies, private organizations that maintain, operate and serve common shared property, LSGs (in some cases building governance bodies), the organizations serving the engineering infrastructures (power and communication transmission lines, gas pipelines, water supply, sewage, heat supply systems).

Serving, maintenance, and operation of a multi-apartment building is carried out through the three pillars that are linked to one another (by law, contract or business habits):

- Regulation sphere of the Public Services Regulatory Commission (PSRC),
- Local self-government body (LSG) regulation sphere;
- Multi-apartment building Management Body regulation sphere.

Financial management system of multi-apartment building maintenance and operation

Currently, the annual reporting period of the multi-apartment building governing body's financial management, starting from annual budget development to its execution and reporting, is made with deficiencies. The causes of the problem are diverse, particularly the low level of interest and confidence of residents in multi-apartment buildings, weak internal and external control, lack of funding stability, non-professional management, etc. This problem, consequently, also poses a number of other issues that hinder the establishment of the condominium institution as a multi-apartment building management body.

At present, most of condominiums carry out costs based on current needs, at the manager's discretion. Cost classification is not implemented, which could also contribute to raising cost effectiveness.

Recommendations on the legal framework and the current situation in Armenia related to the field

Analysis of the legal framework and the current situation in Armenia related to the field result in the following suggestions:

- Revise the requirements for the maintenance of the common equity property defined by the Decision 1161-N and consider it as one single separate document in the form of rules.
- Ensure an increase in the commercialization of services-consumer relations in a multi-apartment building, based on the principle of equal rights and equal conditions of activity.
- Clarify the roles of all participants in the area of state territorial administration and self-governance body through the creation of a single authorized body to ensure the strategy of the housing stock monitoring and development.
- Ensure the participation of multi-apartment buildings' owners in the maintenance and operation of the common property.
- Increasing the professional capacities of multi-apartment buildings' management bodies, introducing a professional certification institutional system based on any higher education institution.

- Investigate the possibility of introducing a system of unified utility billing (account with its sub-accounts) per each relevant service sector.
- Investigate the possibility of creating a housing fund (by guaranteed, turnover, backup capital forming).
- Investigate the possibility of establishing by utility service providers a fixed fee for utilization and maintenance sending to housing fund.
- Make available an electronic non-cash payment system so that any person in Armenia who owns a property, even if absent from the country, can have the opportunity to fulfill each month his obligations of payment aimed at property maintenance.

Review and analysis of existing international best practices applicable to Armenia for multi-apartment building's maintenance, stability enhancement, energy efficiency improvement and operation rules

Effective organization of management processes for the maintenance and effective exploitation of multi-apartment buildings certainly requires the application of appropriate rules that normally define multi-apartment buildings maintenance and operation standards and activities related to multi-apartment building management. Such standards define a system of concepts for all those dealing with the maintenance and exploitation of the common property of a multi-apartment building. Analysis of the accessible literature in this area allows identifying and analyzing the experience of a number of countries in using standards of multi-apartment building maintenance and exploitation, and rules of management.

Analyzing the foreign experience of multi-apartment buildings management, it can be said that the most common practice of residential building management in foreign countries is the creation of associations (condominiums) of housing units' owners, in which decision-making and its execution are entrusted to a management organization (manager) on a contractual basis. However, there are other associations of residential owners such as housing cooperatives (USA, Canada), syndicates (France), housing joint-stock companies (Finland), homeowners' associations, unions (Germany, Sweden) or housing construction cooperatives (Russian Federation), multi-apartment building co-owners' associations (Ukraine) and so on.

Establishment of owners' association (condominium) in a multi-apartment building is legally binding in Norway, Denmark, Germany, the Netherlands, Switzerland, Poland, Hungary and the Czech Republic. Association of owners in Slovakia, Romania, Bulgaria, Estonia, Latvia, Lithuania, Belarus, Moldova is implemented voluntarily.

The term "condominium" is used in Europe, Asia, and America, which means a real estate unified complex, including a land plot with a clear boundary and located there a residential building on which residential and non-residential premises belong to citizens or legal entities, and the common using property is their common shared ownership. In the above-mentioned countries, the legislation sets strict requirements for the obligations of owners living in multi-apartment buildings. In these countries, owners do not consider their duty as a burden, as the proper service of the apartments brings real and obvious results.

In a number of developed countries housing management is a business. The manager or management organization is remunerated by the owners for the proper maintenance and operation of the building. However, if a residential building does not comply with the requirements of residential property safety and quality standards as required by legislation, all owners living in that building are equally responsible to the state controlling bodies.

Management of multi-apartment buildings and housing and communal services provision are an international theme that unites many countries and is governed by quite similar concepts. However, due to objective circumstances, each country has its own peculiarities, nuances, positive or negative experience.

5. Identification of Gaps and Analysis

The Framework Guidelines for Energy Efficiency Standards in Buildings provide guiding principles for sustainable buildings. In particular, these principles provide the following guidance (i) strategic nature; (ii) design and construction of buildings; (iii) management of buildings.

According to the Framework Guidelines, the buildings must be science-based, service-oriented, integrated with the built environment lifecycle, cost effective, using low-carbon technologies, having low energy consumption, performance-monitored and performance-based, safe and healthy. These high standards of buildings should be addressed in the national legislation, which in its turn should be recent and take into account the current trends and modern technologies to enhance energy efficiency in buildings.

