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Application of renewable energies in vehicles in the Mediterranean Urban Environment

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INTRODUCTION & AIM

Renewable energies can be used in the development of public passenger vehicles to reduce energy consumption, improve passenger comfort and enhance the sustainability of urban environments. In this work, a case study of a train carriage is analysed. The carriage is built with five modules. Each module is composed mainly of surrounding panels and lateral windows. It is equipped with photovoltaic cells located in the ceiling (horizontally) and lateral (vertically and inclined) panels.

METHOD

The numerical study evaluates direct and diffuse solar radiation, photovoltaic production, and the mean energy produced throughout the day. Energy for artificial lighting, ventilation, and heating systems is generated in the photovoltaic system. The study is conducted in a Mediterranean environment on a winter day with a clear sky, when the train moves from north to south.

The ceiling is exposed to solar radiation throughout the day, with the left side receiving sunlight in the morning and the right side in the afternoon.

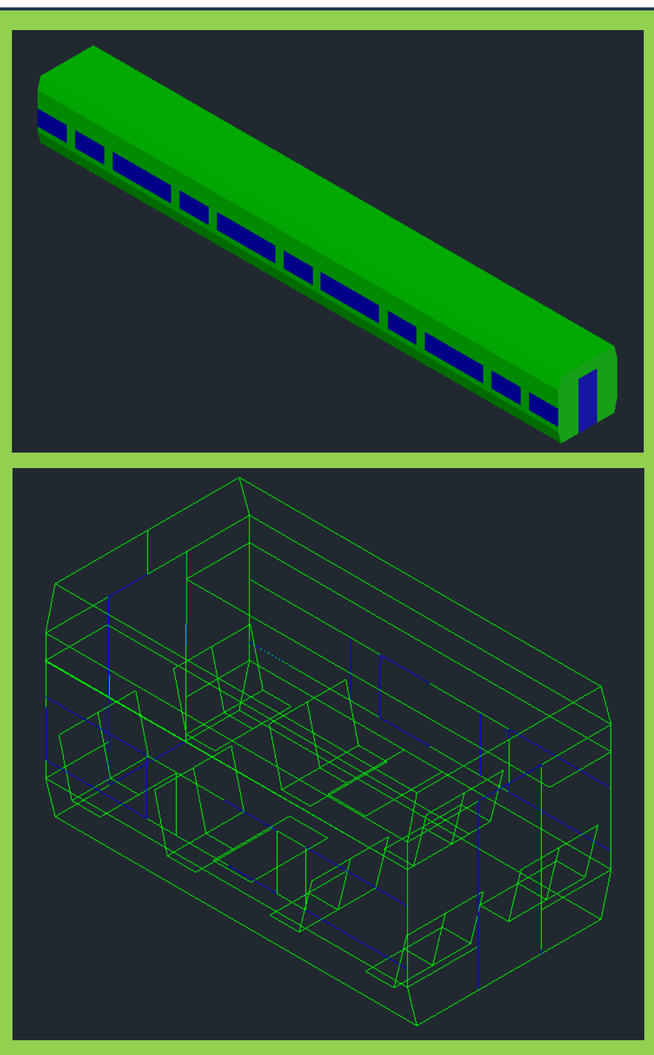

Figure 1. 3D scheme of the train carriage and the modules considered in this study.

RESULTS

The lateral panels generate 59.5 % of the energy produced by the ceiling panels. The lateral panels below the windows account for 45% of the energy of the panels above them. Each carriage module generates 10.5 kWh during the day, which contributes to the artificial lighting (passenger visual comfort), ventilation (passenger indoor air quality), and heating systems (passenger thermal comfort). As electrical photovoltaic production varies throughout the day, storing excess energy in batteries enhances system management.

CONCLUSION

Due to the altitude of the sun, it also occurs in vertical photovoltaic cells, which represent an important contribution to the sustainability of the vehicle and, therefore, to the urban environment.

The solar radiation level peaks on the ceiling at midday, on the left panel at 9 am, and on the right panel at 3 pm.

In winter conditions, energy production is not limited to horizontal cells.

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