Project funded by the EUROPEAN UNION

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Use of energy efficient technologies adapted to climate change in the process of rehabilitation and conservation of historical monuments.

Environmental and Technological Assessment Report

1. Introduction

Nowadays, the world is concerned with the climate change caused by the global warming. Global warming means gradual increase of average temperature of the ground level air on Earth. This process has begun in pre-industrial period and got stronger since the second half of the 20th century. Climate change significantly changes the social, political and economic agenda of the country. Its impact on the economy of the country and income of family agriculture is very strong and consequently, climate change requires decisive and preliminary measures from both management bodies and the broader community, including business and civil organizations.

The best way to combat climate change is to activate the preliminary mechanisms of its mitigation. One of the best tools of doing it is to save energy and use renewable energy in everyday life. Georgia has undertaken specific obligations under Association Agreement with the European Union on the implementation of energy efficient measures in the construction sector of the country, as well as in economic sectors such as energy production, agriculture, heavy industry, processing industry and transport. This obligation concerns the reduction of emissions and greenhouse gases, as well as the use of energy saving technologies and renewable energy sources.

Georgia has approved Clean Development Mechanism and National Energy Efficiency Action Plan. Significant projects are being carried out for the implementation of these plans at both central government and municipal level.

Georgia has been a rapidly growing area of the tourism sector in recent years, which includes cultural and historical monuments into the economic circulation and makes them a part of the clean development mechanism. In the settlements of Georgia, particularly in historic towns, there are many communal and housing funds having the status of cultural heritage, therefore, it is necessary to develop special approaches to the implementation of the Clean Development Mechanism, which will effectively protect the monuments and environment in which they are located.

2. Analysis of legal framework

In accordance with the protocol of Accession of Georgia to the Treaty establishing the Energy Community, Georgia must implement the directive of the European Parliament and of the Council 2010/31/EU of May 19, 2010 on Energy Performance of Buildings (EPBD), the directive of the European Parliament and of the Council 2012/27/EU of October 25, 2012 on Energy Efficiency (EED). According to the Protocol, the deadline for the implementation of directives is June 30, 2018 and December 31, 2018, although the Ministry of Economy which is the responsible body for the implementation of such directives, negotiates with the Secretariat of the Energy Community about the periods of implementation of specific articles of the directives and it may not coincide with the initial date indicated in the protocol.

22010/31/ EU Directive on Energy Performance of Buildings (EPBD)

This directive aims to promote increase of energy performance of buildings, which along with reduction of greenhouse gas emissions, has many other positive outcomes, including: Increase in the employment rate in the construction sector, technology development and innovation, reduction of air and water pollution, increase in human health and comfort, decrease in energy taxes, etc. In order to achieve this goal, the Directive offers a range of measures, including development of minimum energy performance requirements of buildings (Article 3-8). The Directive obliges the countries to develop a methodology at a national level, to determine the minimum energy performance requirements for individual types and categories of buildings. The methodology should envision thermal characteristics of the buildings (insulation, heating and cooling systems, etc.), insulation and hot water supply, air conditioning systems, integrated lighting, climatic conditions, etc. Minimum requirements should be determined by taking into consideration the cost-optimal level. The norms developed and established on the basis of this methodology relate to all new buildings and existing buildings that are subject to major renovation. The exception are historical buildings, religious buildings, temporary buildings, etc. Minimum energy characteristics should be reviewed regularly and updated if necessary. The Directive separately defines the need for determining the requirements of the technical building systems (heating systems; hot water systems; conditioning systems; large ventilation systems or combination of such systems) and indicates that the use of smart meters should be encouraged (Article 8).

Nearly zero-energy buildings (Article 9)

Upon defining a specific period, all new buildings should be nearly zero-energy buildings, this requirement should first be satisfied by the public buildings. The building is considered as nearly zero-energy building, when it has a high-energy performance indicator. Nearly zero or low energy demand is obtained from renewable energy sources located on the site or adjacent territory.

Incentive Measures (Article 10)

The Directive obliges countries to develop the list of current and planned incentives (including financial) for improving energy performance in buildings. This list should be renewed once in two years and the effectiveness of incentives proposed by the countries shall be assessed. Incentives envisage policy tools (regulations, rules, laws, fines, information and raising awareness measures) and financial measures (grants, subsidies, tax remissions, loans, etc.)

Certification of buildings (Article 11, 12, 13)

The certification of buildings is one of the most important issues. Article 3 of the directive is dedicated to this topic. According to the directive, countries must have the system for the development of energy performance certification of buildings. The certificates should include information on energy consumed by the building and also give recommendations for the reduction of energy consumption and improvement of energy performance. It is noteworthy that information and recommendations on the certificate are often technical and are difficult to understand for the users. Therefore, in order to achieve real results, it is important to provide information in an easy and understandable manner. Certificates should be presented at construction, sale, and rental stages and placed together with advertisements in media. The requirement also applies to public buildings, where certificates should be placed in a well-observed place for people. The term of validity of energy certificates is 10 years. Certifications are an instrument of raising awareness on energy performance. Experience of Member states shows that buildings with energy performance are sold and rented more quickly than ordinary buildings. Therefore, special attention is paid to the placement of certificates in advertising applications and public building responsibility to place them in visible place.

Inspection and Control (Article 14, 15, 16, 17, 18)

According to the directive, appropriate instruments should be established to regularly inspect more than 20 kW heat generation systems and more than 12 kW cooling systems. In addition, the heating systems with more than 100 kW would be checked at least once in two years. For the independence of inspection and control systems, directive requires certification of buildings and inspection of heating and air conditioning systems to be carried out independently by the qualified / or accredited experts.

2012/27 / EU Energy Efficiency Directive (EED)

In 2012 Directive on Energy Efficiency, several articles relate to energy efficiency in buildings. According to Article 4 of the directive, it is necessary to develop a long-term strategy for mobilization of investments for renovation of public, private, household and commercial buildings (this should be the part of the Energy Efficiency Action Plan). The Directive also obliges the countries to annually renew 1% of public building area in accordance with energy efficiency principles. If public structures will annually renew more than 1%, this figure will be counted in fulfilling the obligations of the following years. The Directive discusses offering other alternative measures that will have the same effect. The issue of energy audits is also interesting, which is somewhat related to the requirements of directive on energy efficiency in terms of availability of experts. According to Article 8 of the EED, countries shall ensure the availability of high-quality energy audits for end-users. Contracting parties shall also develop programs to increase consumer awareness about the benefits of such audits among household consumers through appropriate consultations and encourage training programmes for the qualification of energy auditors in order to facilitate sufficient availability of experts.