The principles of the Framework Guidelines provide guidance for planners, builders, and the entire building delivery and management chain as elements of innovative sustainability strategy. These principles shift the building industry paradigm from fragmented and serial to holistic and integrated.

5.1. Gap analysis between performance objectives of the Framework Guidelines for Energy Efficiency Standards in Buildings and the existing energy efficiency standards in buildings, recommendations

Armenia introduced in 2016 a mandatory building energy code with the adoption of a new regulation “Thermal Protection of Buildings” (RACN 24-01-2016), which was developed based on Russian Building Energy Code from 2003 (updated in 2012) with application of some methodologies and approaches of EU standards, e.g. EN 15217:2007; EN15316-1:2007; EN15603-1:2007; ISO 16818:2008; and ISO 23045-2008. It links building envelope components and heat losses with established energy limits, taking into account differences in climatic conditions.

It also includes a requirement for issuing a building energy passport and an energy efficiency label/certificate with defined energy efficiency classes.

According to RA government decision No. 77 (21.01.2021), minimum requirements and technical specifications (luminous efficacy, power factor, color rendering index, lifetime) for luminaires to be procured by the State needs are set.

Armenia has also adopted the following laws and government decisions:

- Government of the Republic of Armenia decision of April 12, 2018 No. 426-N: The resolution on “Establishing technical regulations on energy saving and energy efficiency in new residential apartment buildings, as well as in facilities under construction (reconstructed) at the expense of state funds”, came into force in October 2019. Mandatory consideration of energy efficiency in construction/reconstruction under the state funded activities is stipulated by the Government Decision #1504-N (December 25, 2014)

- **Law on Energy Saving and Renewable Energy AL-122 (2004) (Amendments 2016, 2017)**
  The Law was amended in 2016 to introduce (i) development of annual energy balance; (ii) sectoral categorization by energy intensity; and (iii) mandatory technical provisions for energy efficiency in new residential building construction, as well as in new construction, capital renovation or reconstruction with the use of state budget funds.
- **Energy Law Al-148 (07.03.2001) (Amendments 2014, 2017, 2018)**
  It defines energy efficiency and renewable energy sources as one pillar of the energy strategy.
- On April 18, 2018, the Armenian Parliament ratified the **Comprehensive and Extended Partnership Agreement (CEPA)** between Armenia and the European Union. It is targeted at protection, improvement and restoration of environment quality, human health protection, sustainable use of natural resources, as well as promotion of measures to address regional and global environmental issues at the international level.
- **National Program on Energy Saving and Renewable Energy (Adopted by Protocol Decision No. 2 dated 18.01.2007)**
  The Program foresees specific targets for the improvement of EE in buildings with a particular focus on thermal insulation only.

However, there are gaps in methodology used for calculation of EPB in the national standards and regulations, which should be addressed.

The methodology used for calculation of EPB within the energy auditing process is focused on the heat losses from the building envelope and the energy class is determined based on the heat load, instead of taking into account primary energy for heating, cooling, DHW, ventilation, lighting and other technical building systems as required in EPBD. This approach is usually used by the HVAC designers in order to calculate the required thermal power of the heating installation and takes into consideration the following parameters:

- Thermal resistance of building envelope (identifies the heat losses through the building elements);
- Efficiency of heat recovery (identifies the heat losses through the ventilation systems, if any);
- Solar radiation heat gains;
- Occupants heat gains;
- Infiltration heat losses.

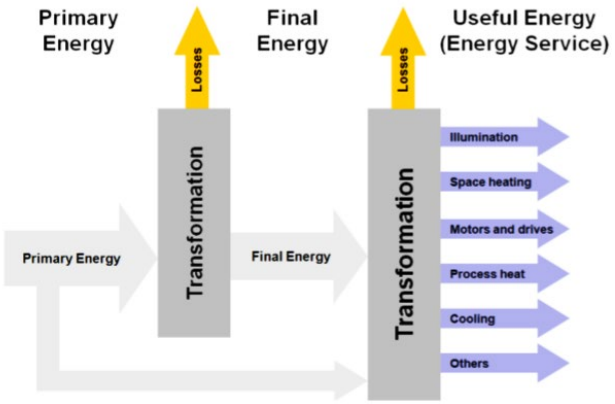
The calculated specific energy consumption in kWh/(m^3.y) is the useful energy for heating, without taking into consideration the efficiency of the heat source (gas boiler, heat pump, etc.) and the type of heating system.

The information in the energy certificate of the buildings includes also:

- General information (type of the building, address, floors, date, etc.);
- Design conditions (designed outdoor temperature, indoor temperature, duration of heating season, degree-days);
- Geometric indicators (floor area, heating volume, area of building envelope elements, etc.);
- Heat resistance indicators (for all building envelope elements);
- Auxiliary indexes (overall heat transfer coefficient of the envelope, infiltration rate, energy tariff and specific energy expenses, etc.)
- Specific indexes (heat losses and heat gains in W/m^3.^{o}C)

- Other coefficients (efficiency of the heating system automatic control, heat losses in the heating system, efficiency of the heat recovery, if any);
- Energy efficiency indicators (calculated performance indicator in W/m^3.^{o}C, standardized performance indicator, energy class of the building);
- Energy consumption (specific and final energy consumption of heating and ventilation).

