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Kliton Bylykbashi
University for Business and Technology - UBT, kliton.bylykbashi@ubt-uni.net

Besar Veseli
University for Business and Technology, besa.veseli@ubt-uni.net

Shqiprim Ahmeti
University for Business and Technology - UBT, shqiprim.ahmeti@ubt-uni.net

Vehbi Sofiu
University for Business and Technology - UBT, vehbi.sofiu@ubt-uni.net

Luca Rubini
Sapienza, Rome, Italy, luca.rubini@cirps.it

The new European Directive EPBD (Energy Performance of Buildings Directive) and the added value of the photovoltaic system

Kliton Bylykbashi[1], Besa Veseli[1], Shqiprim Ahmeti[1], Vehebi Sofiu[1], Luca Rubini[2]

[1]UBT, Pristina, Kosovo
Institution of Higher Education, UBT-College

kliton.bylykbashi@ubt-uni.net
besa.veseli@ubt-uni.net,
shqiprim.ahmeti@ubt-uni.net,
vehebi.sofiu@ubt-uni.net

[2]CIRPS, Rome, Italy

luca.rubini@cirps.it

Abstract. With the "green houses" directive, the European Union intends to reduce greenhouses gasses emissions (GHG) by 55% to 2030 compared to 1990 levels and achieve zero emissions by 2050, with the aim of redeveloping the European building stock and improving its efficiency energy.

The provision advanced by the European Commission has been included in the Fit for 55 reform package and has the objective of acting as a priority on the 15% of the most energy-intensive buildings (located in energy class G) for each Member State; in Italy there are approximately 1.8 million residential buildings, out of a total of 12 million.

The need to increasingly electrify domestic services can only pass through the installation of photovoltaic systems. In fact, if on the one hand these lead to an immediate benefit in terms of energy savings (linked to the reduction of the cost in the bill), on the other hand the calculation of the energy requirement if combined with a heat pump, means that the thermal contribution for the share of heating, cooling and domestic hot water production, inside the building is almost zero (or zero based on the sizing of the building/plant system).

This article will analyze a 120 square meter building (well insulated, equipped with a hybrid heat pump), with an 7,50 kW photovoltaic system and 15 kWh of storage batteries, and without the photovoltaic system and storage, demonstrating how the energy class and the consumption of the case of study, can radically change in the two different configurations.

Keywords: Photovoltaics, 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 is demonstrating the strong role that renewable sources such as photovoltaic play in

achieving this objective. In fact, a well-insulated building will be analyzed as to how the energy class responds, introducing or not the photovoltaic system with storage batteries.
In the same building, the charging column for the electric car will also be set up (another sensitive topic declared by Europe).

2. Characteristics of the building

The building taken into consideration is in Milan, with a surface area of approximately 120 square meters. The climate of Milan, a Lombard city located to the west of the Po Valley basin, is characterized by a humid temperate climate, with a significant annual temperature range (hot summer and cold winter).
Building size:
- 2 floors of approximately 60 m^2 per floor;
- 3 m height per floor with walkable terrace;
- reinforced concrete and perforated brick masonry, with EPX thermal insulation of 120 mm thickness and thermal transmittance of 0.20 W/m^2;
- the windows and doors were replaced with wood-aluminum, low-emissivity double-glazed systems with average transmittance of the window and doors 1.04 W/m^{2}K.
- the building's heating system is made up of a low-temperature heat pump with underfloor radiant panels, and a DHW boiler made up of the heat pump and a support condensing boiler.

The restructuring was carried out in 2021, already considering what the standard parameters defined by Europe would be in the imminent future.

For economic reasons it was not possible to install photovoltaic technology that year, but all precautions were taken for possible future installation.

Fig. 1. View of the building with the preparation of the main electrical and thermal backbones

2.1 Objectives and energy analysis

The aim of this work is to compare how the single-family building developed on two floors can have a different energy behavior based on whether a 7.5 kWp photovoltaic system and storage batteries are installed.

- In the configuration without a photovoltaic system, the overall energy consumption of the building is 76.44 kWh/m^2, due to the energy richness of the heat pump (and the auxiliary integrated condensing boiler);
- In the proposed configuration with PV system, the global consumption drops to 7,76 kWh/m^2 or rather 931 kWh in one year, and can be improved to zero (look cap. 3).

2.2 Thermal analysis of the object

As explained, this paper has the task of demonstrating how the electrification of the services of a building must necessarily pass through the installation of the photovoltaic system.