The requirements of the above-mentioned directives shall be reflected and taken into account in relevant legislation and regulations. The Ministry of Economy and Sustainable Development of Georgia is the body responsible for the implementation of the Directive. In terms of fulfilling the requirements of the Directive, Georgia faces several problems, namely:

- The absence of energy efficiency construction standards - there are no uniform construction norms in Georgia and the standard of 37 countries operates. The construction code has been developed, but its execution is delayed. In addition, there is no single standard of spatial planning and constructions are chaotic, which has a negative impact on constructions with energy performance.
- Existing promotional measures of energy efficiency are insufficiently effective. Targeted bank loans are less productive, since banks do not actually issue low interest loans. Additionally, current subsidized tariffs in Georgia do not grant the opportunity to develop energy efficiency. During low tariff, the investments in

energy efficient technology are less profitable because of long-term returns and relatively low financial savings. Consequently, there is an unfavourable environment for activities of energy service companies in the country.

- The development of energy efficiency is also hindered by the costliness of energy efficient materials and technologies on the market. In public procurement, energy efficient procurement is not implemented, as the main criterion of state procurement is low price.
- There is no uniform practice of certification of buildings or specific flats, and therefore, the consumer is not protected from unsubstantiated advertising.
- Inspection and control systems are less ordered. The problem is the lack of qualified personnel, experts and auditors responsible for energy issues.
- Definition of nearly zero-energy buildings is not defined. According to the directive, countries should themselves determine the characteristics of nearly zero energy building, and for this, a national plan should be developed that will indicate:
    - Detailed practical use of the definition of nearly zero-energy buildings;
    - Numeral expression of primary energy consumption through kW/h on the unit of sq. m. area every year. Average targeted indicators
    - Information about policy, financial or other measures aimed at supporting nearly zero energy buildings, etc.

- One of problematic issues is collecting money from home-owners to improve common property, which is now mostly compensated by municipal funding.

The issue of energy efficiency of buildings in directives consists of complex topics, some steps have already been taken in terms of directive implementation and various events are planned, however, first of all, it is necessary to introduce uniform construction standards and reflect energy efficiency requirements in it considering climatic conditions of Georgia. In addition, due to different climatic conditions, it is likely that introduction of uniform standards may be difficult and climatic zoning will be required.

Object of cultural and historical heritage are topics for separate discussion. As mentioned above, Directive 22010/31/EU does not apply to cultural and historical heritage monuments.

Therefore, there is no reservation or obligation in Georgian legislation and technical regulations in this regard. Moreover, according to the Law of Georgia on "Cultural Heritage", all such monuments are protected by the law and the plan for its rehabilitation, conservation or on-going renovation, as well as the project shall be discussed with the Cultural Heritage Protection Agency of Georgia. Regulations and practices existing at Cultural Heritage Agency exclude the use of non-authentic technology in the process of conducting engineering manipulation.

Regulations related to the monuments of cultural heritage that belong to the housing, administrative and social fund, are relatively light. It is possible to use energy efficient technologies and solutions here with the permission of the municipal authority, if it does not require the change of interface and/or structural changes of these buildings. As for the heating-ventilation system in the housing fund with the status of historical heritage, the use of energy technologies without the permission is possible if it does not require manipulation on the facade and roof.

Considering all the above mentioned, the introductory work of energy efficiency should be initiated primarily on the monuments of cultural heritage belonging to the housing, administrative and social purpose funds. Here the municipality itself is the decision maker, which makes the administrative procedures easier. However, it is a challenge that there is no technical regulation that considers the specifics of such buildings and would have been tailored to their status as well as their functional purpose. Therefore, when searching for engineering solutions in case of such buildings, it is necessary to properly coordinate with the Ministry of Economy of Georgia and the National Agency for Cultural Monuments Protection.

3. Construction technology and engineering

Multilevel and private houses in Georgia were mostly built in Soviet era. When thermal-protection measures of the structures were ignored due to low energy prices. Heating of such buildings requires a large amount of energy.

Nowadays, the strategic goal of introducing energy saving technologies in the construction industry is a conceptual, methodological and project solution designed to improve living conditions, solve ecological issues, save resources and energy. Consumers (investors) often ask for consultation and advice on reducing energy consumption. Within the framework of multiple existing factors for effective consumption of energy, particularly considering increased prices on energy carriers and increased awareness in our consciousness about the environment, the greatest impact can be achieved by the legislation and technical regulation of construction.

The architects do not have power to solve all ecological problems in the world, but nowadays they can design buildings using only the part of energy consumed today, and in addition to that, we may be able to affect traffic flows via adequate urban planning. The location and functional designation of objects, its constructive flexibility and technological resource, orientation, form and structure, its heating and ventilation systems, characteristics of the materials used in the construction - all of this affects the amount of energy spent on building, exploitation and maintenance of the building, as well as mobile transport movement from and to the building.

Multi-residential houses provide many opportunities of increasing energy saving. First of all, it is associated with compact planning of apartments, rational use of public space (the possibility of arranging winter gardening). It is particularly noteworthy that in these types of buildings it is possible to use the roofed (closed) thermal shells (thermal insulation) as efficiently as possible. The arrangement of such shell envisages the improvement of thermal insulation of walls, warming the basement roof and implementation of other measures in order to create a continuous thermal shell of the building.

In low-average floor residential homes, passive warming of the building by the sun can be achieved based on correct ratio of amount and size of windows aperture oriented south and southeast. It is also effective to use three layer windows or windows filled with inert gas together with combined natural air conditioning and ventilation systems. Such buildings are actually energy-efficient buildings. A complex approach of researching and designing energy indicators, as well as finding the right solution for further optimization of their energy efficiency, determines the solution of challenging interconnected tasks that include three main directions:

1. Organizing the micro climate of the building;
2. Minimizing energy costs;
3. Thriftiness of buildings, rational expenditure of material resources.

Selecting the optimal shape of the building, its location and orientation, arranging window apertures and management of microclimate of the building allows the building to reduce the negative impact of the climate on the thermal balance.

An energy efficient building is guaranteed to provide comfortable internal climatic conditions in the building with minimal energy consumption throughout the year and without using expensive power supply systems.

