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The new EPBD: A case study of a renovation of a country house in Kosovo

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Abstract. With the "green houses" directive, the European Union intends to reduce GHG emissions by 55% to 2030 compared to 1990 levels and achieve zero emissions by 2050.
Reducing emissions of polluting gases and fighting global warming are two objectives of the utmost importance for Europe, pursued through a policy that encourages the ecological transition.

One of the most discussed interventions in this sense is the so-called Green Homes Directive or the EPBD Directive which aims to gradually eliminate buildings with inadequate energy performance by promoting the redevelopment of energy-intensive buildings.

How can Kosovo respond to this objective at this moment? This article will address the dimensioning of a building to be renovated, respecting the European parameters.

The building will be zero consumption, composed of an excellent passive project (thermal insulation of the opaque walls and windows), optimal system design (low temperature generation systems, photovoltaic systems and charging for the electric car) and by an excellent system for monitoring and managing the building's thermal and electrical loads.

Keywords: Photovoltaics System, Climate Change, NZEB, Storage Systems, Sustainable Economy, Energy Independence, Renewable Energy, Energy Saving.

1. Introduction

The European Union, with the new reform known as "green houses", has set as its objective the encouraging of the renovation of private and public buildings, to reduce energy consumption and CO_2 emissions of the building stock of the 27 member states.
The directive communicates that these buildings are responsible for 40% of final energy consumption and 36% of greenhouse gas emissions associated with energy, also highlighting that 75% of the total assets are not energy efficient and natural gas is mainly used for heating buildings, representing approximately 42% of the energy used for space heating and the residential sector.
In this article, will be dimensioned the renovation of a rustic house, in an NZEB building, capable of respecting all the binding parameters preset by the main European Directives relating to the construction of new buildings, including the EPBD directive.
This project, carried out in a Roman province, will be transposed into the climate of Prishtina to demonstrate how the thermo-structural parameters and characteristics of the chosen systems can also be implemented for the young nation of Kosovo.

2. Thermal and boundary conditions of the project

For the simulation of the building, carried out with advanced and combined software (BIM, FEM, TRNSYS and others), the climatic conditions of Kosovo were taken into consideration, and below are the main data taken from: weatherspark.com.

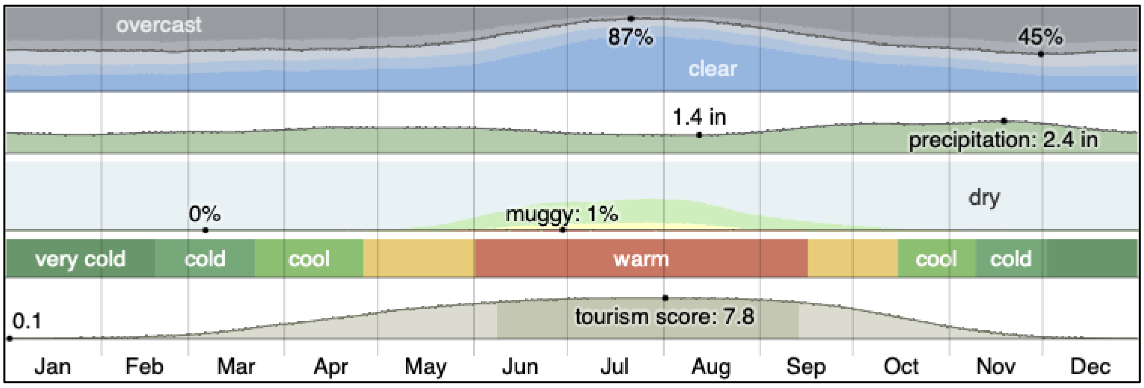


Fig. 1. Kosovo weather by month (source: weatherspark)

"The warm season lasts for 3.4 months, from June 1 to September 15, with an average daily high temperature above 75°F. The hottest month of the year in Kosovo is August, with an average high of 83°F and low of 57°F.

The cold season lasts for 3.3 months, from November 25 to March 2, with an average daily high temperature below 48°F. The coldest month of the year in Kosovo is January, with an average low of 24°F and high of 39°F."