All related energy consumption and savings data generated by local methodology used for calculation of EPB is based on useful energy figures, hence, all the data should be translated into final energy (based on the benchmark efficiency of the natural gas heating devices of fixed 90 per cent - in the last decade the majority of buildings have made a transition to local gas-fired heating boilers), primary energy and CO_2eq respectively (based on the fixed baseline coefficient for Final Energy, Primary Energy Factors and GHG emission factors for fuels stated and regularly updated in the Guidebooks).



According to the Framework Guidelines, the "total primary energy use in buildings' conditioned spaces, including heating, ventilation, cooling and hot water, can be limited to 45 kWh/m2a or, including plug-in loads (appliances), to 90 kWh/m^{2}a." "Limiting building heating and cooling requirements to 15 kWh/m2a in new builds and to 25 kWh/m^{2}a for retrofit projects", however the buildings constructed in 1960s-1980s consume from 140 to 210 kWh/m^{2}a, where the thermal retrofit of such a multi-apartment panel building can reduce consumption to 74 kWh/m^{2}a after thermal rehabilitation of the building façade.

In summary, the main gap between the local approach for EPB assessment and the best EU practices, as well as the "Framework Guidelines for Energy Efficiency Standards in Buildings", is the numeric indicator that express the building energy class – kWh/(m^3.y) of useful energy for heating and ventilation (Armenia) vs kWh/(m^2.y) of primary energy for heating, cooling, DHW, ventilation, lighting and other technical building systems (EPB).

According to the "Framework Guidelines for Energy Efficiency Standards in Buildings", limiting building heating and cooling requirements to 15 kWh/m²a in new builds and to 25 kWh/m²a for retrofit projects (final energy in conditioned space) each reduces energy needs sufficiently to permit renewable energy or zero carbon sources to meet most or all of the remaining space conditioning energy requirements. Total primary energy use in buildings' conditioned spaces, including heating, ventilation, cooling and hot water, can be limited to 45 kWh/m²a or, including plug-in loads (appliances), to 90 kWh/m²a.

The approach used in Armenia is focused mainly on building envelope and the energy required to maintain thermal comfort, while EU through EPBD and Delegated Regulation 244/2012 require more general approach that evaluates the overall impact of the energy used in the building sector, taking into consideration the energy sources, the efficiency of the energy usage, the environmental impact and last but not least the comfort and the healthy environment.

This offers a serious challenge both to national authorities in view of the need for regulatory changes and to the construction professionals who need to adopt and implement this approach in practice. At the same time, the

proposed measures have the potential to stimulate market development and increase the demand for energy efficient buildings by imposing a clear and reliable method for estimating energy savings.

Below topics are not reflected in the existing calculation methodology of EPB and certification system and should be included further on:

1. Efficiency of heating, ventilation and air conditioning control systems;
2. Efficiency of heating and cooling generation;
3. Cooling losses in building systems;
4. Lighting, appliances, pumps and ventilators with or without useful heat gains inside heated volume;
5. Renewable sources for both heat and electricity, taking into account the perimeter the energy is produced;
6. Final energy consumption in kWh/(m^2.y) and kWh/y;
7. Primary energy consumption in kWh/(m^2.y) and kWh/y;
8. CO_2 emissions calculation in kgCO_2/y.

The "Armenian Building Energy Efficiency Regulatory Review, Comparison with EU Best Practices and Recommendations for Enhanced Enforcement of Minimum Energy Performance Requirements in Buildings" study implemented by the Energy Charter team revealed that Armenia's regulatory framework still has significant gaps for compliance. Moreover, there is a notable lack of experience and capacity to make the due transition to state-of-the-art energy efficiency and performance-based regulations. One of the reasons for the existence of unclear and misleading provisions is that along with CEPA and EPBD harmonization the Republic of Armenia is working with the EAEU, which also has comprehensive regulatory and standards provisions. Some of the gaps identified include the following:

- Absence of methodology for evaluation of cost-effectiveness (cost-optimality);
- Energy auditing of buildings methodology accepted, but lack of organized training, certification and registration of energy auditors and accredited state institution for certification of persons/entities performing energy audits;
- Absence of a State roster of certified energy auditors;
- Format and procedures for carrying out voluntary and mandatory energy auditing of buildings, but not completely EPBD harmonized;
- Template for building energy passport exists, but not fully EPBD-compliant, as it lacks HVAC, DHW, appliances, lighting technologies and building carbon index;
- Certification of EE in buildings is still voluntary, no mandatory provisions in place even for larger buildings;
- Lack of training, certification and registration of inspectors of boilers and cooling systems;
- Mandatory enforcement of EE in buildings only applied to new residential construction and buildings built, reconstructed or fully rehabilitated with state/public funds;
- Responsibilities of building owners are poorly assigned, both during construction and operations;
- There are no provisions for accountability (sanctions) for enforcement/non-compliance;
- Limited testing and certification of building materials;

- Lack of regular information flow on changing regulatory framework for different experts in the chain of construction, including architects, engineers, construction companies and those controlling or checking, but it also requires information and material for non-technical partners such as experts in finance, developer and house owners.

