Design, testing and modelling of façade integrated photovoltaic systems

Summary

The present work focuses on integrated solar energy systems (BI-SES), namely integrated photovoltaic thermal systems (BIPVT) in buildings. In recent years there has been a growing interest, from the point of view of engineering and architecture, in the strategic development of building facades to meet current requirements for energy efficiency and sustainability. This study aims to develop new façade solutions with the integration of solar energy systems, evaluate their performance, experimentally and numerically and, through a parametric analysis based on validated models, to improve the system design. The case study is located in the Solar XXI building of the National Energy and Geology Laboratory in Lisbon, Portugal. It consists of a test room with a BIPVT system installed that was later tested with the new prototypes P1a (photovoltaic module with internal insulation module) and P1b (photovoltaic module with internal water tank module) with a complex automation system.

An extensive experimental campaign was developed with the registration and analysis of different external and environmental climatic parameters of the test room and the BI-SES elements, and the thermal characterization of the elements was also carried out. This study was complemented with a numerical analysis that consisted, in a first phase, in the dynamic simulation of computational fluids (using ANSYS Fluent) for the analysis of BI-SES elements and, in a second phase, in the energy simulation of the integration of BI-SES elements. SES in the test room (using EnergyPlus). A parametric analysis was performed with 82 scenarios, varying parameters such as the position of the window protection device, the number of photovoltaic panels in the system, the thickness of the air layer, the air exchanges between the BI-SES systems and the room and their modes of operation.

The main conclusions of the study indicate that the existing BI-SES (BIPVT) and the new prototype in its two versions, have the potential to increase the sustainability of the building, reducing the energy needs for heating and cooling. However, its operation needs to be adapted to other existing systems in the thermal zone, such as shading devices, having the automatic mode of operation, with intelligent operational set points, proved to be the most suitable.

Keywords

BI-SES (Building Integrated Solar Energy Systems), BIPVT (Building Integrated Photovoltaic Thermal Systems), computational fluid dynamics, building energy simulation, experimental campaign.

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