Designing energy efficient building - this is a complex work considering a multi-faceted approaches, rational choice of thermal insulation materials, selection of engineering equipment and effective use of renewable energy sources. When designing such a home, one of the most important components for the efficient life cycle of the building is provision of the ecosystem.

A building is called energy efficient, the design of which, in contrast to other ordinary (typical) buildings, takes into consideration architectural-construction and engineering-technical measures that provide a significant reduction in energy consumption on the exploitation and thermal supply of these buildings, considering the high comfort microclimate of this building. Such buildings should be considered with a defined period of operation. When it will be maximally energy efficient and after which it will be demolished without damaging the environment. Energy efficiency during the operation of the building is a guarantee of a successful life cycle. The life cycle of average multi-storeyed buildings is 30-40 years.

The company AINT-GOBAIN ISOVER has developed a new concept of energy efficient house with annual energy demand of 15 kWh / sq. m. The realization of the project simultaneously ensures the increase in comfort of living conditions, as well as the economy of energy resources. A big number of buildings are built in Germany, Denmark and other countries based on this concept. The concept was developed on the grounds of mathematical modelling methods of experimental research and thermal transfer processes on operated buildings, using infra-red thermography methods and constructions research. According to the processed concept, when designing energy efficient buildings, you must adhere to several main architectural and construction principles in terms of increasing energy efficiency:

- Optimization of architectural forms of the building, considering the potential impact of the wind;
- Optimal direction of the building towards the sun, providing the ability to maximize the use of solar energy;

- Increasing thermal insulation of outside boundary constructions (external walls, roofing, floor above the non-insulated basement) to maximal capacity technology-wise;
- Minimize the length of thermal bridges, thermal nodes and thermal wiring present in the construction to lower heat losses;
- Maximize thermal resistance of transparent boundary constructions (glassing);
- Establish a ventilation system for fresh air supply, expulsion of generated and consumed air, distribution of heat within the building and organizing heat regeneration of ventilation air.

The combination of the above listed factors ensures the minimum energy requirement for the building, and the main factor of increasing energy efficiency is to increase thermal resistance of building elements and decrease the number of thermal bridges.

In 19th century, capital buildings in Tbilisi and other big cities of Georgia (Batumi, Poti, Telavi, Kutaisi) were mainly built by the projects of architects with European education. In case of Tbilisi, the large historic centre of the old town mostly consists of houses built before 1917, which comprise about 10-12% of the city's total residential buildings. These buildings are mostly three-storey (often local varieties, square or flat) structures built from bricks. Their windows often have a single glassing and wooden frames and require renovation. It should be noted that most of these buildings today are granted the status of a cultural heritage monument.

The assessment results of residential area of these buildings show that the majority of buildings are well designed. The coefficient of their ratio with surface volume of limiting frame is not high, therefore, their thermal losses are not very high and with their thermal-technical characteristics, they correspond to the best European level of that time. The walls of the buildings are made of brick, their thickness is about 80 cm and in some cases, it reaches 100 cm and more. Such walls often have additional thermal insulation via grain insulator. For example, the walls of the current building of the Ministry of Education were thermally insulated in such a manner. Sometimes double windows were used. The floor roofs had a heat and sound insulation layers. Attic roofing also had thermal insulation. The staircase cells were closed and they had porches for additional thermal insulation. The ovens were located in such a way that several rooms were warmed up simultaneously. Due to the high thermal inertia of the walls, it was enough to heat them every 3-5 days to warm the apartment. The energy efficiency of these buildings is higher than the buildings built during the Soviet era. The heat resistance of the walls of these buildings can be approximately evaluated as: R=1.0-1.5 m2C/W. According to experts' evaluation, thermal resistance coefficient of older buildings is 2-3 times greater than the coefficient of buildings built in the Soviet era, although over time the thermal resistance of the walls is diminished.

It should be noted that the frame of these buildings is quite damaged and it is necessary to evaluate in details the residential buildings of old Tbilisi, to determine which buildings shall be renovated and which buildings shall be demolished. The roofs of old residential buildings are designed with the attic, thus, a decision on roof thermal insulation in case of all buildings should be made during rehabilitation works.

In the period of Soviet Union, such standard of construction was completely eliminated, and the architecture of the Soviet period paid attention to two issues only: Static stability and hydrogeological evaluation. This approach was passed on as a toxic heritage to the construction sector of independent Georgia. Recognizing primacy of Energy Pact and EU directives has put changing those approaches on agenda, in first place in the direction of energy efficiency.

The new construction norms envision the increase of thermal transfer resistance of restrictive constructions and approximation to modern requirements. The ratio of resistances of old and new restrictive constructions considering climatic conditions are as follows:

Restrictive constructions	Required barrier of heat transfer Thermal resistance of the structure R0 m²C/W		Ratio of new and old norms requirements
	СНиП II -3-79	New cn/r (project)	
1. walls	0 5	2.1	4.2
2. Layers and attic roofs	0 75	2 8	3 7
3. Cold basements and floor coverings	1 34	2 8	1.5
4. Translucent constructions	0 18	0 35	1 9

Since the topic of our research is to ensure energy efficiency of historical heritage monuments, it is obvious that we cannot talk about energy efficiency standards of construction and we mainly must focus on the increase of energy efficiency of existing structures. This is achieved through increasing thermal insulation of the building, ensuring natural cooling, maximal use of natural light (lighting), installing energy efficient systems of heating and cooling and rational consumption of energy.

The method of thermal insulation of buildings

Thermal insulation of the building is possible via different household (sand, straw, slices, newspaper, goffered cardboard paper, sawdust, woo, etc.) as well as industrial (mineral cotton, fibreglass, foam plastic, perlite, cork etc.) materials.

The first option of insulation approach is natural cork. This thermal insulating material may be used for external constructions of the building (under the plaster on walls and under the bitumen of roofs), as well as the filler in bulkheads and to insulate the floor. 3 cm thick cork tiles equals 150 cm thick concrete, 40 cm brick, 15 cm oak and 3.5 cm mineral cotton with its thermal insulating properties. The use of this material is especially important in the old wooden houses that have a status of cultural heritage and it is necessary to preserve an authentic look during wall insulation. In Georgia, usually, insulation with this material is done from the inside of the building through their inter-bulkhead use (see Appendix 1).