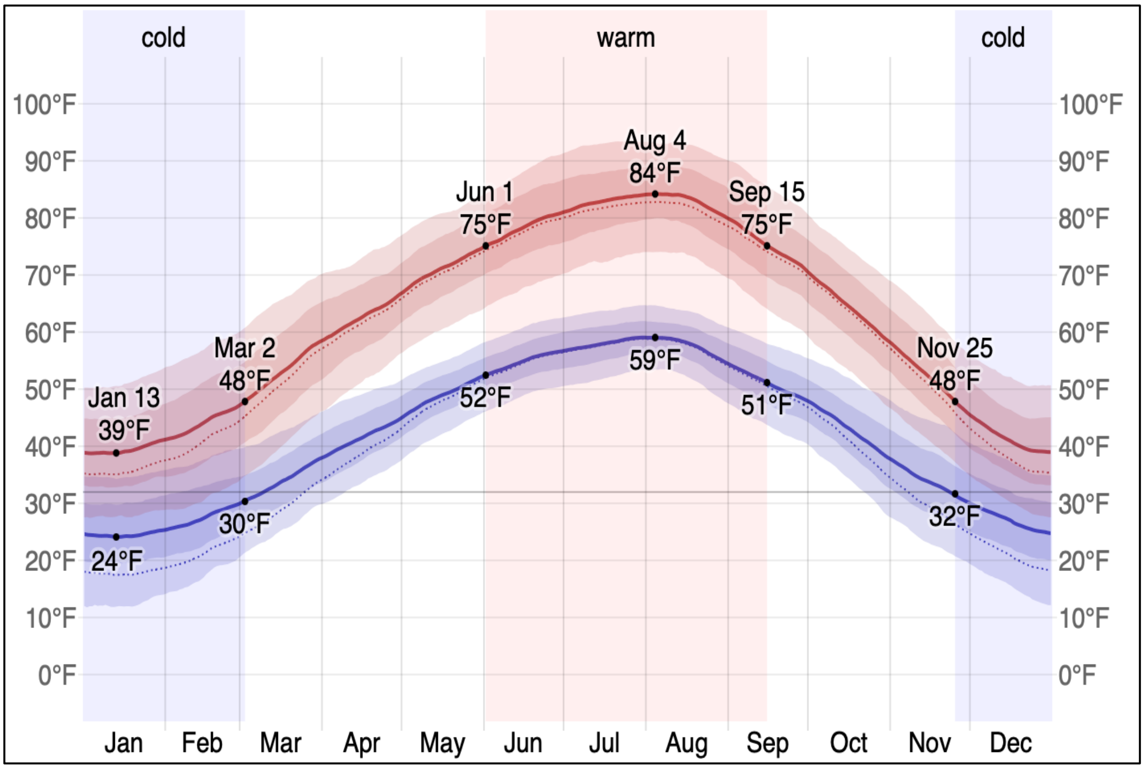


Fig. 2. Average High and Low Temperature in Kosovo (source: weatherspark)

A further fact to take into consideration is linked to the fall of snow, in fact this is very important for the structural reinforcement of the building (terrace floor) and for the inclination of the photovoltaic modules, which will be raised and inclined from the terrace.

"As with rainfall, we consider the snowfall accumulated over a sliding 31-day period centered around each day of the year. Kosovo experiences significant seasonal variation in monthly snowfall. The snowy period of the year lasts for 4.5 months, from November 5 to March 23, with a sliding 31-day snowfall of at least 1.0 inches. The month with the most snow in Kosovo is January, with an average snowfall of 4.5 inches.
The snowless period of the year lasts for 7.4 months, from March 23 to November 5. The least snow falls around July 22, with an average total accumulation of 0.0 inches."