This is because the simple use of the heat pump with a low temperature system does not give the building energy independence, without from green energy sources.
It is noted that in this case of study, the energy consumption of the building without and with the photovoltaic system is summarized in the following table.

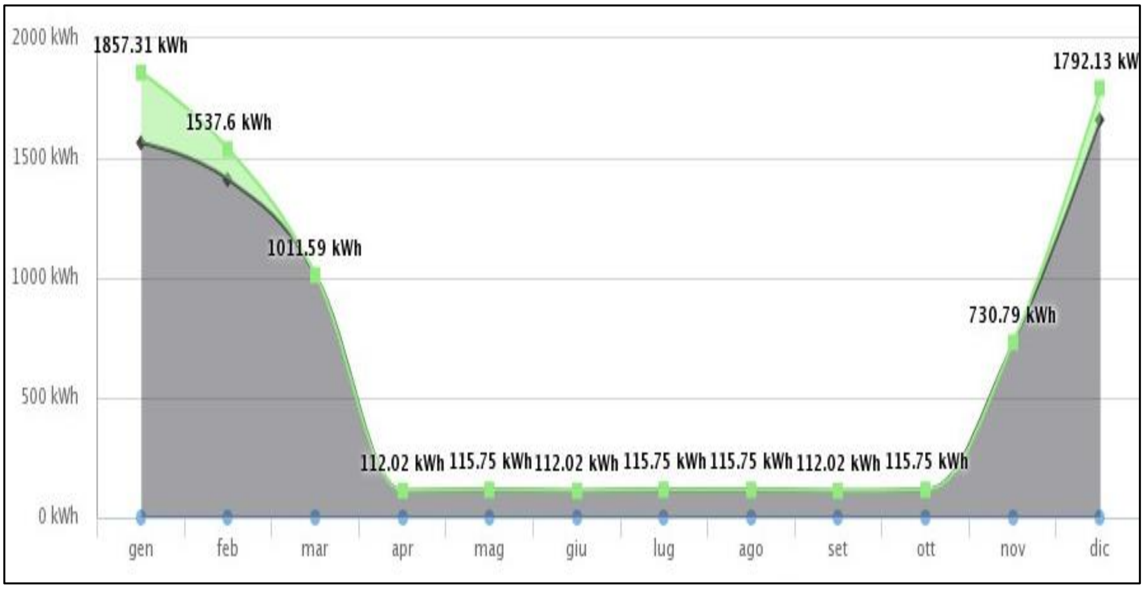

Fig.2. Energy consumption of the building without and with the photovoltaic system.

In figure two you can observe the consumption resulting from heating from the heat pump in the gray area, while the green area determines the energy produced by the photovoltaic system (The green area also considers the share of energy that is transferred to the national grid during the summer period before recovering it during the winter period of need. There are now green contracts that can be established between the network and the consumer).

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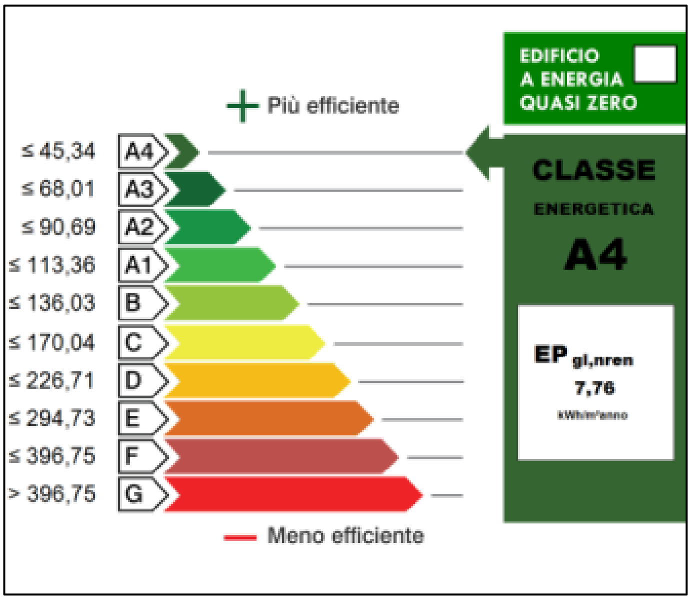

Fig.3. Global energy consumption of the building with the photovoltaic system.

What can be seen is that the presence of the photovoltaic system increases the energy class of the building from B to A 4, with a global energy consumption index of 7.76 kWh/m^2.

