O 20. ENERGY AUDITING IN ALBANIAN HOSPITALS, A CASE STUDY FOR LEZHA REGIONAL HOSPITAL

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ABSTRACT: General objective of this paper is to realize an Energy Audit Services for the facilities in order to contribute towards improving the energy efficiency of the building sector and specifically towards energy efficient hospital buildings. The Energy Audit did prepare the technical analysis based on energy performance assessment of hospital buildings for Lezha Regional Hospital. Main goal of the study has been how to collect data and provide useful information on the existing energy performance of selected Hospital buildings through energy auditing as well as suggest possible interventions for improving their energy efficiency. The audit of the Lezha Regional Hospital also aims to integrate the latest technological solutions in order to get a significant energy saving in the existing hospital building, through better management of energy resources and reduction of losses. An analysis of building structure, technical systems and thermal comfort is given. Electricity represent the main energy source followed by diesel oil. Are identified and analysed factors that influence energy consumption. This analysis presents the key findings and recommendations from the application of EE/RES measures for Lezha Regional Hospital as an example that can be applied to other hospitals. Following energy audit, a list of prioritized energy conservation measures requiring further consideration are drawn up, indicating the energy saving for each one, the respective investment required and providing a cost-benefit analysis, showing both economic and financial indicators.

Keywords: *Energy auditing, hospitals, thermal comfort, heating, lighting.*

1. INTRODUCTION

Saving money on energy bills is attractive to businesses, industries and individuals. Customers, to whom energy bills receive a large share of revenue, and especially companies where energy bills are a major component of operating costs, have a strong motivation to start and continue an energy cost control program. Cost-free or low-cost operating changes can save 10-20% on utility, customer or industry bills (Dorri, 2017). While programs for capital expenditures with a payback period of up to 2 years can offer a 20-30% higher savings. In many cases energy cost control programs result in saving energy consumed and reducing polluting emissions into the environment. Hospitals are known as major energy consumers and in most European countries the high proportion of obsolete elements makes hospitals public buildings with low energy efficiency. Nowadays there is an urgency to achieve real energy savings from existing building stocks and to build new more sustainable hospitals.

In this context efficient energy management possesses a key challenge for all building management and especially for hospitals. Adding the benefits of energy survey and audit as instrument to improve energy management has the potential to improve overall energy situation. Energy Audit is the key to a systematic approach for decision-making in the area of energy management (Thumann and Younger, 2008). It attempts to balance the total energy inputs with its use, and serves to identify all the energy streams in a facility. It quantifies energy usage according to its discrete functions. The Energy Audit would give a positive orientation to the energy cost reduction, preventive maintenance and quality control programmes which are vital for production and utility activities. Such an audit programme will help to keep focus on variations which occur in the energy costs, availability and reliability of supply of energy, decide on appropriate energy mix, identify energy conservation technologies, retrofit for energy conservation equipment etc. In general, Energy Audit is the translation of conservation ideas into realities, by lending technically feasible solutions with economic and other organizational considerations within a specified time frame. The primary objective of Energy Audit is to determine ways to reduce energy consumption. Energy Audit provides a reference point for managing energy in the organization and also provides the basis for planning a more effective use of energy throughout the organization (Dorri et al. 2019).

General objective of this work is to realize an Energy Audit Services for the facilities in order to contribute towards improving the energy efficiency of the building sector and specifically towards energy efficient hospital buildings. Also how to collect data and provide useful information on the existing energy performance in Hospitals. An analysis of building structure, technical systems and thermal comfort is made. And finally to suggest possible interventions for improving their energy efficiency. For this purpose, Lezha Regional Hospital is studied and analysed.