The second variant of the insulation approach is the "basalt fibre" (thermal insulation based on the basalt fibre material) is obtained through the processing of fibre material obtained by melting basalt pieces. It is widely used insulator in Western European countries. Its thermal conductivity is quite high. It is also an ecologically clean product and has a high fire resistance. Basalt fibre is not produced in Georgia in classic form, but a number of companies are exporting it from different countries. Due to the fact that there is a sufficient number of raw materials in Georgia required for its production, it is desirable to recommend local companies to expand their activities and produce high-energy products. These products are used inside the building, as well as during outside works. When used on outer wall, it sticks directly to the wall and is sealed up via sand concrete from above (see Appendix 2).

The third option of insulation approach is to increase the energy efficiency of windows and small windows - the absolute majority of buildings with cultural heritage status as of today do not have duplicated (dual) windows, especially in the Black Sea region of Western Georgia, where the winter is mostly warm and moderate. Therefore, there is no need for dual windows in this region, although single windows are ineffective in both winter (in terms of thermal transfer outside) and the summer (in terms of keeping conditioning effect). Therefore, the necessity of installing energy-efficient windows will significantly increase the thermal resistance of these structures. Wherever this is allowed, metal-plastic should be used with 3 or 6 chamber glass unit filled with inert gas, and if the legislative base requires to use wooden material, we should use a wooden structure with 3 chamber glass unit filled with inert gas (as the 6-inch glass unit is heavy for the wooden structure and there is no need for it in Western Georgia). See examples of energy efficient windows in Appendix 3.

Natural cooling system

In absolute majority of buildings holding the status of cultural heritage in large cities of Georgia, cooling system is based on the principle of natural ventilation, where windows and small windows are installed so that it can create a draught movement of air masses. In such buildings, usually, the ventilation shafts are used for exhaust of CO or are broken. Along with temperature rising, this method loses efficiency and the population uses the Fragmented Ventilation System (Conditioners) based on halocarbon, which is not energy efficient and negatively affects the environment. If consumption of air draught movement is maintained for ventilation, it is necessary to use effects strengthening it, such as: Presence of green cover, ensuring movement of winds within the city (restriction of high-storeyed houses), etc. More advanced methods can be used, specifically: A) Ventilation in passive ducts, for which it is necessary to activate the existing ventilation shafts and add new ventilation channels. B) Active air ventilation, when hot air is forced out of the building through electric ventilation, cold air is delivered via natural ventilation (from windows). In this case, ventilation system will be installed in the entire building. C) Ventilation with restoration of air balance, in this case, forcing out the hot air as well as bringing in of cold air and circulation within building is done using electro ventilation. In this case, the use of halocarbon and conditioning is not implemented, but the building is cooled with forceful ventilation of cold and hot air. In this case, the central system of air ventilation, as well as cold air ventilation should be set up. All four discussed methods can be used in Georgia due to their cheapness and simplicity (models are graphically shown in Appendix 4.)

Use of natural light

Light frequency defines space movement and rhythm, creates spatial composition through the lights. Frequency distribution can be divided into three formats: Linear, random and organized. During linear lighting, the effect is perceived as a single line lights. It creates illusion that has continuing nature. Randomly distributed lighting is not subject to any geometric logic or specific sample. Organized lighting gives us the opportunity to perceive the form and model. The light direction and distribution is a kind of sculptor that defines the architectural shape. It has the ability to determine the light direction and give it a specific character.

Architecture is visually formed by light effects. There are scattered and focused lights. This kind of direction and light distribution gives the architect the opportunity to present the space and objects with various effects. To maximize the use of natural lighting (solar light), maximum approximation of building location to the climate belt is used, as well as the use of glass root and glazing. However, since all these models require structural changes in the building, their use on cultural heritage monuments in Georgia are prohibited by the law.

Heating and cooling systems

Because of enviable climatic conditions, central heating systems in Georgia were not universal even in the Soviet Union, even in large cities. In particular, 53% of the population of the city of Tbilisi during the USSR used individual boilers to heat the living space.

Nowadays, heating and cooling systems are divided in 90% of Georgian housing fund and 75% of commercial fund. Heating is mainly based on the use of gas boilers, while the air conditioning system via air conditioning using electricity. Thus, the heating and cooling system is individual on the level of housing fund area and in fact, there is practically no central heating and conditioning system. In the commercial spaces there is central heating and ventilation systems on building levels, however, there are cases where fragmented approach on building level is used in commercial spaces (more than half of the hotels use so called "Split conditioners" for heating and cooling of each room". Such a system of heating and cooling is neither cost-efficient nor energy efficient, but its massive replacement requires large initial costs and due to the absence of such amount, we use the system that we have. The above mentioned refers to the monuments of cultural heritage which belong to the housing fund or administrative area.

Nowadays, there is no discussion on energy efficiency of the heating and cooling system of those buildings, although in general, the issue of cost inefficiency of utility costs of the housing fund (and especially) of heating is a subject of public discussion. However, the main emphasis is made on thrifty spending of energy resources and carrying out even tougher tariff policy, while the use of energy efficient technologies may be the most optimal way to get out of current situation.

Our task is to consider several models / technologies that can be useful in relation to cultural heritage monuments, as well as the entire housing fund.

The first of such proposed technology is "Combined Heat and Power System" (CHP). It is noteworthy that the combined heat and power system is not a technology but a method of using technology combination. It is based on water heating in parallel with the electricity production. This approach may be based on the internal combustion engine that produces energy and circulating water within heating system is heated with its exhaust gases (see Appendix 5a). The second approach is the system of boilers when water circulating within a heating system is heated with fuel and results into steam, which rotates turbine to generate electricity (see Appendix 5b). It should be noted that in boiler method, bio-gases can be used for water boiling. The combined method to get heating and electricity is central heating system, which is used for heating and electric power supply of large and separately standing buildings. It requires quite a large installation area and its use is counter-productive for small spaces.

"Combined Microsystem of Heat and Electricity" was developed to correct this flaw. It is quite a compact equipment that operates on natural gas or diesel system and supplies heat and electricity. This micro-system is divided into three types: Micro-system based on Stirling engine, which heats water and air, where hot water circulates within the heating system, while warm air rotates the turbine within Stirling cylinder and generates electricity. It should be noted that Stirling engine is not stable and this type of micro CHP equipment is not widely used. More widespread is the model based on internal combustion engine (See Appendix 6a), where electricity and heat are generated through fuel. Lately, there are works on equipment based not on fuel combustion but on chemical reaction, but those works are not in nearest future perspectives. Speaking of this model, we should note that this is a complex and expensive technology; the stationary CHP requires large areas and it can still be optimal for rural communities. The use of these technologies within city conditions is impossible in Georgian reality. As for the micro CHP, this is a relatively new and still refined technology. In addition, it is noteworthy that energy efficiency of CHP (both systems) does not exceed 92%. As for this technology in Georgia, its high price excludes its universal distribution. Installation of stationary CHP system within the city requires appropriate allocated area in the total area of the building, which is actually available in 90% of existing buildings (housing fund). In addition, the Law of Georgia on Electricity Supply, the supply of voltage in the consumer network is subject to strict regulations and this regulation does not facilitate the use of CHP system.

