Thermal imaging as an essential inspection procedure for identification of energy efficiency problematics in albanian existing public buildings

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Abstract: *The Energy Efficiency Directive (2012/27/EU) established a set of binding measures to help the EU achieve its 20% energy efficiency target by the year 2020. New directive is called Energy Efficiency Directive (EED). According to INSTAT (Institute of Statistics) the share of non-residential building sector in Albania is approximately 20.6 %. Public buildings with all the sub-categories have a significant contribution on energy demand in buildings. Therefore, according to the new law No.116/2016 "For energy performance in buildings" since 2018 public buildings with area higher than 250m^2 are subject of this law for certification of energy performance in buildings. Regarding the National Energy Strategy 2018-2030 Albania's target is set to 15 % for energy savings in the sector. This article deals with identification of energy efficiency problems in the public building sector in Albania. Typology of the buildings mainly constructed before the 1990 has poor energy efficiency measures, due to the lack of the investments. Thermal imaging was identified as an necessary procedure for scanning of the building. Energy consumption and building characteristics through thermal imaging have been investigated with the aim to improve the energy performance of the public buildings. This will contribute to optimize the energy efficiency measures by energy audits.*

Keywords: ENERGY EFFICIENCY, THERMAL IMAGING, PUBLIC BUILDING, MEASURES.

1. Introduction

Energy consumption in buildings reaches up to 30 % of the total energy consumption in Europe and USA. This trend is similar for Albanian energy sector as well. According to INSTAT (Institute of Statistics) energy consumption of non-residential building is approximately 20.6 % of the total energy consumption [1]. In the recent years a number of initiatives in the Albanian energy sector have been recorded. The Energy Efficiency Directive established a set of binding measures to achieve the 20% target in Energy Efficiency (EE) [2]. On the other hand Albania has made a significant progress in preparation of the National Energy and Climate Action Plan (NEACP). Establishing the Agency of Energy Efficiency (AEE) in 2015 [3] was the first steps in this sector, followed by approve of a number of laws in the sector, such as the law for energy efficiency, the law for energy performance in buildings, energy audits etc. In order to quantify the results in the energy efficiency sector the AEE has issued the law of energy performance certification in buildings. The realization of this service will be carried out by licensed energy audit professionals. Practices of energy audits will be compulsory for energy consumers higher than 1 GWh, for buildings going under a considerable reconstruction, applications for Energy Efficiency fund as well as for buildings that are designated for sale/for rent and public buildings greater than 250 m^2. The energy audits in Albania for large energy consumers will be estimated once per three years. It is estimated that the total electricity consumption in Albania is approximately 8,000 GWh/year. About one third of the electricity supply comes from import due to Albania's high dependency on hydropower. Electricity is often the main energy source for space heating, especially in urban areas. Share of electricity consumption in Albanian households according to Eurostat [4] is 31.7 % for space heating, 29.8 goes for cooking, whereas 21.4 % and 11.7 % for domestic hot water and lighting/electrical equipment respectively. Electricity consumption for space cooling is 5.5 %. According to the National Energy Agency 2018-2030 [5], the implementation of EE measures up to 2020 has led to a 6.8 % savings in energy efficiency. It is supposed that by year 2030 energy savings through EE measures will reach op to 15.5 %. This figure corresponds to a total cost investment of 532 million Euros in the sector. Energy Audits represents a new reality in the Albanian energy market, hence specialists, companies, and institutions are facing a lot of challenges. This paper will focus on the practical use of thermal imaging in the realization of energy audits in buildings. The case study is carried out in a public building in the Durres harbor.

2. Thermal imaging

According to The European Commission definition the energy audit is defined as "[…] a systematic procedure to obtain adequate knowledge of the existing energy consumption profile of a building or group of buildings, of an industrial operation and/or installation of a private or public service, identify and quantify cost-effective energy savings opportunities and report the findings. It is obvious that the legislative framework emphasizes the role identify energy inefficiencies, to reduce energy inputs and to determine potential measures for improving energy efficiency and thermal comfort [6]. According to [7] theoretically we can perform three types of energy audits based on the analytical level: a) walk-through audit which results on a general visual inspection of the object. The time spent is relatively short, however a preliminary energy saving potential could be analyzed; b) standard audit that gives a quantified energy losses and c) simulation energy audit which is based on deep inspection and simulation of the energy performance. The three levels of analysis require energy data collection and processing of complex results. Thermal imaging is a non-contact technology that has a wide range application, see Figure 1. Thermal imaging can be applied during energy audit inspection in buildings. This step will help to detect the energy heat losses, the thermal insulation problematic in walls and roofs. Identification of air leakage, thermal bridges, and moisture presence can be found by thermal imaging procedure.

Fig.1 *Thermal imager used in in this case Testo 868 [8]*

Thermal imaging can be used in electromechanial equipment to detect problems related to corrosion, damage and other problems that may result in high impact problem to the facility. Heating Ventilation and Air Conditioned (HVAC) installations can also be

detected. However, the use of thermal imaging requires a good understanding of knowledge related to heat transfer, thermodynamics, electronics and optics [9]. The accurate use of thermal imaging will lead to proper diagnosis of building energy audit. Thermography can be used in entire building to examine heat and gain losses through building envelope. The main fields of operation for thermal scanning measurements are: determination of the percentage of the areas with thermal problems; insulation level detection; U-value measurements; dynamic characterization of walls; and moisture content determination [10,11,12].