5.2. Gap analysis between the requirements of existing energy efficiency standards in buildings and their actual implementation, recommendations

In Armenia, there is low awareness about the multiple benefits of energy efficiency projects and lack of technical expertise and capacity to identify, evaluate and implement projects. A Roadmap to Energy Efficient Buildings in Armenia also stated that "good communications and awareness-raising are also important for effective engagement with key market and supply chain actors (construction firms, auditors, installers, etc.)".

The lack of awareness regarding the possibilities and benefits of using advanced energy efficiency technologies limits their application for heat supply solutions in the public sector, even though the application of such technologies can be technically, functionally and economically more feasible compared to traditional ones.

The pilot projects on infrared space-heating systems and heat pumps demonstrated the potential benefits of these systems under certain conditions, and several new infrared space-heating systems were subsequently installed. A certain amount of interest in heat pump application emerged among private investors as a result of a seminar, organized by the project, and an awareness campaign on the benefits of the implemented pilot project. Since information on the intensive development and spread of energy efficient technologies is often not available to consumers or investors, or is not understood properly, awareness raising and impartial advertising are important for ensuring the further development and improved energy efficient operation of the sector.

Little incentive currently exists for decision-makers to change from the existing situation and to adopt environmentally friendly heat-supply solutions. Thus, the application of individual heating solutions continues, even in new urban areas with high heat density. Moreover, technically sound heating systems are forced to discontinue their operations, because a percentage of the population refuse to use district heating services.

Additionally, there is a lack of a regulatory framework for ensuring appropriate working relations between apartment owners in multi-story buildings after privatization, in terms of common rules and responsibilities. Local financial institutions also lack skills and knowledge to adequately partner with private sector for EE investment financing.

Recommendations

Based on the in-depth analysis of the barriers in Armenia, as well as on known operational tools from other countries throughout Europe, the gap analysis concludes that exploitation of the significant untapped potential for EE improvement in Armenia demands the adjustment and tailoring of intervention mechanisms to current market needs. To achieve this, new initiatives overcoming the mentioned barriers should be established to offer the following:

- **Technical assistance for legal-regulatory support** (forms, templates for contracts, energy audits, monitoring tools, etc.), as well as transposition of latest EU energy acquis under the Comprehensive and Enhanced Partnership Agreement;

- **Capacity building for quality project design** (energy audits, technical design, surveillance, monitoring and verification), and capacity building of project promoters;
- **Design risk assurance schemes** based on cash flow from generated savings (i.e. not rely on sovereign guarantees), affordable non-sovereign credit guarantee mechanisms, considering public building assets cannot be collateralized;
- **Low-interest loans** for self-repaying energy efficiency retrofits and renewable energy installations, including lower cost of capital and managed risk premiums, provided reliable technical assessments of the realistic risk estimates;
- **Blend in grant co-financing** for investments that do not generate savings (e.g. accessibility and structural reinforcements, aesthetic renovations) to help maintain economic viability of projects: the need for grants should be based on the financial analysis for proposed measures – to achieve positive net present value for comprehensive thermal refurbishments (usually within 20-35 per cent threshold), with the use of cost-optimal renewable solutions, and adequate structural adjustments. This would ensure that the interventions do not artificially favor low-hanging fruit, avoid investing in long-term, building-level solutions, required by the national and international norms.
- **Leverage the support of the Government** of Armenia (Ministry of Finance and Central Bank) to mobilize lower-cost hedging arrangements for foreign currency risks;
- **Seek opportunities for private sector participation through energy service companies** and energy performance contracting to share performance risks and leverage private sector finance. If adequate methodological and political guidance can be put in place to allow for energy performance contracting to be recorded off balance sheet, this will eliminate one of the major barriers for energy efficiency financing allowing governments to invest in energy savings while complying with the debt and deficit thresholds;
- **Internalization and quantification of non-monetary benefits,** such as avoided greenhouse gas emissions, increased service and utilization of public institutions (e.g. universities, policlinics, hospitals, art facilities, etc.), improved indoor comfort, extended building lifetime, reduced health hazards of under-heating and unsustainable heating options, created jobs, reduced import dependence and enhanced national energy security, etc.;
- In **public buildings** – seek opportunities to join donor and IFI efforts to scale up the individual successes to country-wide public building energy efficiency retrofitting program packaged with public sector energy management and optimization of public budget expenses. Such an initiative should be based on public-private partnership and energy performance contracting, provide alternatives to sovereign guarantees, and contain sufficient blending of grant resources to allow for bankability of energy efficiency investments despite the high cost of capital, foreign exchange hedging and need to combine revenue generating energy saving improvements with capital renovation;
- In **residential buildings** – design tailor-made, simplified, easy-to-use loan products, that are supported by grants and guarantee schemes, as well as massive outreach efforts and presence of public and private intermediaries that bring the financiers and the borrowers together, share the credit risk and support with the heavy administrative burden of accessing large numbers of households for unified building-level intervention.