Heating condensing boiler is relatively viable technology for heating that can be successfully used in Georgia for the heating of buildings. Steam is produced during the combustion of natural gas, which in the case of a non-condensing boiler flows out of the chimney together with other gases produced during combustion. The combustion gas generated by combustion in the condensation boiler (gas temperature reaches 120-150 degrees) undergoes one more process until it passes into the chimney. Condensing heat-exchanger ensures that hot gases are met with flows of cold water coming from the system (see Appendix 6b). At that time, the heat of combusted gas is transferred to water, which warms up and then transfers into main heat-exchanger and is additionally heated to the required level through the flame. The temperature of combusted gas falls from 150 degrees to 55 degrees, and this is when condensation is created from combusted material, which is flushed out of the boiler in form of water via special pipe. Based on the fact that condensation boiler cools combusted material to the maximal extent to transform heat into energy, steam present in it is cooled and condensed. Due to this process, the boiler that uses temperature produced during combustion of natural gas has high-energy efficiency, combustion loss is just 0.8%, loss of unused heat is just 1%, therefore, energy efficiency of this boiler equals to 109.2%. This boiler is available at Georgian market and can be successfully used in housing fund that holds the status of cultural heritage.

Rational use of energy.

Home automation is a very flexible system, which the consumer adjusts independently according to his own needs. This means that each owner of "smart house" can independently choose which house communication he/she wants to manage. The opportunities of this system include execution of following tasks:

Leak protection - provides timely discovery of leaks in water pipes and seals the faulty section of line.

It consists of leakage sensors and locking mechanisms that lock down the damaged section.

Climate Control - includes management of floor heating, ventilation, heating and conditioning systems. Ensures maintenance of temperature and humidity in the facility at settings set by you. Air quality control is possible. The system consists of a control panel, humidity and temperature sensors, ventilation and heating systems.

Control of shutters and curtains - enables automatic and manual management of shutters and curtains. The system includes control panel and shutters / curtains control electric motors.

Canopy management - enables automatic and manual handling of canopies. The system includes a control panel and electric motors for canopy management.

Lighting management - the system integrates light bulbs in a unified network that can be managed by a smart phone and tablet. This system allows you to set different modes through which you control the lighting power of each bulb. The system consists of relays, dimers and various lighting equipment.

Access System - provides limited access to a specific area or specific location of the building, often used along with the video control system. The system also provides data storage and analysis opportunity. It consists of controlling system, electric locks, access card readers (code panels or biometric readers), video cameras, and automatic control devices of doors.

Automation of heating and cooling system - with the help of this system, you control the temperature in the entire building as well as in its specific rooms. There is also a system, which based on the analysis of meteorological conditions in winter, provides heating of pipes in order to avoid their damage from freezing.

Automatic irrigation of the lawn - provides timely irrigation of the lawn. The system consists of a control panel, weather detectors, and various equipment of irrigation systems.

Touch panel of the unified system control - provides control and management of various equipment: All communications in the house, all devices that have access to electricity.

Nowadays there are several such systems available at Georgian market, including computer systems created in Georgia.

4. Renewable energy and energy saving systems

Solar power

The principle of solar panel work is based on the photo effect that is caused by difference in potentials during the effect of electromagnetic radiation when two different materials interact. This effect is explained by the fact that the light contains a quantum of energy that is called a photon. In the photovoltaic effect, electrons will be ejected from the material, which is effected by the light beam, the frequency of which exceeds the frequency that forces the material to eject the electrons. Photovoltaic process is carried out by solar panels. In general, solar panels are of three types:

1. Crystalline silicone solar panels

The lowest quality silicone panel is made from quartz. Quartzite is a stone containing silicon dioxide. (SiO_2). In order to get silicon, the quartz is placed in the fluid and is melted at 1900 Celsius. Then melted quartz is mixed with carbon, which enters in the reaction. The reaction results are silicon powder, after catalysis and distillation of which we obtain polysilicium.

2. Thin solar panels

Thin solar panels are the second-generation solar panels that are made from one or more layers, or using material having thin photovoltaic capacity. Several technologies are used commercially, Cadmium telluride (CdTe), Copper indium gallium selenide (CIGS), Amorphous thin silicium (a-Si, TF-Si). The thickness can be from several nanometres, up to 10 micrometres. Similar panels are much cheaper but are less efficient.

3. Third generation solar panels

These panels have the ability to overcome Shockley–Queisser limit, which sets the efficiency limit of solar panel to 31-41%. These panels are composed of many layers that are made from amorphous silicium or gallium arsenide.

PV systems

Such a system can be simple, which consists only of the PV panel and load that works when the sun is shining. However, when it is necessary to illuminate the entire building, the system needs to work day and night. It should also work on oscillating current as well as on direct current, which must have a battery and generator.

Based on the configuration, we can outline the three basic types of PV system: Autonomous, connected to network and hybrid.

Autonomous - These PV systems work on solar energy only. These systems only contain the PV module and the load; it is also possible to add battery to save energy. When using the battery, you need a regulator that disables the module after charging the battery.

Network connected PV systems - are very popular, in case of integrated arrangements within buildings. Such a module is connected to the network via the inverter, which converts oscillating current into direct current. In case of small systems, such as a residential house, the inverter is linked to a distribution board, where the electricity is transferred to the network or to a specific device in the building. This system does not require a battery until it is connected to the network, because in case of insufficient power from the module, the distribution board will automatically switch the system to the network. Large PV systems operate as power plants. Their power output can reach several hundred megawatts.

Hybrid systems - they include PV modules and electric generators that can work on gas, diesel or wind energy. This system needs more control. Diesel or other type of engine should be turned on when electricity reaches the extreme discharge state. The generator can be used to charge the battery as well as to supply electricity into the network.