2. MATERIALS AND METHODS

The Primary health care network in Albania consists of 413 health facilities (Health Centres). but the package of services, management and accountability mechanisms are being reviewed in the context of the administrative and territorial reform (INSTAT, 2020). Hospital services are provided through 42 public hospitals (municipal & regional). While university hospitals, situated in Tirana attract an increasing flow of patients, due to the missing services in municipal & regional hospitals. Specialized services, reliable on technology, have traditionally been concentrated in university hospitals in Tirana. Lezha Regional Hospital is located in Lezha city, in north-west Albania (see Fig. 1). In Table 1 some general information is given about this hospital. The last general building retrofit took place in 2005. In 2018 the emergency complex) has been renewed (emergency rooms, registration, entrance, policlinic partly). The level of medical equipment is medium to high, e.g. new dialysis centre, new emergency with advanced equipment (CT, MRT scanners, reanimation, etc.). The general condition of the building is good. The level of damages of the building envelope and openings is low and maintenance level is medium. The block is supplied by heat by diesel boilers. The building management (interviewed stakeholders' director and facility managers) has a good understanding of retrofit and energy and efficiency aspects. A preliminary feasibility study for the CHP prepared by the study sponsored by the Ministry of Energy has been prepared and shows approximately that this technology is not positive to be implemented on this hospital. The operation expenses of the hospital are covered by funding from the Ministry of Health and secondary heath funds. In case of lower expenses, due to energy saving, the budget funds will be cut respectively. Preliminary evaluation of conditions is done according to visual inspection, verification measurement (on demand), interview with facility manager and expert estimations. Energy audit is realised according to the scheme represented in Figure 2. In order to realize the Energy Audit for Lezha Regional Hospital, a preliminary meeting with the hospital director was realized and objective of the energy audit was presented and next steps. Later data collection was performed. For this meeting with finance and technician department was established. During this step already collection forms were used and filled.

Table 3. General information for Lezha Regional Hospital

Construction Year	1969
Number of floors	3
Daily operating schedule (hours)	00.00 – 23.59
Days in a week on emergency	7
Total number of the administrative officers and patient/doctors/client including the security people	Administrative & working staff = 49 medical staff = 313
No of beds	486
Percentage of average annual bed occupancy	65%
Annual number of incoming/outgoing patients	1 878
Heated spaces surface (m2)	2 145
Air conditioned spaces surface (m2)	429
Average height (m)	3
Heated space volume (m3)	6 435
Air conditioned spaces volume (m3)	4 287

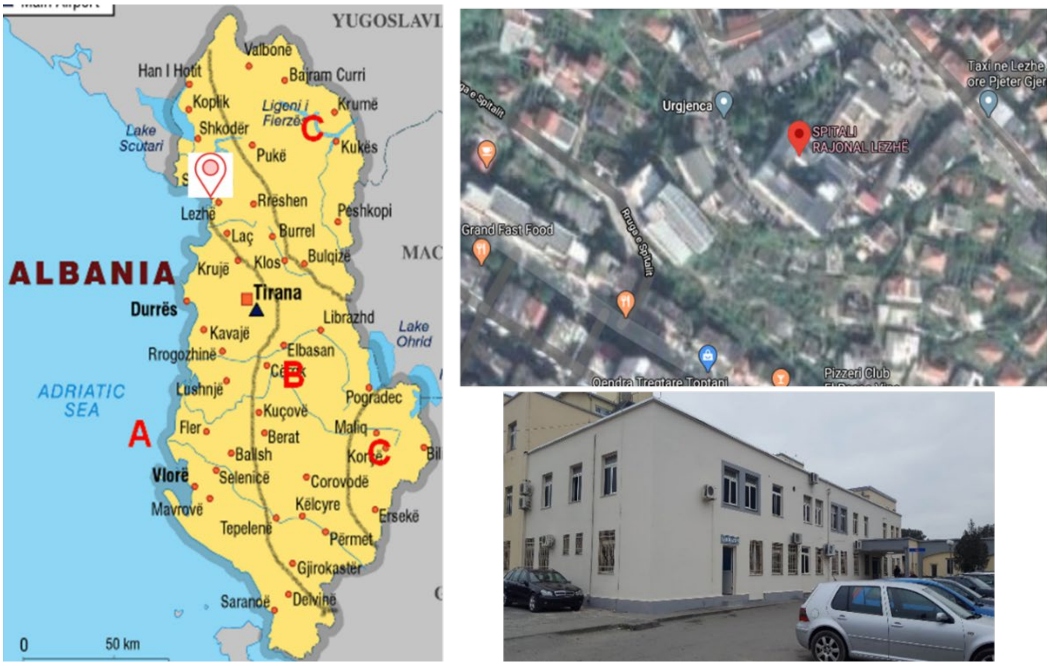

Figure 1. Position and view of Lezha Regional Hospital

Main energy source is electricity (almost all hospitals are highly depended on electricity). Another source is oil, especially for heating (boiler) during the winter or Domestic Hot Water (DHW) production (Dorri et al., 2019). And small amount of gas for cooking was used.

