O 26. OVERVIEW OF ENERGY EFFICIENCY FOR PUBLIC BUILDING IN ALBANIA

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ABSTRACT: This paper tends to give a general overview regarding the situation of energy efficiency for public building in Albania. As first attempt, will be their classification based on energetic viewpoint. Classification is based in many factors like: destination, users, time of operations, thermal comfort, etc. Based on this analysis 6 type of public buildings are distinguished: hospitals, kindergarten, schools, universities, dormitories, institutions of central and local government. Also an analysis of their energy behaviors is made in order to highlight their weaknesses. Analysis put in evidence that due to the design and construction the existing building stock is not in compliance with the laws and their regulatory, regarding energy performance. Electricity represent the main primary energy source since this sector has a highest electricity dependence and consumption. Other identified primary energy sources are: diesel oil, pellet and natural gas, used mostly for heating during winter season or domestic hot water production. Most of buildings do not meet minimal thermal comfort standards and suffer from a poor thermal insulation, so most of energy is consumed for heating or cooling. Another problematics was building operation and management, which is poor or inexistent. Due to this heat loses from air infiltration represent 20÷40% of total heat loses in the building. At the end some conclusions and recommendation are given in order to improve energy efficiency and thermal comfort in public building.

Keywords: Public buildings, energy efficiency, building typology, thermal comfort, thermal insulation.

1. INTRODUCTION

Albania faces challenges to face in the short term on the issue of energy performance in buildings. As a candidate country for membership in the European Union, Albania must follow the overall European policy orientation by adapting its legislation and other development orientation instruments. Albania today faces the challenges of development and a constant transformation of the economic, social, cultural and environmental context. In Albania there is a phenomenon different from other European countries, which have a lower energy consumption in the building sector compared to the industrial and service sectors (see Figure 1) [AEA 2017]. In Albania, the building sector is one of the largest consumers of electricity and especially electricity. This sector in 2017 recorded a total consumption by households of 54% of final electricity consumption where the largest percentage goes for space heating, 60% of it and the remaining 25% goes for water heating [AKBN 2016].

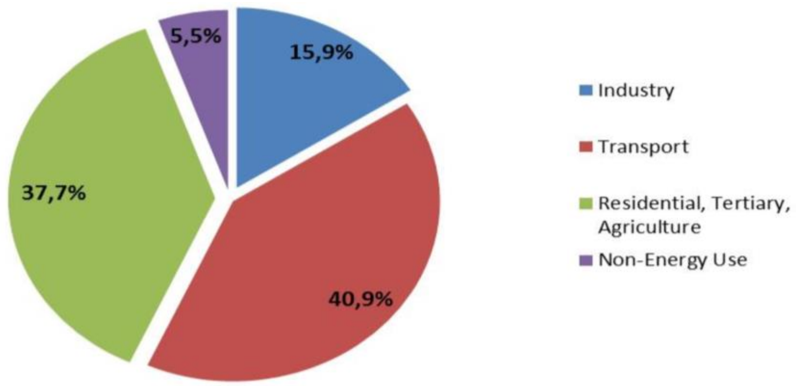

Figure 1. Final energy consumption by sector in Albania

As we can see the electricity consumption from the buildings and services sector is dominant over the industry sector. This means that there are great opportunities for increasing efficiency in these sectors,

with the aim of reducing energy consumption. Therefore, attention should be paid to energy efficiency. In this case, the construction sector holds great potential for savings and may turn to a low carbon sector. Although there are many opportunities to improve energy efficiency in the public buildings sector, overlapping and not clearly defined policies to guide these opportunities in Albania remain to be significantly improved. Designing intelligent policy packages is not a simple process, but requires setting energy performance standards for end users. It is also not known how the building sector should be structured for the purpose of policy making, in the sense of the great potential for energy savings to reduce carbon emissions, and where this potential is concentrated in public buildings. Finally, it is necessary for the Government to know the cost of achieving savings and achieving energy performance standards in public buildings with a view to procuring "green" during the reconstruction of these buildings.
Main objectives of this paper are:

- ✓ Classification of public buildings based on energetic viewpoint. Factors that influence this classification.
- ✓ Analysis of their energy behaviours, in order to highlight their weaknesses.
- ✓ Identifying primary energy sources.
- ✓ Recommendation to improve their energy efficiency and thermal comfort.