In Georgia, automated systems are mostly used, which with the financing of Georgian government and international donors are used to supply electricity to families still living in high mountain settlements. In recent years systems related to networks have been developed, which was supported by the legislative regulation, according to which the owner of such system, in case of occurrence of excessive electricity (for example during the day), should supply it to the system via reverse mode and receive equivalent of this electricity free of charge in solar system during deficit (for example during the night). Balance of supply and reverse are calculated at the end of the calendar month, if balance is positive (i.e. the electric system has supplied more than it got via reverse from consumptions), then the customer pays the charge of the network, and if the balance is positive, then the electric system shall pay the consumer 11.9 tetri (4.2 US dollar cents) on each kilowatt of the reversal balance. As for the hybrid system, it is installed at Tbilisi International Airport where the solar system is integrated into the network and is ensured by the generator. The system capacity is 337 MW and it can work in reverse mode with the Tbilisi Electricity Distribution Network. As of now, none of the PV system types are used on cultural monuments.

Solar thermal heating (heliosystems)

The use of sun for heating is implemented through a thermal collector. The collector determines how effectively we use a light ray. It contains a black surface that is called absorbent and transparent surface. Absorbent can absorb a large part of the energy coming (Qsun) from the sun, increases the temperature and turns the heat into a working liquid. As a result of fluid's movement, the absorbent is cooled and process can be repeated.

Total solar energy (Qsun) cannot be used and of course we have losses, part of the heat amount is reflected by the protector or the absorbent itself. While other losses are caused by the objects adjacent to heat exchange. The efficiency of the collector is mainly dependent on two factors: the first is the zone where the sunlight is absorbed, and the other are losses that are caused by those around. It depends on the weather, as well as the physical characteristics of the absorbent. Isolation plays an important role in reducing losses, especially if the temperature difference between the environment and the absorbent is large.

We can distinguish three types of collectors: Open, closed and vacuum.

In open type collectors, we have no transparent protector; therefore, the loss of sunrays is minimum. Such collectors are used in places where the temperature difference between the environment and the absorber is small, for example: Swimming pools.

Closed type collectors have transparent protectors, resulting in increased losses caused by reflected rays. Similar collectors are used by the absorbent the temperature of which is above 100 C.

Vacuum absorbents are placed in vacuum capsules. Therefore, very little heat is lost by the influence of environmental bodies. Similar type of collectors are much more expensive.

Modern solar collectors often use technology known as light trap, solar cells. For example: The oxidized coating layers with transparent conductivity are used in above glass layers. If their plasma frequency coincides with infrared, the sun's full radiation will be able to penetrate in the glass, but the radiation from the hot bodies cannot penetrate the glass layer and is reflected backwards.

The collectors also vary according to their forms. We distinguish between flat and concentrated collectors. Flat tape-like collectors contain flat absorbent that are directed towards the sun. Their temperature may be up to 100C. They will use direct and dispersed solar radiation. It is mainly used for water heating, and heating of building, air and industrial processes. Concentrating collectors can produce a much higher temperature than the standard flat collector can. The output of concentrated collector increases via reduction of its loss area. This can be accomplished through the placement of optical device between radiation and absorbent. For this reason, the size of absorbent can be reduced. One negative side of such collectors is that they need to move toward higher volume of radiation. This increases the value and needs additional maintenance.

The collectors should be connected to each other in parallel or in line. Connecting collectors in parallel means that the incoming temperature is the same for everyone, and linear activation means that the incoming temperatures for one is the outgoing temperature for the other. Parallel turning on of collectors is mainly used, because it's more balanced and reduces the drop of pressure. Often, in areas where temperate change between winter and summer is very high, such solar thermal systems are used that contain the boiler as an auxiliary equipment. Its main function is to assist the system if the solar energy is insufficient.

Closed and vacuum collectors are widely available at Georgian market and are mainly used for water heating in private houses. In singular cases, heliosystem is used as a heating system component, where the water heated in heliosystem enters equipment's heat-exchanger and its further heating is implemented with the flame. Heliosystems are widely used in hotels for obtaining hot water, as well as a component of heating system. Vacuum helio-collectors are mainly used in Georgia, and it is also supported by the fact that since 2015 such systems are being manufactured in Georgia, which reduced the value of such collectors at the market by 40%.

The example of use of helio systems in apartment house was Tbilisi, in 2010. Four blocks were selected by the initiative of city municipality and 12 vacuum collectors were placed in parallel connection on the roof of each building. The warm water received from this collector was supplied directly to apartments in hot season, while in winter - to the boiler working on natural gas, which supplied approximately 20 apartments with high temperature water for heating and consumption of hot water. This was a pilot project, which should have been observed for three years and if this approach had showed efficiency, it would have been widely implemented in the city's municipal sector. The trial period was completed in 2012 and the system demonstrated the efficiency, but the work has not continued. An example of using heliosystems in historical and cultural monuments is the hotel “GINO” located on Rabat territory in Akhaltsikhe, where vacuum panels are used for heating and to get hot water. Considering specifics of Georgia, the use of helio collectors in housing sector of Georgia is undoubtedly perspective direction.

Wind Energy Transformers (Wind Electronic Turbine)

Wind turbine is a mechanical aggregate that transforms wind kinetic energy into electricity. Wind turbine is of two types: horizontal (HAWT) and vertical (VAWT). Another name for horizontal turbine is winged turbine, because rotation of its rotor is achieved through interaction of the wind masses on the horizontal wing surface. In case of vertical turbine, rotation is achieved with interaction of the wind masses on arched pipes placed vertically against each other. Wind turbine can be of small and large output; small turbines are used to autonomously provide power to the equipment placed on buildings, marine and air ships. The generation of electric power to supply the electrical system is implemented through high performance turbines. Wind power density is a necessary factor for the use of wind turbines. The use of large turbines is effective in areas where wind power density is greater than 50 meters. Horizontal wind turbines are more common because their coefficient of efficiency is much higher than of vertical turbine, though the value of the horizontal turbine is several times higher.

The use of wind energy in Georgia has a great perspective, because due to hilly terrain, 60% of the country's territories are regions where wind energy density is 70-90 meters, and wind density at 30% of the country's territories is stable up to 50-64 meters.

The first wind power plant was opened in 2016 by co-financing of the European Bank for Reconstruction and Development and the Georgian Energy Development Fund. Seven wind turbines were installed on the Trialeti range near the town of Gori, with a capacity of 20.7 MW. According to the Government of Georgia, additional 3 stations will be opened by 2030. The hindering factor of this plan is that the initial cost of the wind power plant is twice as high as of the equivalent hydroelectric power plant.