3. Case study

Thermal examination of an office building in the harbor city of Durres is used for this case study. The building is placed within the harbor and the measurements are carried our during winter period in the beginning of January. A preliminary energy audit is performed in this case with one day spent in the building. This type of energy audit consists in quickly determining the energy consumption and possible energy savings; identification of rapid measures with almost zero cost for energy saving/improvement; determining the necessity for standard energy audit. The preliminary audit utilizes almost ready available or easily obtained data. At the same time this type of audit is used as a "reference point" for future energy studies.

Fig.2 *Office building view in Durres during a cloudy day*

Data collection about thermo-physical building characteristics, mode of operation, energy consumption of equipment and other helpful information were gathered.

4. Results and Discussion

For the thermography analysis in the office building Testo 868 win an integrated digital camera was used. The visualizing temperature sensitivity difference is 0.1 ^{o}C. The object was examined in seven different measuring points, see Fig 3 to Fig.7.

Fig.3

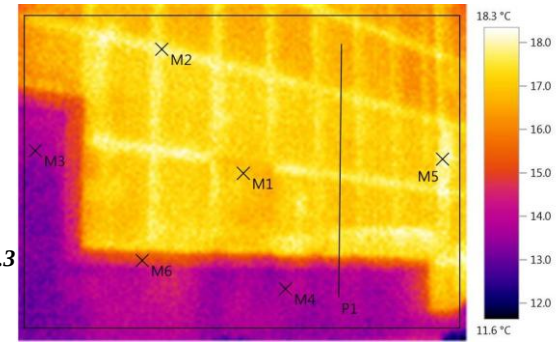

Fig. 4 *Façade view of the office building*

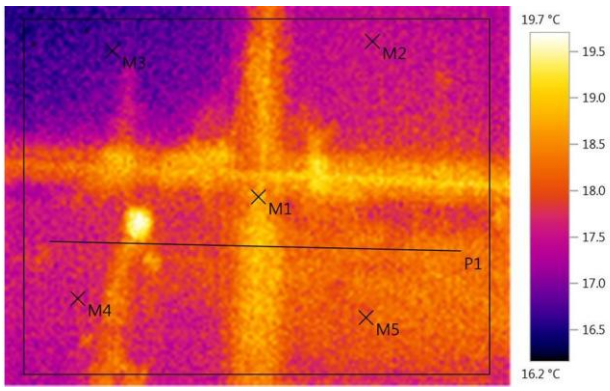

Fig.5 *Temperature distribution in the window frame*

Fig. 6 *Indoor view of the office building*

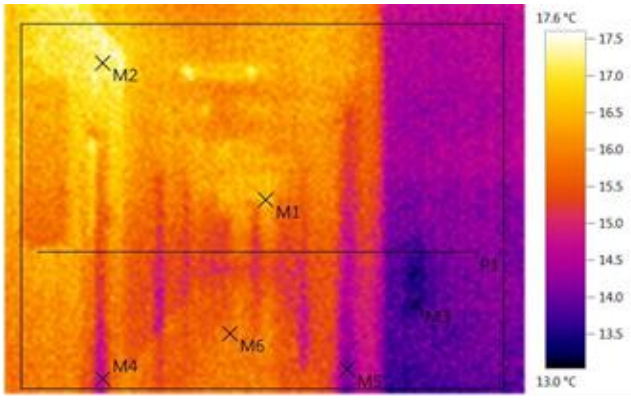

Fig.7 *Temperature variation of the indoor area of the building*

In this case thermal imaging is used as an instrument to quick inspection of walk-through energy audit. During thermal imaging we were aware of the physical phenomena taking place and the interaction between outdoor and indoor environment. The measurement corresponds to the winter season; however the office building operated at full capacity. During the day the solar radiation on the external building surfaces is absorbed and increases its surface temperature. However, during winter the external surface of the wall without thermal insulation will have a lower temperature. In order to avoid the clash of temperature increase as a result of solar radiation thermal imaging measurements were carried out during a cloudy day as shown in Figure 2. It is important to mention that heat absorbed by the surface has an impact that continues in a few hours. Detecting cold and warm surfaces has a direct negative impact on thermal comfort. Thermal imaging is an important tool for detecting thermal insulation that reduces heat losses by conduction through the building envelope.

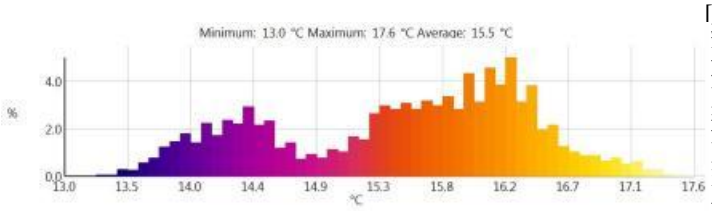

Fig. 8 *Temperature histogram profile*

5. Conclusions

Energy demand in the building sector is of special challenge. In 2012, the final energy consumption in this sector was as much as 35% of national energy consumption (EUROSTAT 2015). Also, the sector was responsible for 75% of the amount of electricity in final energy consumption. Quality of service with energy supplied to buildings is much lower than that of the Union European countries. Usually, public buildings in Albania are partially supplied with space heating and for a few hours during the day. This article highlights the latest progress on legal framework done by Albanian institutions in the recent years. Thus, consolidation of the AEE leads to a matrix of laws regarding energy performance in buildings and certification of the process. Energy audit examination requires knowledge of building characteristics, energy flows and energy measurement. Thermal imaging is a well-known technology used in different applications. In this paper an office building placed in the port city of Durres was examined. The investigation through thermography was carried out during winter, in a cloudy day. The results present the temperature distribution on outdoor surface of the building envelope. Thermal bridges detection is of primary importance for this case. In order to have a better description of the temperature profile a thermal imaging of indoor area has been conducted. Thermal imaging has an important role in walk-through energy audit and can be used as an essential tool during standard energy audit.

5. References

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