2. MATERIAL AND METHODS

Public buildings in general were built here before the 1990s. Unlike private residential buildings after the 1990s, there were no new construction booms. As far as the physical situation is concerned, they are in a bad situation (they need deep and non-partial reconstructions). Regarding the thermal side the situation is even worse (very few have thermal insulation, efficient windows, etc.). In Albania, public buildings constitute one of the most troubling social and economic problems in the country, which have emerged especially after the 1990s.
The basic material used for the construction of the bearing structure in these buildings was full brick clay or silicate 25-38-51-64cm thick, with masonry brick dividers of 8-10-12cm thickness and structures horizontally made with soles, concrete / reinforced or ceramic reinforced. Roof or roof covering (especially in cold areas) with concrete / gun soles and modest thermal insulation with penobetonite coating, with thermal conductivity coefficient (λ = 0.35 W / m°K). In the old stock of public buildings, the windows were generally of wood or metal frame glass with a transmission coefficient of 4.1-5.9 W/m^2K. The windows in today's construction are better than the old stock because of the quality of the materials and materials used in them. The most commonly used material in the cassette composition is duralumin and less PVC. The stock of public buildings is being replaced by double glazed windows as an efficient measure to reduce energy consumption. The transmission coefficient of these windows has values from U = 2.8 W/m^2K to 1.1 W/m^2K. The basic structure for the new building stock is a monolithic trans-pillar element, with 20-25cm thick brick walls, finishes being more acceptable and modern. Many of these buildings have used thermal insulation materials enhancing the thermal properties of the building. The cover made in the new stock is with terraces or roofs (especially in cold areas) with concrete/reinforced soles and thermo-insulated with polystyrene coating with coefficient of thermal conductivity (λ = 0.035-0.040 W/m°K).
For the classification and compilation of the stock typology of public buildings we have relied on several factors, such as:

- ✓ Destination of the building,
- ✓ Building structure of the building,
- ✓ Users of the building and their number,
- ✓ Hours of use and use of the building,
- ✓ Requirements for thermal comfort of the building,
- ✓ Specific requirements mainly related to the function of the building (security level, etc.),
- ✓ Building technical systems

So at the end of all this analysis regarding the factors that influence the classification of public buildings typology regarding its energy behaviour we can say that these factors are intertwined. But normally the typology determinant is the destination of the building as we can say that it includes little of the other factors mentioned. Based on these justifications we can distinguish several types of buildings, with destination:

- education and education (including schools, kindergartens, universities). These are distinguished by their high concentration and number of users and relatively high energy consumption. They work mainly during the day and not throughout the day. Mainly during the summer season they are closed or have very limited activity (eg. for staff).
- health (hospitals, health centres, ambulances, polyclinics, etc.). Here, especially, hospitals are distinguished for continuous function 24 hours a day, 7 days a week and no annual breaks. Depending on the size, they have specific requirements for technical systems and are sensitive energy consumers.
- cultural and sports (museums, galleries, cinemas, sports halls, etc.). They are distinguished for limited time activity and limited human presence. Even in the case of activities they are limited to 2-4 hours.
- accommodation and hotel services (dormitories, asylums, shelters, etc.). Distinguished for use 24 hours a day. They have significant consumption for SHW but also for energy for air conditioning.
- local and central government institutions (municipalities, ministries, agencies, etc.). Distinguished for limited use during the day, there are no high requirements for SHW.
- warehouses, no air conditioning requirements.
- different destinations (military, law enforcement, prisons, etc.). In addition to air conditioning, they have specific requirements for lighting to ensure their safety.

So based on all the above justifications and relying mainly on destination in harmony with other factors: users and thermal comfort requirements, the team of specialists concluded that public buildings can be classified into 6 (six) representative types of stock, like below:

- ✓ Hospitals
- ✓ Dormitories
- ✓ School
- ✓ Kindergarten and nurseries
- ✓ Universities
- ✓ Buildings of public institutions (municipal and government)

Figure 2. Photos from 6 different building typology

For the selection of buildings that would then be the subject of energy auditing we were guided by the following selection criteria:

a. Typology of the building (hospital, school, boarding house, etc.)
b. Climatic zone where the building is located (zone A, B or C, see Fig. 3)
c. Condition of the building (whether reconstruction interventions have been carried out in the last year or not)
d. Level of cooperation with building managers and managers,
e. Availability of data on the structure of the building and its energy consumption,
f. Impact of buildings in the area (size, number of people attending, working hours, etc.)

Figure 3. Climatic zones of Albania

In total 60 buildings were studied from all 6 typologies and from 3 climatic zones.