Small wind turbines located on the buildings are less effective due to its small and non-stable power, if it is not intended for the autonomous power of the particular aggregate. Today, such turbines (primarily vertical types) are used in agricultural settlements and mainly in greenhouse farms, to supply electricity for heating aggregate management scheme. As for the use of small wind turbines on apartment buildings in urban settlement, it is not effective in terms of price and instability of generated energy; it is unacceptable in the interest of city ecology. Movement of wind masses within urban settlements is critically important for ventilation. A large number of wind turbines on the roofs of high apartment buildings will significantly hinder wind flow and significantly worsen ecological conditions. Due to the above mentioned, micro turbines can be used in a low-density area of the settlement to autonomously provide power to traffic lights, communication, cameras and other special means.

As for the use of small wind turbines on historical and cultural monuments, this is inadequate because it will not have any cost efficiency or energy efficiency.

Thermal pump

This is a working equipment with refrigeration cycle, which transforms low potential heat energy present in environment (ground, air, waterways, etc.) into high potential heat and after pumping the latter into the building, it can be used for air or water heating until desired temperature. At the same time, it gives the opportunity of pumping excessive heat in the buildings into environment (in this case the cooling of the building air). Thus, the thermal pump is a reversible machinery that can work both in the heating and cooling mode. The use of thermal pump is considered as the use of renewable energy according to EU classification.

The thermal pump uses certain amount of electricity for the implementation of refrigeration cycle from relevant thermal energy and environment (ground, air, water reservoirs, etc.) The accumulation of excessive generated thermal energies are used as needed. The efficiency of the aggregate is characterized by coefficient of performance (COP), which is obtained by the ratio of consumed power of heat energy pump with relevant power of received heat energy. For example: if by supplying 2 KW power at the entrance to the heat pump we receive 5 kW heat power, in this case the coefficient of the heat transformation is 2.5.

There are four types of thermal pumps:

Air / Air Type - takes heat energy from surrounding atmospheric air and transmits the air into the building. This type of thermal pump does not work at environmental low temperatures and does not produce hot water. It is considered as addition to other heating systems. Reversible thermal pump can work in cooling mode - to cool the building air by pumping out warm air into environment.

Air / Water type - takes energy from surrounding atmospheric air and transmits it to a heating system working on water. Some models of the modern thermal pumps work even when the environmental temperature is minus 20C. This type of thermal pumps can also be used for hot water supply;

Geothermal type (geothermal water, etc.) Water / Water type - takes energy from the depths of earth, water reservoir or river.

Ground / water type - Takes heat from the ground (1.5 m in depth or deep well) and transmits water.

Exhausted air type (the same as air / air) - reuses power (heat) which flows from ventilation channels of the apartment and returns it to the heating system.

The foremost advantage of the heat pump is the economy. Thermal pumps use about 1 share of the electricity to free 2-3 solar energy shares accumulated within the environment. Operation period of their pump varies according to types and manufacturers, however, in general the air / water and air / air type thermal pump made by the authoritative manufacturer operate for about 20-30 years.

Another advantage of thermal pumps - the possibility to switch from winter warming mode to the summer air conditioning mode; Instead of normal radiators, ventilation channels are connected to the external collector. The thermal pump is compact (a sufficient thermal pump module does not exceed the usual refrigerator) and is virtually noiseless when operating.

Following aspects can be considered as disadvantages of the geothermal thermal pump: high cost of equipment, the difficulty and the costliness of installation of underground or underwater heat exchange contours. The disadvantage of air/air and air/water thermal pumps is its relatively low transformation coefficient, which is associated with the low temperature of boiling of the refrigerator agent in the external "air" evaporator. In general, the disadvantage of thermal pumps is relatively low temperature during heating, not more than 50-60 degrees, also the higher the temperature of warm water, the lower is the efficiency and reliability of thermal pump (due to increased high pressure of refrigerator agent in the system).

For the installation of a thermal pump, high initial costs are required: Thermal pump and system installation cost is 300-1200 dollars per 1 kW of the required power. The period of return for the thermal pump is 4-9 years, and the working period till major repair is 15-20 years.

Therefore, if installation of thermal pump is implemented with the funds taken as credit, the saving gained through the use of thermal pump may be less than the value of credit's use. Hence, we can expect massive use of thermal pumps, if the price of thermal pump equipment will be comparable to costs of connecting to gas network and installation of gas heating.

As of today, thermal pump can be used to lower energy utilities, but cannot be the main supplier of heat and hot water. In this case, it is more rational (cheap) to use the usual recuperative system of air.

Thermal pump technology is known in Georgia, however, it is not used other than one example. The hotel complex Hotel Castello Mare was built few years ago at the seaside resort Tsikhisdziri (Kobuleti municipality, Western Georgia). Its two blocks, according to preliminary calculations, would require up to 1 MW of total heat energy. In 2011, the company "Geowatt" designed and built the boiler pumps with maximum capacity of 250 kW in the hotel blocks. Thermal pumps get energy from the bottom of the coastline and their COP = 4.0, which is quite a high indicator.

As for the use of thermal pumps in the buildings with the status of cultural and historical monuments, its hindering factors are high initial costs. From technical perceptive, it can be said that the most feasible for Georgia is the use of air/air type thermal pumps, but research shall be conducted for each monument and based on the findings, the best model of technical solution shall be selected.

As for the **biomass technology**, it is noteworthy that in the 90s of the last century this technology was actively widespread in the agricultural regions of Georgia. Experience of those years confirmed that operation of small biomass equipment is unstable and cannot compete with natural gas. The use of biomass is energy efficient and cost effective for heating and energy generation, if it is integrated with sewage and purification systems of large towns or large livestock compounds. The scale size here gives us the opportunity of profitability. In all other cases, these systems cannot compete with other energy sources. As for historical and cultural monuments, the use of biomass system is prohibited due to technical, economic and socio-cultural factors.

5. Urban society and ecology

Urbanization is an irreversible vector of development in the 21st century. It brings more comfort, mobility, well-being and economic growth, but it also has negative consequences. The biggest ecological challenge that is brought by the cities and their economy is the emission of heat gases and harmful effects in the environment.