5.3. Barriers to adopting and implementing the high-performance standards in buildings, recommendations

The barriers to energy efficiency investments in multi-apartment residential buildings can be summarized as follows:

- lack of housing strategy or clear policy on state/local government responsibilities towards vulnerable groups;
- implementation and enforcement of acting laws and regulations in the field of multi-apartment building maintenance and management;
- lack of overall awareness and understanding of the legal and regulatory framework, the rights and responsibilities of home-owners associations, the general benefits of EE.
- weak capacity for building management, project development, financial planning and management, fund-raising, human resources, reporting and customer/member relations:
    - some homeowner associations' (HOA) managers still initiate cash-paid service recruitment
    - some HOAs implement maintenance work no more frequently than once every 1-2 years
- lack of financial resources due to low maintenance fee rates and low collection;
- poor creditworthiness due to their new status, slow development, failure to collect service fees, and failure to conduct creditworthy accounting, bookkeeping and reporting;
- difficulty securing the necessary number of votes for strategic decision-making with respect to heat supply issues (the situation is exacerbated by the growing number of autonomous apartment-level solutions) and the significant share of absentee households (around 20 per cent).

The barriers to implementation of energy efficiency measures in public buildings can be summarized as follows:

- lack of public funds to support EE retrofits in public buildings and municipal energy infrastructures in general;
- lack of institutional and technical capacities of state and local authorities to identify and implement EE upgrades, design quality projects, raise or leverage financing;
- limited experience of working though public-private partnership schemes, which could enable private-sector involvement in EE improvements in public sector and leveraging of third-party financing;
- bureaucratic barriers imposed by the Ministry of Finance for energy performance contracts and EE loan agreements assumed by public institutions, limiting access to Treasury accounts and failure to acknowledge the monetary benefits of public sector EE programs for long-term reduction of operational expenses of the state/public budgets;
- lack of adequately structured and affordable financial resources that support not only EE upgrades, but also the much-needed capital renovations, handicapped accessibility improvements and structural reinforcements to comply with seismic resilience standards;
- historical records of low comfort levels and artificially reduced energy consumption levels, which leave limited financial baseline conditions, jeopardizing the calculated economic viability of investments.

Recommendations

The Urban Development Committee recognized the need to amend or rewrite the Law on MAB Management with the appropriate amendments to be provided in the Civil Code regarding the provisions of management of multi-apartment buildings, and to revisit Government Decree No. 1161-N on the Adoption of Obligatory Norms for the Maintenance of the MAB Common Shared Properties.

This reform must be accompanied by a national program to promote residential buildings energy efficiency aimed at the following actions:

- Elimination of legal-regulatory barriers and development of long-term favorable environment with adequate institutional support;
- Enhancing the capacities of local institutions to publicize and promote a program aimed at enhanced EE in MABs;
- Development of an innovative financing scheme which would be calibrated to the real financial viability of such investments in MABs based on estimated risks, occupancy, social/affordability constraints, technical and economic shortcomings;
- Developing and implementing a representative pipeline of EE retrofit projects in MABs which will be financed to test, fine-tune and scale EE investments in 19,000 MABs throughout the country;
- Support all above efforts through outreach and training to ensure there are the necessary specialists in the labor market and the people's mind-set and behavior are adequately informed about the costs and benefits of energy efficiency.

To address the mentioned barriers, the current initiatives by various international organizations and funds aimed at public building/infrastructure energy efficiency (R2E2, EIB, E5P, UNDP, GCF, MPSF, EPTATF) must be scaled up into a national programme to promote residential and public buildings' energy efficiency aimed at the following actions:

- Elimination of barriers for borrowing by municipalities and public institutions based on the economic viability of EE investments;
- Seek regulatory solutions to streamline such investments through energy performance contracting and account for them as off-balance and not record as public debt;
- Support lending with technical assistance for project identification, energy auditing, development of investment pipelines, support to the procurement processes, technical design, surveillance and commissioning;
- Combine investment programmes with the capacity building of public institutions in identification, design and implementation of EE actions, energy accounting, energy information management, energy management systems, benchmarking, building energy passportisation and certification;
- Create favorable investment environment in multi-apartment buildings;
- Introduce private sector participation through private maintenance companies & ESCOs;
- Strengthening the institutional capacity of the State to develop and implement EE policy;
- Leveraging international and local financial institutions' resources to address underserved segments of EE financing market;
- Strengthen capacities among HOAs, SMEs, ESCOs, municipalities to plan and implement EE;
- Strengthening the institutional capacity of the State to develop and implement EE policy.

Conclusions

Armenia has considerable untapped potential to raise the energy efficiency of its buildings, but several barriers and challenges must be addressed if notable progress is to be achieved in the coming decades.

In summary, the first steps for assessment of EPB are taken with the adopted/amended during the last years' laws, regulations and standards that introduce energy efficiency requirements in new multi-apartment residential buildings and buildings renovated by state funds. However, the provided list of standards is applied on voluntary base, without clear guidelines which standards should be used in specific cases.