3. FINDINGS AND RESULTS

In this paragraph are given shortly main findings from 6 buildings typology:

3.1. Hospitals

This building typology is more complex both in terms of structure and function but also in the complexity of energy consumption. There are facilities that run 365 days a year, 7 days a week and 24 hours a day, so they never close. Distinguished for consumption in all six services: 1) Heating; 2) Cooling; 3) Hot water; 4) Cooking; 5) Electrical appliances, 6) Lighting. All hospitals have different constructive characteristics and do not present analogies with each other. They were mainly built in the 1960s-1990s and a small part were built in the 2000s. Hospitals generally suffer from poor thermal insulation of buildings resulting in significant high heat loss of the overall heat transfer coefficient U = 1.3 ÷ 1.6W / m2K. The windows are almost entirely of glass with a duralumin frame, where the glass is often single and some are double glazed. They operate with central heating systems with diesel fuel boilers and in a few cases, especially in recently renovated spatiels, there are also pellet boilers. There is no ventilation system but it is mainly carried out through a natural vent (opening windows or doors). For the production of hot sanitary water in some of them where there are central boilers is produced through boilers. In most cases, hot water is produced through independent electric boilers mounted on toilets. Almost entirely they have efficient lighting systems avoiding halogen and incandescent lamps.

3.2. Dormitories

Dormitories just like hospitals are big energy consumers because of their long operating time, both during the day (24/24 hours a day) and during the week (7/7 days a week). Outside services are: 1) Heating; 2) Cooling (partially); 3) Hot water; 4) Cooking; 5) Electrical appliances, 6) Lighting. The buildings were mainly built in the 1970s and 1990s and some of them have undergone partial renovations in the 2000s. They probably represent the typology of the worst construction and thermal comfort conditions. Heating systems were mostly central with diesel fuel boilers but largely non-functional. The lighting was not at the proper levels due to damage but also due to the lack of proper lighting. It lacks almost thermal insulation and has moisture problems. Hot water is mainly provided only by electric boilers and only in toilets for showers.

3.3. Schools

Schools constitute an important part of the stock of public buildings in terms of their quantity and territorial distribution. They have a very extended time span of their construction from the 1950s to the 2000s. They are distinguished for consumption in five services: 1) Heating; 2) Cooling (partially); 3) Hot water; 4) Electrical appliances, 5) Lighting. They are characterized by different typologies in terms of construction structure and capacity of students. Mostly the walls are of brick, while the earliest and stone constructions with high values of the overall heat transfer coefficient U = 1.3 ÷ 1.7 W / m2K. Heating for the most part is provided by central boiler systems running on diesel fuel or pellets. Generally, the lighting in the classrooms was at the right levels while the corridors were lowered. Mechanical ventilation is missing. The hot water is mainly supplied through electric boilers installed in the toilets.

3.4. Kindergarten

One of the most important typologies evaluated during this process has been kindergartens, this for their social impact and the fragility of their users who are children from 0 to 6 years. Even this building typology is characterized by different types of construction structures and different number of their users. Consume energy in all six services: 1) Heating; 2) Update; 3) Hot water; 4) Cooking; 5) Electrical appliances, 6) Lighting. The period of their construction is extended over the period '70 ÷ 2000. Most of the reconstructions have mainly affected the exterior facade and partly the installation of technical systems (boilers, air conditioners, etc.). The windows are made of single or double glazed aluminium frames. Heating is mainly accomplished by central heating systems with boilers and radiators, which operate with diesel fuel or pellets. Warm sanitary water is provided mainly by electric boilers and toilets only. While summer cooling needs only in some recently remodelled gardens are air conditioners installed for separate spaces and in other cases the cooling is done by natural ventilation (leaving doors and windows open).

3.5. Universities

These buildings have different characteristics regarding the structure of the building and their main needs are for heating in winter but also for cooling, these relatively small as in hot season universities operate with a very limited capacity. Just as schools have a high concentration and large number of users, so they have significant energy consumption. Have energy consumption in five services: 1) Heating; 2) Refresh (partially); 3) Hot water; 4) Electrical appliances, 5) Lighting. They are mostly built during the 1960s-2000s. Most of them are adopted so the original destination was not for university. Regarding heating they are mainly with central systems with diesel fuel boilers. Whereas the recently refurbished ones also have central air conditioning systems (both for heating and cooling). Lighting systems are generally at acceptable levels and there is a trend in the use of LED lamps, especially in any new refurbishment or new construction. In most cases, hot sanitary water is missing, and in cases where it is carried out through electric boilers in the toilets. Here too, ventilation is done naturally through the opening of doors and windows. There is a massive use of split air conditioners and partially for certain areas of central chiller building systems.

