

Passive Greenhouse Systems in Poland

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Abstract : Passive systems allow solar radiation to be converted into thermal energy thanks to appropriate building construction. Greenhouse systems are particularly worth attention, due to the low costs of their realization and strong architectural appeal. The paper discusses the energy effects of using passive greenhouse systems, such as glazed balconies, in an example residential building. The research was carried out for five localities in Poland, belonging to climatic zones different in terms of external air temperature and insolation: Koszalin, Poznań, Lublin, Białystok and Zakopane. The analysed apartment had a floor area of approximately 74 m². Three thermal zones were distinguished in the flat - the balcony, the room adjacent to it, and the remaining space, for which various internal conditions were defined. Calculations of the energy demand were made using the dynamic simulation program, based on the control volume method. The climatic data were represented by Typical Meteorological Years, prepared on the basis of source data collected from 1971 to 2000. In each locality, the introduction of a passive greenhouse system led to a lower demand for heating in the apartment, and the shortening of the heating season. The smallest effectiveness of passive solar energy systems was noted in Białystok. Demand for heating was reduced there by 14.5% and the heating season remained the longest, due to low temperatures of external air and small sums of solar radiation intensity. In Zakopane, energy savings came to 21% and the heating season was reduced to 107 days, thanks to the greatest insolation during winter. The introduction of greenhouse systems caused an increase in cooling demand in the warmer part of the year, but total energy demand declined in each of the discussed places. However, potential energy savings are smaller if the building's annual life cycle is taken into consideration, and amount from 5.6% up to 14%. Koszalin and Zakopane are localities in which the greenhouse system allows the best energy results to be achieved. It should be emphasized that favourable conditions for introducing greenhouse systems are connected with different climatic conditions. In the seaside area (Koszalin) they result from high temperatures in the heating season and the smallest insolation in the summer period, while in the mountainous area (Zakopane) they result from high insolation in the winter and low temperatures in the summer. In the region of middle and middle-eastern Poland active systems (such as solar energy collectors or photovoltaic panels) could be more beneficial, due to high insolation during summer. It is assessed that passive systems do not eliminate the need for traditional heating in Poland. They can, however, substantially contribute to lower use of non-renewable fuels and the shortening of the heating season. The calculations showed diversification in the effectiveness of greenhouse systems resulting from climatic conditions, and allowed to identify areas which are the most suitable for the passive use of solar radiation.

Keywords : solar energy, passive greenhouse systems, glazed balconies, climatic conditions

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