The analysis of legal-regulatory environment, existing institutional capacities, available financing resources, coupled with the technical and economic potential for energy efficiency investments in buildings, has identified a number of gaps, which can be summarized as follows (Table 11):

Table 8: Gaps in EE investments in buildings and proposed measures

No.	Gap	Proposed actions (Elements)
1	Need to complete legal-regulatory reforms and enforcement	• Harmonization with EU Acquis • Enhance capacity building • Market liberalization and integration in regional markets
2	Insufficient technical and institutional capacities of EE promoters	• TA to improve capacity of EE promoters • Internalization and quantification of non-monetary benefits
3	Lack of tailor-made, affordable financing schemes for upscaling investments in building EE	• Low interest debt financing • Grant co-financing • Leveraging of national social services • Guarantee vehicles
4	Lack of adequate resources to overcome barriers for country-wide public building energy efficiency roll-out program	• Expansion of lending schemes to public and municipal infrastructure energy efficiency • Grant co-financing • Design an exemplary energy efficiency upgrade campaign • Public Energy Management Program
5	Untapped market for multi-apartment residential building EE investments	• Grant technical assistance for developing enabling investment environment • Grant co-financing for concessional lending • Credit guarantees to reduce the imposed margins
6	Absence of EE product and service delivery mechanisms for rural households leading to fuel poverty and dramatic deforestation	• Grant technical assistance for developing enabling investment environment • Grant co-financing for concessional lending • Credit guarantees to reduce the imposed margins • Monetarize the benefits of mitigated deforestation
7	Lack of awareness on the benefits of energy efficiency among decisions makers, service vendors and end-users	• Nationwide public outreach campaign

Development of secondary legislation, regulatory tools, enforcement procedures, calculation methodology and tools, reference databases, control and compliance assurance procedures, procedures for certification and

labelling in building EE, accreditation and certification of experts should be considered. Primary energy factors in the format of official database/platform in the national legislation are yet to be defined. The efficiency of the heating systems in EPB calculations, as well as energy for cooling, DHW, lighting (preferably only for administrative and office buildings) and other technical building systems (fans, pumps, etc.) are to be provided and included in the EPB certificate.

In some cases, deep renovation is not possible in only one step, mostly because of the high initial investment. International collaboration is likely to remain key for ensuring both the short-term success and the long-term viability of Armenia's efforts. Best EU practices, already applied is some countries, show that renovation can be a long process that allows measures to be done step-by-step in order to maximize the final effect and reduce the energy consumption as much as possible.

Collaboration and engagement with the EU in the context of CEPA, or UNDP's work around de-risking and scaling up efficiency financing, for example, are opportunities for Armenia to make progress in key areas. The challenge for policy makers will be to ensure coordination across these and other initiatives, and to ensure that lessons are used to inform wider building efficiency progress.

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Annex 1 - List of legal, regulatory, and normative technical documents

I. Legal Acts		
1	AL-122-N,09.11.2004 AL-130-N,14.04.2011 AL-67-N, 12.05.2016	The Law of the RA on Energy Saving and Renewable Energy
2	Governmental Resolution 1504-N 25.12.2014,	Resolution of the Government of the Republic of Armenia on Implementation of Energy Saving and Energy Efficiency Improvement Measures in Facilities Constructed (Reconstructed, Renovated) under the State Funding
3	Governmental Resolution No 426-N,12.04.2018	A resolution on "Establishing technical regulations on energy saving and energy efficiency in new residential apartment buildings, as well as in facilities under construction (reconstructed) at the expense of state funds", came into force in October 2019
II. Construction Norms (mandatory building codes)		
1	RACN II-7.01-2011	Construction Climatology
2	RACN 24-01-2016	Thermal Protection of the Buildings
3	RACN 22-03-2017	Artificial and Natural Lighting
III. National Standards (voluntary standards, unless referred to in government-adopted technical regulations)		
1	AST 197-2000	Thermal insulation product "Aniks". Technical specifications
2	AST 206-2000	Thermal insulating slabs fibrous perlite. Technical specifications
3	AST 207-2000	Thermal insulation product foamstone. Technical specifications
4	AST 240-2005	Energy saving; terms and definitions
5	AST 246-2006	Energy conservation: Regulatory and procedural guidelines: Basic concepts
6	AST 247-2006	Energy conservation, energy efficiency, composition of indicators, basic concepts
7	AST 248-2006	Energy conservation. Energy consuming general industrial equipment. Types, groups, and indicators of energy efficiency; identification
8	AST 249-2006	Energy conservation; assurance for energy consuming products energy efficiency indexes to their normative values. Methods of verification. general requirements
9	AST 250-2006	Energy conservation; informing the consumers about the energy efficiency of appliances and residential utility equipment; general requirements
10	AST 254-2006	Energy conservation; energy certificate of the consumer of fuel and energy resources; basic rules; standard forms
11	AST 255-2006	Energy conservation; methods of determining the economic effectiveness of the energy efficiency measures
12	AST 256-2006	Energy conservation; secondary energy resources; terms and definitions
13	AST 257-2006	Energy saving. Calculation of electrical power. General provisions
14	AST 304-2008	Renewable energy. Solar energy. Terms and definitions
15	AST 305-2008	Renewable energy. Solar energy. Solar collectors. General technical specifications