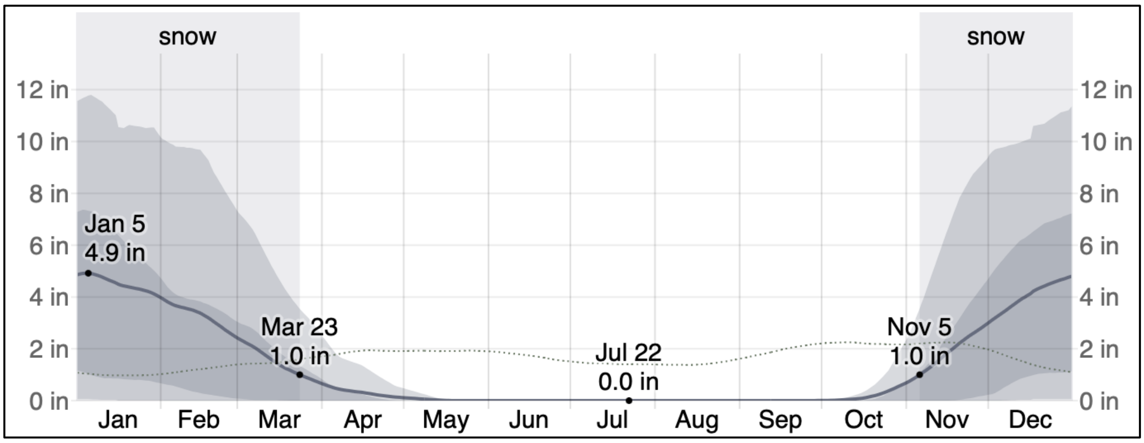


Fig. 3. Average Monthly Snowfall in Kosovo (source: weatherspark)

These parameters were fundamental for the thermo-energy simulation of the same building built in the province of Rome, transported to the capital Prishtina.

3. Characteristics of the building

The building taken into consideration is 210 m^2, built on a single floor and with a well-prepared structure in terms of energy (long side facing south with shade created by trees with seasonal leaves) with good parts with windows and equipped with automatic shutters that they have the function of letting the sun's rays pass through, during the winter and limiting them in the summer season.

<u>A.- Passive structure:</u>
The main characteristics of the building envelope are summarized below.

- The old tuff perimeter wall was insulated with XPS extruded expanded polystyrene insulating sheets, with thermal conductivity 0,034 W/mK, bringing the thermal resistance of the walls to 5,15 m^{2}K/W.
- The replaced fixtures, of the low-emissivity aluminum-wood type, are certified with a transmittance of 0.95 W/m^{2}K.
- The attic was insulated with a 14 cm thick XPS sheet, bringing the transmittance of this structure to 0.201 W/m^{2}K.
- The floor composed of bio resin was also treated and reduced in transmittance by approximately 1.2 W/m^{2}K, making the latter also compliant with what is required by law.
- The thermal bridges were all made compliant with project requirements.

<u>B.- The building's heating and electrical system</u>
The building's systems have been well sized between electrical and thermal system. Below are the main characteristic data:

- Generation is guaranteed thanks to two combined generators which are a high efficiency hydronic heat pump (COP 4.45 and EEF 4.35), and a condensing boiler that supporting the DHW group.

- The terminals of the heating system are fan coils, well sized according to the project needs, to guarantee both cold and heat with a single final machine and to reduce intervention costs (if compared with a radiant floor system).