Most of energy is used in 6 services:

1) Heating (by oil boilers and AC)
2) Cooling (by AC)
3) Hot water (by oil boilers and electrical boilers)
4) Cooking (by LPG gas)
5) Electrical Equipment (electricity)
6) Illumination (electricity)

Figure 2. Scheme of energy audit performed

Comfort conditions at hospital are average, since space heating is secure in average, no space cooling, no hot water and lighting is close to average standard figures. As a standard, we used those temperatures:

Patient rooms inside temperature should be +20 ºC.

Medical staff' room inside temperature should be +20 ºC.

Halls for brake time inside temperature should be +18 ºC.

In the meantime, according to Energy Building Code the comfort level temperature for patient rooms should follow the EU standard of 20 ºC. Therefore, heating degree day calculations are significant in reflecting the demand for energy. Hospital buildings should be designed to an outside degree template of 0 ºC for Lezha Municipality

Comfort conditions for lighting: Comparison of existing lighting conditions with the comfort requirements, conclude that they do not met adequately. Number of lamps placed, is not in proportion to the intensity of the lighting they should provide. This happens because in some premises no efficient lamps are used and where they exist, are too old and dysfunctional. Also in order to have a full understanding for the building and technical systems a site visit were realised (Fig. 3).

Figure 3. On-site measurement

3. RESULTS AND DISCUSSION

After data collection and site visits, normally greatest work is done to analyse these data and findings. Calculations for each of hospital facilities are as follows:

- ✓ the relevant actual energy consumption,
- ✓ baseline energy demand without introduction of EE measures (but fulfilling comfort levels), energy demand with introduction of EE measures (but fulfilling comfort levels)
- ✓ the respective energy saving values for each EE measure.

These values, together with investment values and respective energy prices, were used to determine:

- ✓ Energy savings in kWh/m^2 year (consistent with achieving mandatory comfort levels);
- ✓ Financial Internal Rate of Return (FIRR) of each package of EE measures;
- ✓ Financial Net Present Value (NPV) of each package of EE measures;
- ✓ Simple payback period of each package of EE measures;
- ✓ Overall total investment value of each EE measure and of the whole package of EE measures.

From a general viewpoint we realised some important findings, like:

- ➢ Physical and thermal situation of the hospital is generally not good. For this reason, it represents a great potential for energy saving by taking energy efficient measures (thermal insulation, efficient window/door, lighting, etc.).
- ➢ Lezha hospital has a central heating system but not a cooling systems.
- ➢ Automatic regulation system is missing or outdated, so it is difficult to measure the use of energy.
- ➢ Only one part of the hospital building is heated, to save energy and to have lower costs.

As we stated above main energy source was electricity and the second one was diesel oil for the boilers. In the figure below is given electricity and diesel oil consumption for the last year (2019).