16	AST 306-2008	Renewable energy. Solar energy. Solar collectors. Testing methods
17	AST 307-2008	Renewable energy. Solar energy. Solar photovoltaic modules. Types and basic parameters
18	AST 326-2010	Energy saving. Power consumption in compressors and pumps. General provisions
19	AST 327-2010	Energy saving. Power supply and consumption. General provisions
20	AST 328-2010	Energy saving. Technological power consumption. General provisions
21	AST ISO 16818-2008	Building environment design; energy efficiency; terminology
22	AST 1434-1-2010	Heat meters, part 1: general requirements
23	AST 1434-6-2010	Heat meters, part 6: installation, commissioning, operational monitoring and maintenance
24	GOST 2694-78	Buildings foam-diatomite and diatomite
25	GOST 5742-76	Cellular concrete thermal insulation products
26	GOST 7076-99	Construction materials and products. Method for determination of thermal conductivity and thermal resistance in constant thermal regime
27	GOST EN 822-2011	Thermal insulating products for building applications: determination of length and width
28	GOST EN 823-2011	Thermal insulating products for building applications: Determination of thickness
29	GOST EN 824-2011	Thermal insulating products for building applications: determination of squareness
30	GOST EN 825-2011	Thermal insulating products for building applications: determination of flatness
31	GOST EN 826-2011	Thermal insulating products for building applications: determination of compression behavior
32	GOST EN 1602-2011	Thermal insulating products for building applications: determination of the apparent density
33	GOST EN 1604-2011	Thermal insulating products for building applications: determination of dimensional stability under specified temperature and humidity conditions
34	GOST EN 1605-2011	Thermal insulating products for building applications: determination of deformation under specified compressive load and temperature conditions
35	GOST EN 1606-2011	Thermal insulating products in building applications: determination of compressive creep
36	GOST EN 1607-2011	Thermal insulating products for building applications: determination of tensile strength perpendicular to faces
37	GOST EN 1608-2011	Thermal insulating products for building applications: determination of tensile strength parallel to faces
38	GOST EN 1609-2011	Thermal insulating products for building applications: determination of short term water absorption by partial immersion
39	GOST EN 12085-2011	Thermal insulating products for applications in building: determination of linear dimensions of test specimens
40	GOST EN 12086-2011	Thermal insulating products in building applications: determination of water vapor transmission properties
41	GOST EN 12087-2011	Thermal insulating products in building applications: determination of long term water absorption by immersion
42	GOST EN 12088-2011	Thermal insulating products in building applications: determination of long-term moisture absorption by diffusion

43	GOST EN 12089-2011	Thermal insulating products in building applications: determination of bending behavior
44	GOST EN 12090-2011	Thermal insulating products in building applications: determination of shear behavior
45	GOST EN 12091-2011	Thermal insulating products in building applications: determination of freeze-thaw resistance
46	GOST EN 12430-2011	Thermal insulating products for building applications: determination of behavior under point load
47	GOST EN 12431-2011	Thermal insulating products used in building for floating floors: determination of thickness
48	GOST 31924-2011	Thick building materials and products of high and medium thermal resistance: determination of thermal resistance by means of guarded hot plate and heat flow meter
49	GOST 9573-2012	Thermal insulation slabs of mineral wool with synthetic binder. Technical specifications
50	AST ISO 10077-1-2015	Thermal performance of windows, doors and shutters. Calculation of thermal transmittance. Part 1. General provisions
51	AST ISO 10077-2-2015	Thermal performance of windows, doors and shutters. Calculation of thermal transmittance. Part 2. Numerical method for frames
52	GOST 10140-2003	Thermal insulation slabs of mineral wool with bituminous binder. Technical specifications
53	GOST 10499-95	Thermal insulation products made of glass staple fiber. Technical specifications
54	AST ISO 10456-2016	Construction materials and products. Hydrothermal properties. Tabulated design values and procedures for determining established and design values of thermal properties
55	AST EN 15217-2012	Energy performance of buildings: methods for expressing energy performance and for energy certification of buildings
56	AST EN 15316-1-2012	Heating systems in buildings: method for calculation of system energy requirements and system efficiencies, part 1: general provisions
57	AST EN 15603-2012	Energy performance of buildings: overall energy use and definition of energy ratings
58	AST ISO 23045-2012	Building environment design: guidelines to assess energy efficiency of new buildings
59	GOST 32025-2012 (EN ISO 8497:1996)	Thermal insulation: determination of steady-state thermal transmission properties of thermal insulation for circular pipes
60	AST 362-2013	Energy conservation: energy passport of the building. Basic rules. Standard form
61	AST EN 15242-2014	Ventilation for buildings - Calculation methods for the determination of air flow rates in buildings including infiltration
62	AST ISO 7345-2015	Thermal insulation. Physical quantities and definition
63	AST ISO 8145-2016	Thermal insulation. Mineral Wool Boards for overdeck insulation of roofs. Technical Specifications
64	AST ISO 8301-2016	Thermal insulation. Determination of thermal resistance in steady-state thermal regime. Thermal Flowmeter