3. Design of system

As we said, the system set up for this building is a 7.5 kWp system with 15 kWh of batteries. Below are the main project graphics.

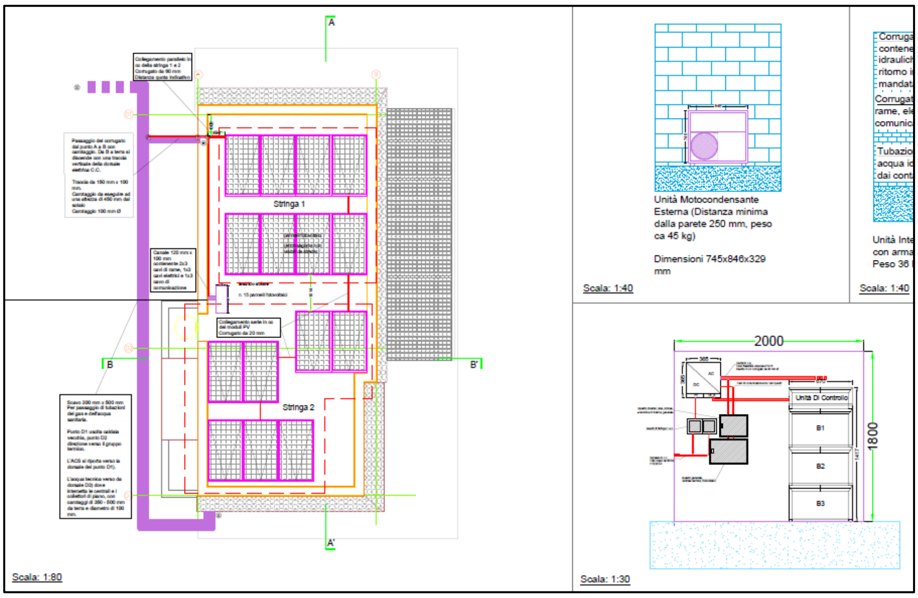

Fig.4. Layout of the 7.50 kWp photovoltaic system with 15 kWh of battery.

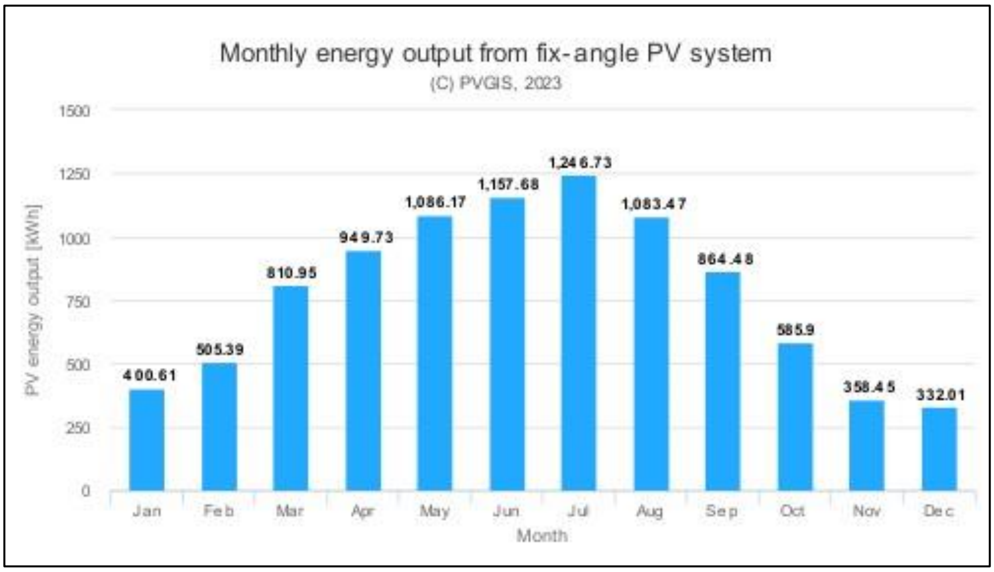

Fig.5. Mmonthly energy production of the photovoltaic system.

To bring the building back to zero consumption, two interventions can be carried out:

- The first increases the photovoltaic system by approximately 1.5 kW but this would bring the building to three-phase, with an increase in management costs due to the electricity contract (contactor greater than 6 kWp).
- The second is the use of a solar thermal system capable of reducing the consumption of 7,76 kWh/m^2, deriving from DHW heating to zero, as this system supports the heat pump with a gas boiler.
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4. 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.

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