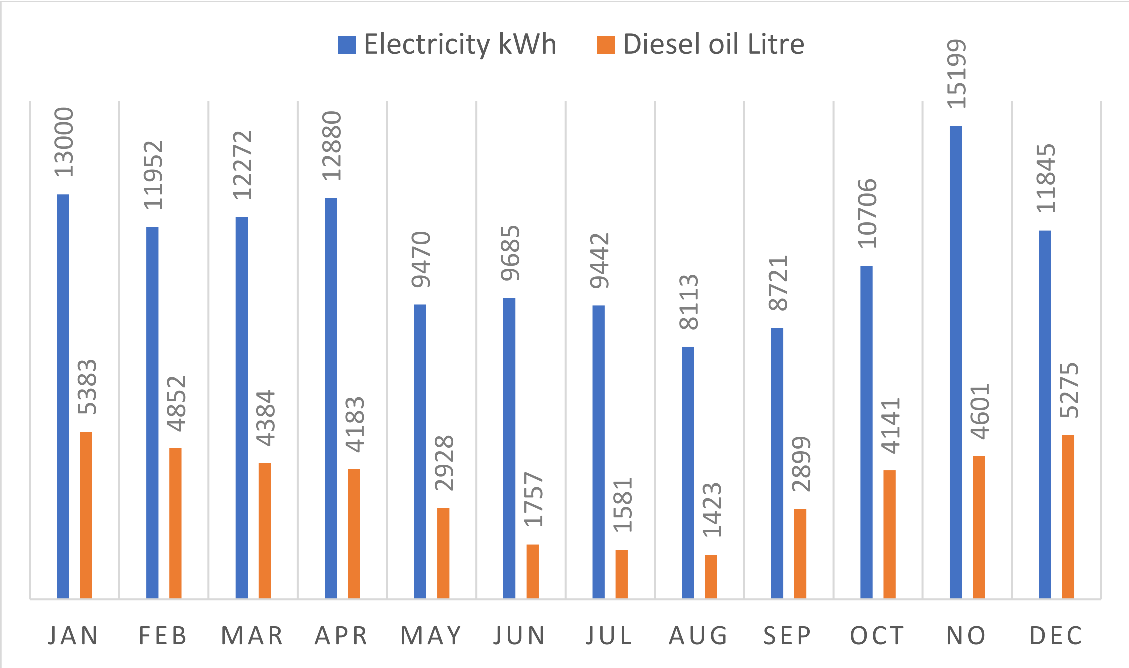

Figure 4. Energy consumption (electricity and diesel oil)

As we can see energy consumption is greater during winter season for heating purpose. Diesel boilers provide not only central heating but also Sanitary Hot Water (SHW). But heating is not covered all by boilers also by electricity, like split air conditioners. While cooling in the summer season is provided only by these split air conditioners. Hospital does not have a ventilation system, this is done naturally by opening doors and windows.

While thermal losses and needs are done based on the existing "Albanian Building Code" (DCM No. 38, 2003). Determination of the energy loss coefficient G_v ($G_v \leq G_v^{max}$) is done as follow:

$$G_v = \frac{Q}{V_b(t_{in} - t_{out})}$$

Where: Q – heat losses, V_b – inhabited volume, t_{in} – inside temperature, t_{out} – outside temperature.

Also: $G_{vo} = G_{vt} + G_{vv}$, where: $G_{vt} = (F/V)\cdot k_m$ is transmissivity and G_{vv} is for ventilation

Annual Transmissivity losses:

$Q_{tr} = DD * G_{vt} * 24 * V/(1000 * S)$ [kWh/m²a]

DD - Number of Degree Days

Gvt - as given before

V - Heated volume

S - Exposed surface

Ventilation losses:

$Q_{vent} = DD*n*24/1000*\rho*c_p*V/(3600 * S)$ [kWh/m2a]

n - Number of air changes per hour

ρ - density of air

c_p - specific thermal storage capacity of air

So annual Total losses: $Q_{tot} = Q_{tr} + Q_{vent}$ [kWh/m²a].

Analysing heat losses we have seen that most of heat was lost due to infiltration and then do to walls and roofs. Figure below represents heat losses by each building element.