In terms of environmental pollution in Georgia, pollution of atmospheric air is one of the most acute issues, while more than 80% of pollution comes from auto transport. Toxic substances together with exhaust gases that are ejected into atmosphere cause a real threat to the vast majority of the population that is under this harmful influence. Atmospheric air pollution by auto transport is conditioned by a number of physical-chemical factors, from which following is noteworthy: The intensity and volume of emission of harmful substances, the number of vehicles, the age of existing car park and technical condition, etc. In conditions of increasing motorization, development of clean public transport is crucially important to reduce vehicles' impact on environment.

One of the important segments of this pollution is municipal transport, the car park of which definitely requires renewal. There are two approaches used in Georgia within the field of ecologically clean municipal transport: A) Transport working on compressed natural gas (CNG) and B) Electric transport.

Transport working on compressed natural gas

Natural gas is distinguished by not only low-cost but also with ecological and technical safety and actuality of its use, as the engine fuel increases annually around the world. Unlike petrol, natural gas does not contain resinoid component and sulphur, due to which no burning remains and plaque are formed on parts of combustion compartment of engines working on gas. Natural gas burns completely, and therefore, it does not leave a soot. Natural gas is used for fuel not only in road transport and in mail line motorship, but also in ships and stationary internal combustion engines. Currently, almost 2900 cities of 85 countries from all five continents of Earth use natural gas as gasoline fuel in municipal transport. In 2015, 140 German buses working on compressed natural gas were brought into Tbilisi, in 2019, 150 buses of the same production were added to this park.

Electric transport

Municipal transport driven by electric motors is the safest for the environment, as it does not produce harmful substance emission into the environment. The cheapening of electric car technologies made it possible to move the municipal transport to electric motorized park. With the support of the Government of Georgia and the European Development and Reconstruction Bank, cooperation was launched with the German company "EUROBUS" and the Chinese company "ZTE Corporation". Within the framework of this cooperation, 1 electric bus was brought to Tbilisi in 2018. It is planned to bring 10 electric buses to Tbilisi in 2019 and the same number of buses in Batumi. According to Transport Policy document of Tbilisi by 2023, 40% of the city's bus park will be replaced with electric buses.

In addition, it is planned to transfer municipal taxies to electric cars. For this purpose, Georgia and Chinese corporation "Changan Automobile Group" jointly launched an electric auto mobile factory in Kutaisi, which will produce first electric car of sedan type in 2020. Most of these cars will be used in the taxi service sector.

While comparing these two technologies the advantage of the electric bus based on ecology standard is obvious and it is also profitable in terms of finances. The experiment carried out in

Tbilisi in 2018 showed that a bus working on diesel fuel (EUR 6) in Tbilisi consumes the fuel of 73.8 GEL (26 USD) per 100 km, the bus working on compressed natural gas consumes the fuel of 105 GEL (37 USD) per 100 km, while the cost of energy consumed by electric bus for 100 km is only 20,22 GEL (7 USD). Obviously, the electric car has no alternative in the municipal field, considering the ecological standard and cost effectiveness.

Municipalities can also reduce negative impact on environment by providing energy efficient lamps for lighting of streets and buildings, which significantly reduces energy costs and financial expenses. Replacement of one tungsten spiral lamp with LED bulb protects environment from 1 ton carbon dioxide and 8 kg of peroxide emissions. Among the energy bulbs, Georgian municipal sector uses LED bulbs for the lighting of street lamps as well as illumination of municipal administrative buildings. Since 2016, production of electric efficient bulbs has been launched in Georgia, which made this technology more accessible for municipalities.

6. Use of Energy efficient technologies on examples of historical objects

As already mentioned above the object of cultural and historical heritage are topics for separate discussion. Directive 22010/31/EU does not apply to cultural and historical heritage monuments. Therefore, there is no reservation or obligation in Georgian legislation and technical regulations in this regard. Moreover, according to the Law of Georgia on "Cultural Heritage", all such monuments are protected by the law and the plan for its rehabilitation, conservation or on-going renovation, as well as the project shall be discussed with the Cultural Heritage Protection Agency of Georgia. Regulations and practices existing at Cultural Heritage Agency exclude the use of non-authentic technology in the process of conducting engineering manipulation.

Regulations related to the monuments of cultural heritage that belong to the housing, administrative and social fund, are relatively light. It is possible to use energy efficient technologies and solutions here with the permission of the municipal authority, if it does not require the change of interface and/or structural changes of these buildings. As for the heating-ventilation system in the housing fund with the status of historical heritage, the use of energy technologies without the permission is possible if it does not require manipulation on the facade and roof.

Considering all the above mentioned, the introductory work of energy efficiency should be initiated primarily on the monuments of cultural heritage belonging to the housing, administrative and social purpose funds. Here the municipality itself is the decision maker, which makes the administrative procedures easier. However, it is a challenge that there is no technical regulation that considers the specifics of such buildings and would have been tailored to their status as well as their functional purpose. Therefore, when searching for engineering solutions in case of such buildings, it is necessary to properly coordinate with the Ministry of Economy of Georgia and the National Agency for Cultural Monuments Protection.

7. Conclusion

Energy efficiency is one of the major challenges of the 21st century. Today's technologies provide an opportunity to consume energy efficiently and reduce negative impacts on the environment without losing comfort and deteriorating the level of life of the population.

As of today, light, heating, air conditioning and warm water supply can be provided to the housing and administrative building via technologies that significantly reduce the energy and finances. The main problem is the cost of such technologies and its low availability to the masses of the population.

Georgia is connected to Europe's Energy Pact, which generates a number of commitments in the construction industry. Today, there is a number of technologies available for energy efficient buildings and most importantly, new buildings may fully comply with the zero energy building standard. Nevertheless, the amorphism of Georgian legislation on energy efficiency requirements gives the opportunity to construction business sector to use less advanced technologies.

As for the cultural and historical heritage monuments, Georgian legislation makes it impossible to conduct engineering manipulations on objects with such status to ensure energy performance. It is therefore necessary to modify the legal framework and heritage status on such monuments, which have maintained housing, social and economic functions to allow the use of energy efficient technologies.

In the Black Sea region, due to similar climatic and geographical conditions, it is quite possible to use unified technological approaches. Synchronization of legal framework and technical standards of construction should be done.

It is necessary to establish a dedicated expert centre, which will offer technological solutions to decision-makers in order to achieve energy efficiency of cultural or historic monuments. This will support the exchange of experience and technologies.

Attachment (attached to a separate file)