65	AST ISO 9251-2014	Thermal insulation - Heat transfer conditions and properties of materials – Vocabulary
66	AST ISO 10211-2014	Thermal bridges in building construction - Heat flows and surface temperatures - Detailed calculations
67	AST EN 12977-1-2016	Thermal solar systems and their components. Custom built systems. Part 1. General requirements for solar water heaters and combined systems
68	AST ISO 13153-2014	Framework of the design process for energy-saving in single-family residential and small commercial buildings
69	AST ISO /IEC 13273-1-2016	Energy efficiency and renewable energy sources. Common international terminology. Part 1. Energy efficiency
70	AST ISO/IEC 13273-2-2016	Energy efficiency and renewable energy sources. Common international terminology. Part 2. Renewable energy sources
71	AST ISO 13789-2014	Thermal performance of buildings - Transmission and ventilation heat transfer coefficients - Calculation method
72	AST ISO 13790-2014	Energy performance of buildings - Calculation of energy use for space heating and cooling
73	AST ISO 14683-2014	Thermal bridges in building construction - Linear thermal transmittance - Simplified methods and default values
74	AST EN 15316-3-3-2015	Heating systems in buildings - Method for calculation of system energy requirements and system efficiencies - part 3-3: Domestic hot water systems, generation
75	AST 371-2016	Methodology for performing energy audit in residential and public buildings
76	AST EN 15241-2015	Ventilation for buildings. Calculation methods for energy losses due to ventilation and infiltration in commercial buildings
77	AST EN 15265-2016	Energy performance of buildings. Calculation of energy needs for space heating and cooling in buildings, using dynamic methods. General standards and assessment procedures
78	AST EN 15316-3-2-2015	Heating systems in buildings. Method for calculation of system energy requirements and system efficiency. Part 3-2. Domestic hot water supply systems, distribution
79	GOST 16136-2003	Thermal insulating perlite bitumen slabs. Technical specifications
80	GOST 16381-77	Thermal insulating construction materials. Classification and general technical requirements
81	GOST 17177-94	Thermal insulation materials and constructions
82	GOST 20916-87	Thermal insulation slabs of foam plastic based on phenol-formaldehyde resin. Technical specifications
83	GOST 21880-2011	Thermal insulating mineral wool broached mats. Technical specifications
84	GOST 23307-78	Thermal insulating mineral wool vertical-striped mats. Technical specifications
85	GOST 23208-2003	Thermal insulating cylinders and semi-cylinders of mineral wool on synthetic binder. Technical specifications
86	GOST 23250-78	Construction materials. Method for determination of specific heat capacity
87	GOST 24748-2003	Heat insulation lime-siliceous products. Technical specifications
88	GOST 25380-2014	Buildings and structures. Method for measuring density of heat flows passing through building envelopes

89	GOST 25880-83	Building thermal insulation materials and products. Packing, marking, transportation and storing
90	GOST 26253-2014	Building and structures. Methods for determination of thermal resistance of building envelopes
91	GOST 26254-84	Building and structures. Methods for determination of the resistance to heat transfer of building envelopes
92	GOST 26281-84	Thermal insulation materials and constructions. Acceptance rules
93	GOST 26629-85	Buildings and structures. Method of thermovision control of enclosing structures thermal insulation quality
94	GOST 26602.1-99	Blocks for windows and doors. Methods for determination of the resistance to heat transfer
95	GOST 26824-2010	Buildings and structures. Methods for measuring the luminance
96	GOST 30256-94	Building materials and products. Method for determination of thermal conductivity by cylindrical probe
97	GOST 30290-94	Buildings materials and products. Method for determination of thermal conductivity by surface converter
98	GOST 30804.4.30-2013	Electric energy. Electromagnetic compatibility of technical equipment. Power quality measurement methods
99	GOST 31166-2003	Building and structure envelopes. Method for calorimetric determination of the heat transfer coefficient
100	GOST 31168-2014	Residential buildings. Method for determination of the specific consumption of thermal energy for heating
101	GOST 31309-2005	Building heat-insulating materials based on mineral fibers. General technical specifications
102	GOST 31430-2011	Thermal insulation product for building applications. Method for determination of organic material content
103	GOST 31911-2011	Thermal insulation products for building equipment and industrial installations. Determination of declared thermal conductivity
104	GOST 31912-2011	Thermal insulation products for building equipment and industrial installations. Determination of design thermal conductivity
105	GOST 31913-2011	Thermal insulation material and products. Terms and definitions
106	GOST 31925-2011	Building materials and products of high and medium thermal resistance. Methods of determination of thermal resistance by means of guarded hot plate and heat flow meter
107	GOST 32144-2013	Electric energy. Electromagnetic compatibility of technical equipment. Power quality limits in the public power supply systems
108	GOST 32493-2013	Geosynthetics. Tensile test with wide strip
109	GOST 32497-2013	Porous aggregate for thermal insulation of buildings and facilities. Technical specifications
110	GOST 32498-2013	Buildings and structures. Method for determining energy efficiency of interior lighting
111	AST GOST R 55710-2013	Lighting of indoor workplaces. Norms and methods of measuring
112	AST ISO 50001-2012	Energy management systems. Requirements with guidance for use

IV. Advisory Handbooks		
1	06.11.2013 N343	Order of the Minister of Urban Development of the RA Technical solutions for thermal insulation of envelopes of residential, public and industrial buildings in construction and reconstruction in the RA
2	23.12.2013 N394	Order of the Minister of Urban Development of the RA Catalogue of Replicable Energy Efficient Individual Residential Houses in Communities of the RA