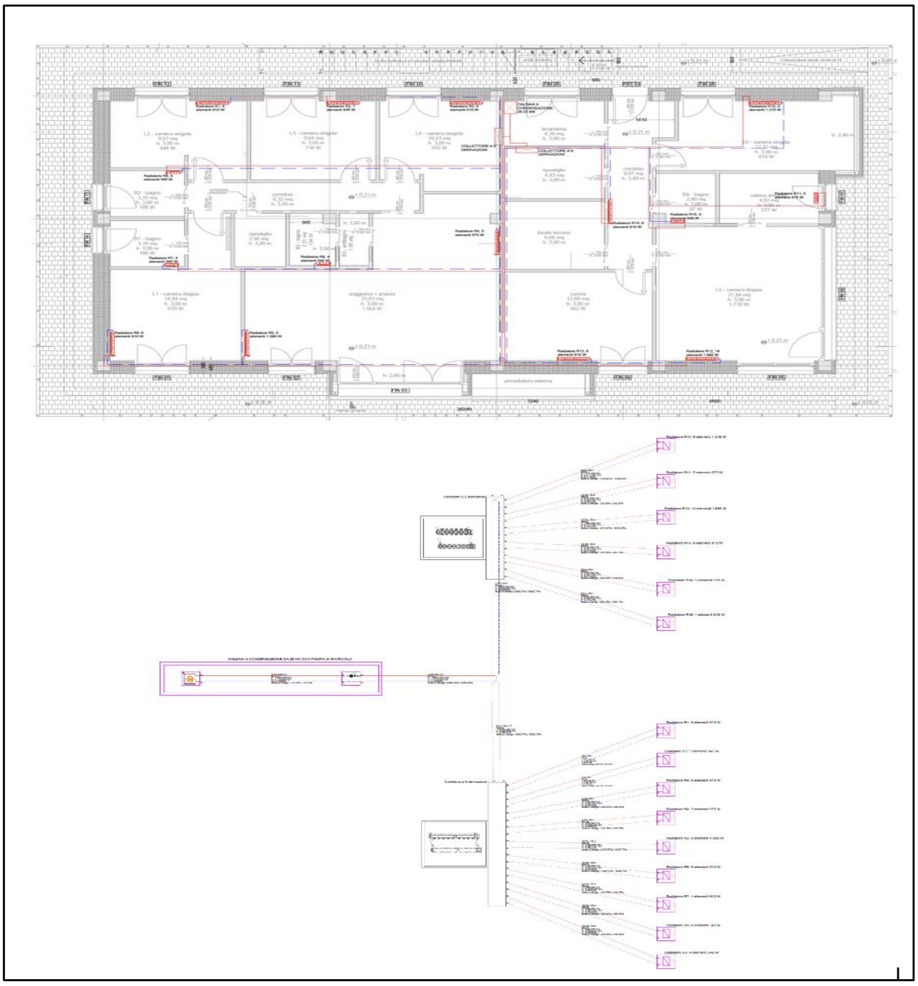
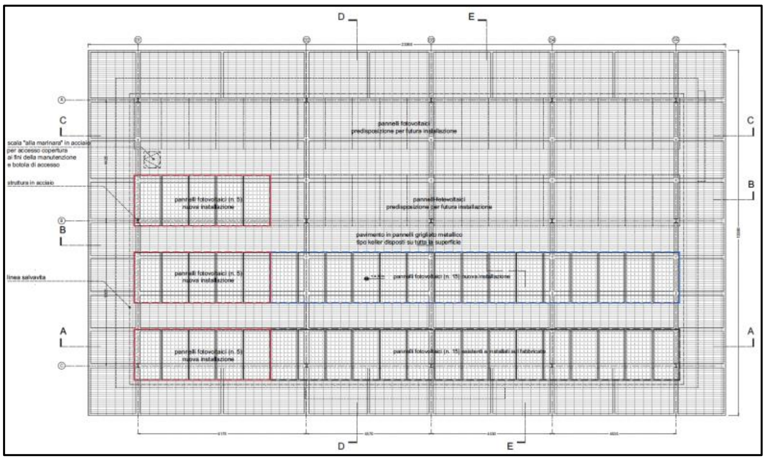


Fig. 6. Layout and hydraulic single-line diagram of the heating system

- Regarding photovoltaic technology, was opted for the installation of a double system. The first system is dedicated to the home, and is a 7,830 kWp system, with approximately 15 kWh storage batteries. The second is for use of the agricultural company available or to other users (not the subject of the study).
- Furthermore, a Wallbox system for charging the electric vehicle was thought of.



