



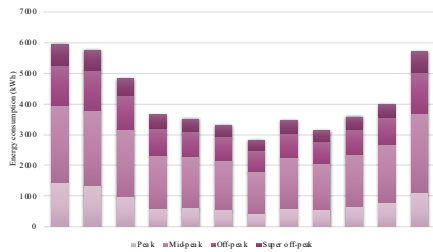
ENERGY EFFICIENCY ASSESSMENT OF A YOUTH HOSTEL BASED ON MULTIZONE MODELING AND SIMULATION

Presented at the IX Ibero-American Congress on Entrepreneurship, Energy, Environment, and Technology (CIEEMAT 2025) in Portalegre, Portugal, this paper provides an energy performance assessment of a youth hostel in northern Portugal through multizone dynamic simulation. The study combines on-site data collection, energy billing analysis, and advanced building modeling in DesignBuilder using EnergyPlus as the calculation engine.

INTRODUCTION

The building sector is a major contributor to global energy use and greenhouse-gas emissions, so energy efficiency is a key goal of EU and national climate policies. The EU's Energy Performance of Buildings Directive (EPBD) provides a framework for evaluating and improving building energy performance. Dynamic multizone simulation tools play an important role by modeling realistic building conditions such as thermal zones, internal loads, and HVAC operation to predict heating, cooling, and overall energy needs.

OBJECTIVES



The primary objective is to calibrate and validate a simulation model that accurately represents the building's energy behavior, quantify energy needs and associated CO₂ emissions, and identify key areas for improvement. The building has an annual electricity consumption of approximately **50 MWh** and is subject to a four time-of-use tariff, which differentiates between peak, mid-peak, off-peak, and super off-peak hours, each with distinct costs.

RESULTS AND DISCUSSION

The main entrance was identified as the area with the highest heating deficit (5.18 kW), suggesting a potential area for improvement. Cooling needs were not analyzed in detail since several air-conditioning units are non-operational and rarely used. Internal gains were broken down by source, showing that lighting contributes very little to thermal gains despite significant energy use, mainly due to the efficiency of LED fixtures. The model also estimated annual CO₂ emissions at 84.21 tonnes. Follow the comparison table:

	Real Consump. (kWh)	Simulation (kWh)	Diference (%)
Electricity	49.985,00	48.237,26	-3,5%
Propan gas	238.257,00	235.572,07	-1,1%
Total	288.242,00	283.809,33	-1,5%

METHODOLOGY

The determination of the BEPI (Building Energy Performance Indicator), based on the multizone dynamic simulation for the building under study, must be carried out using software accredited under ASHRAE Standard 140, developed by the American Society of Heating, Refrigerating and Air-Conditioning Engineers.

To carry out the simulation, it was needed to study and analyse **buildings characteristics** - predominantly rectangular (With a total usable floor area of 2,102.08 m², distributed over 3 floor), **energy consumption overview** (electricity and gas) - essential for understanding its operational efficiency and environmental impact, **climate zone** – regarding NUTS, **building occupation** (0.042 occupants/m²), **Lighting system** that is essential to evaluate the LPD and also **building energies systems** quantified on the following table:

System / End-Use	Installed Power (kW)
Heating (HVAC)	131
Cooling (HVAC)	56.4
DHW Production	104
Lighting	3.7
Other Equipment	300.15
Total Installed Power	≈ 545

CONCLUSIONS

The economic and regulatory analysis shows that relatively simple retrofit measures — such as installing a condensing boiler, variable-speed pumps, and roof insulation — can reduce heating needs by **15–22%**, leading to annual savings of **€5,500–€7,200** and a payback period between **4.5 and 6 years**. When complemented by renewable energy integration, such as solar thermal for DHW or photovoltaic self-consumption, the building could move toward nearly zero-energy building (nZEB) requirements foreseen in the EPBD and supported by the Renewable Energy Directive (RED III).