3.6. Public Institutions Building

This type of typology encompasses almost all central level public institution buildings (ministries, national agencies, police stations, prisons, etc.) but also local ones (subordinate to municipalities). Their use coincides with the official working hours of 8/24 hours a day and 5/7 days a week and almost year-round. Requirements are for both winter heating and summer cooling. This makes the requirements for technical systems complex. They consume energy in five services: 1) Heating; 2) Update; 3) Hot water; 4) Electrical appliances, 5) Lighting. Constructions are mainly of brick wall and the roofs are mainly of flat soles. They are characterized by high heat transfer coefficients high U = 1.2 ÷ 1.7 W / m2K. The windows are mainly of single or double glazed aluminium structure. In the case of large-scale buildings, central heating and cooling systems are installed. In the case of heating systems, they are mainly diesel fuel and rarely pellets. Recent refurbished buildings mainly install central systems with chillers or VRFs to provide both heating and cooling in the summer. In small buildings, heating and cooling is carried out by means of individual heat pumps for each room. Hot sanitary water is missing or supplied through electric boilers mounted on toilets. The lighting system is at acceptable levels and there is a tendency to install LED lamps.

In Table 1 are given briefly the most common heat losses factors.

Table 1. Heat losses from building enveope

Factors	Impact in heat losses
Air infiltration	25% ÷ 45%
External walls	20% ÷ 30%
Terrace/roof	5% ÷ 10%
Floor	2% ÷ 5%
Windows + doors	20% ÷ 30%
Thermal bridges	3% ÷ 8%

Figure 4 below represent an image from thermal camera for a building façade.

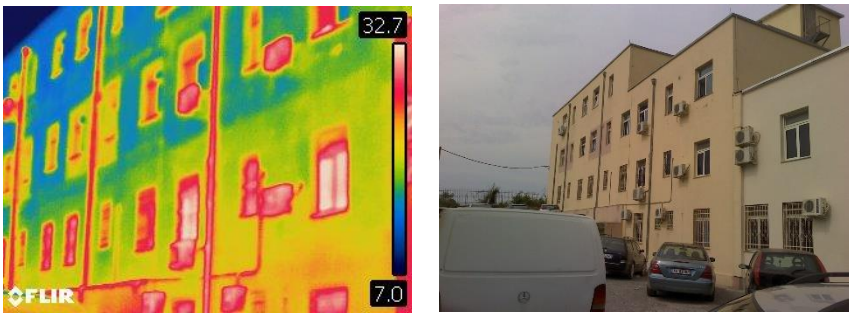

Figure 4. Image from thermal camera

Main energy source is electricity (almost all typology are highly depended on electricity). Another source is oil, especially for heating (boiler) during the winter or Domestic Hot Water (DHW) production. Rarely are find gas boiler. In the last years' pellet is another fuel alternative for heating or DHW production. In cold zones wood stove are still in use.
Physical and thermal situation of the existing stock of public buildings (new and old stock) is generally not good. For this reason, this stock represents a great potential for energy saving by taking energy efficient measures (thermal insulation, efficient window/door). Many public buildings do not have a central heating system and especially do not have cooling systems. Even when there is a central system, there is usually no automatic regulation. Automatic regulation system is missing or outdated, so it is difficult to measure the use of energy. With the exception of buildings constructed in the last decade, buildings in Albania are without isolation or have limited isolation. In Albania, only one part of the building is heated, to save energy and to have lower costs.

4. CONCLUSIONS AND RECOMANDATIONS

While there are many opportunities to improve energy efficiency in the public buildings sector, overlapping and not clearly defined policies to guide these opportunities in Albania need to be significantly improved. Designing intelligent policy packages is not a simple process, as the energy efficiency potential is distributed among different types of buildings and fragmented among end users.
Also below are some general recommendations:

- Deep renovation for existing building, including: thermo-insulation (thickness of insulation varies according climate zones), double or triple glazing windows; tents and shutters.
- Replacement lighting system with more efficient one.
- Increasing the level of Building Management System (especially for complex buildings like hospitals).
- Regarding technical system: renewal or replacement of old boiler systems with gas or pellet boilers.
- Use of Renewable Energy Systems
- Use of Solar Thermal Panel for DHW production

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