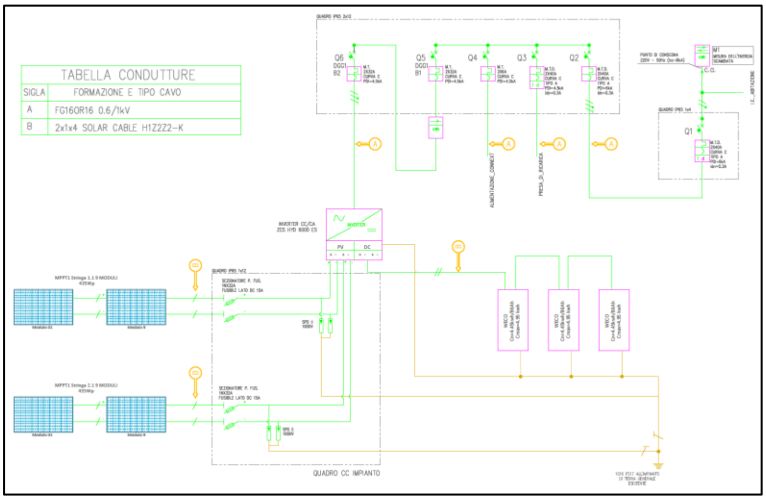


Fig. 7. Layout of PV module and of the electrical single-line diagram of the photovoltaic system and the wall box

4. Comparative energy analysis

Very interesting, once the goodness of the project has been noticed, is to understand how much overall energy the building manages to save and how many kWh per year are saved.

To do this, the two energy class outputs reported by the building certificate are reported.

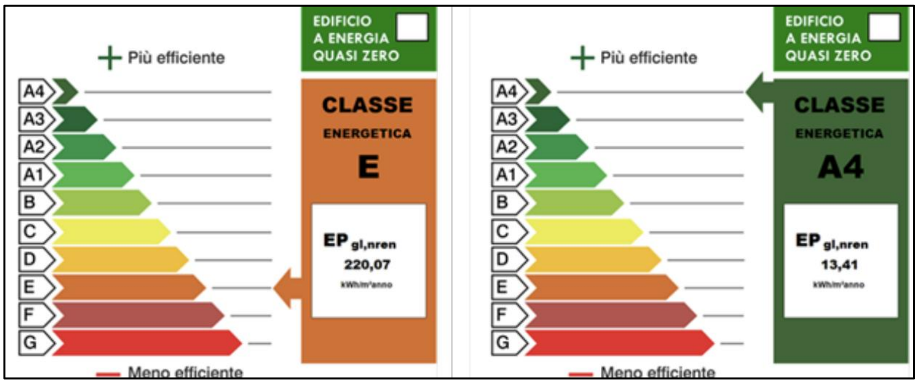


Fig. 8. Pre and post intervention – energy consumption

What can be observed is that the certified energy consumption is significant, going from 220,07 kWh/m^2 to 13,41 kWh/m^2 in a calendar year.

This implies that there was an energy saving of 206.66 kWh/m^2 per year, equal to 43.398,60 kWh for the entire building in one year. Transforming this value into Tons of Oil Equivalent (TOE), the result is even more significant, as it is talking about 8,12 TOE per year.

5. Conclusions

As can be seen, the ecological transition and the reduction of building consumption today absolutely must take place with a series of targeted and combined interventions, but it is of fundamental importance to combine passive interventions with active ones (photovoltaic generators and thermal solar system).

Of fundamental importance is a good design of the building which must be envisaged today as an integrated structure of mixed systems including electrical engineering and advanced IT (monitoring of consumption through devices that detect consumption in real time, management of consumption profiles through apps on devices such as smartphones and more and home automation integrated between climatic conditions and building).

The combination of all these technologies allows us to configure the so-called Green House or ZEB (Zero Energy Building) today.

This work has underlined how a low consumption building (without photovoltaic and solar systems the consumption would be 76.44 kWh/m^2) can even be brought to zero.

In this work, the energy contribution can be well evaluated, as this value is highly tangible, the only flaw of this intervention is the high investment, which today cannot be thought of without state incentives, especially for a young state like Kosovo. On the other hand, the ecological transition is a collective good and therefore it is good that the community participates in this.

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