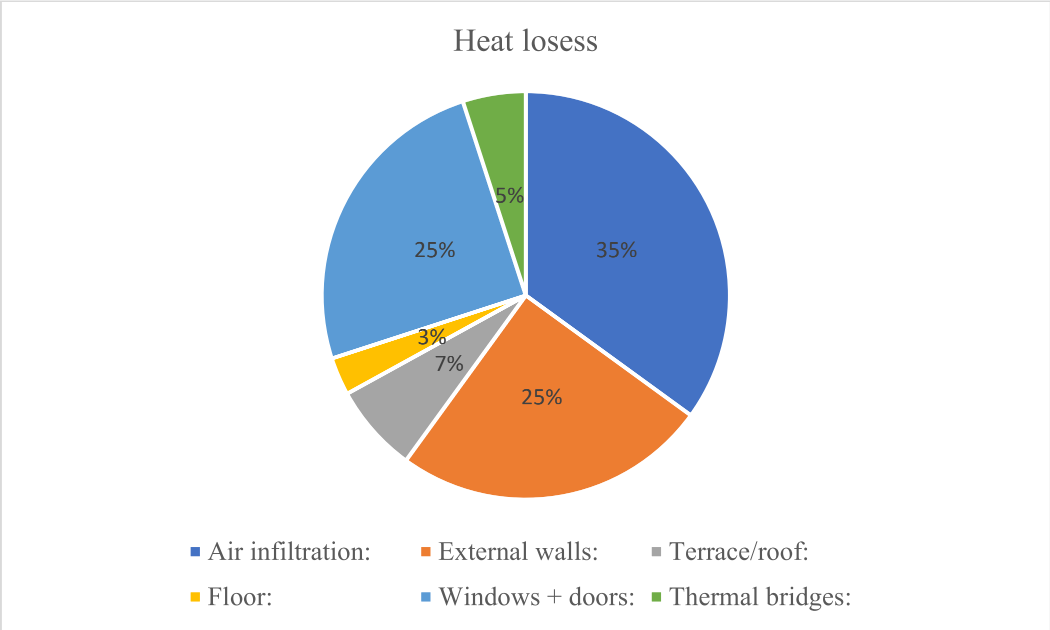

Figure 5. Heat loses from each building element

In order to analyse more in details heat losses scanning by thermal camera was performed (See Fig. 6).

Figure 6. Images from thermal camera scanning

From these images we can state that buildings have a poor thermal insulation and poor windows quality. The energy losses depend on the structure of the building, insulation material thickness and the climatic conditions. The energy losses have not a linear correlation with the above three parameters. The difference in the extra savings will be lower for extra cm of insulation. Thus, for the first cm-s, as it was underlined above, there are higher savings than the other cm-s. The economical insulation thickness is that the sum of the costs of energy losses and costs of investments for insulation, to be lower. With the current world prices of energy market, the economical thickness of the insulation for Europe is 8-12 cm. The previous experience has shown that the electricity prices are subject to the rapid changes. The optimum insulation layer is calculated based on the program of technical-economic analysis of thermal insulation, by taking into consideration the fuel cost, maintenance of district heating plant, initial investment of the thermal insulation material, labour power for placing the insulating material etc. By using the external insulation, we can eliminate the existing thermal bridges, the damages of concrete walls can be repaired, the losses can be reduced drastically and the lifespan of the building is extended. In general, the problems related to the condensation should be avoided, there is not any more the risk of dew point in the walls and the construction remains dry during all the time. Before installing the external layer of insulation, the transporting load abilities should be tested and the cracks and existing damages should be repaired. Installation of a thermal insulation of the outside wall and roof will bring energy savings, will protect forest from its continuous destruction and will also protect the environment.

4. CONCLUSIONS

An energy audit can help an organization to identify opportunities to improve energy efficiency. It can be part of a site-wide energy management system. The use and operation of hospital requires the provision of services such as heating, cooling, ventilation, lighting, domestic hot water, transportation systems (e.g. elevators, escalators and moving walkways) in hospital facilities. In addition, energy is used by the electrical appliances within the hospital facilities. The energy consumption in the all hospitals to be selected depends on: i) local climatic conditions; ii) the characteristics of the buildings envelope; iii) the designed indoor environment conditions; iv) the characteristics and settings of the technical buildings systems; v) usage, activities and processes in the buildings; vi) occupant behaviour and operational regime; vii) energy systems and equipment used in the buildings; and other (less important) factors. Energy performance indicators (benchmark values, if available) or average statistical specific energy consumption data, are usually published nationally for the all hospitals to be selected of different types and ages and structures/income. Following the detailed energy audit, a list of prioritized energy conservation measures requiring further consideration will be drawn up, indicating the energy saving for each one, the respective investment required and providing a cost-benefit analysis, showing both economic and financial indicators.

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