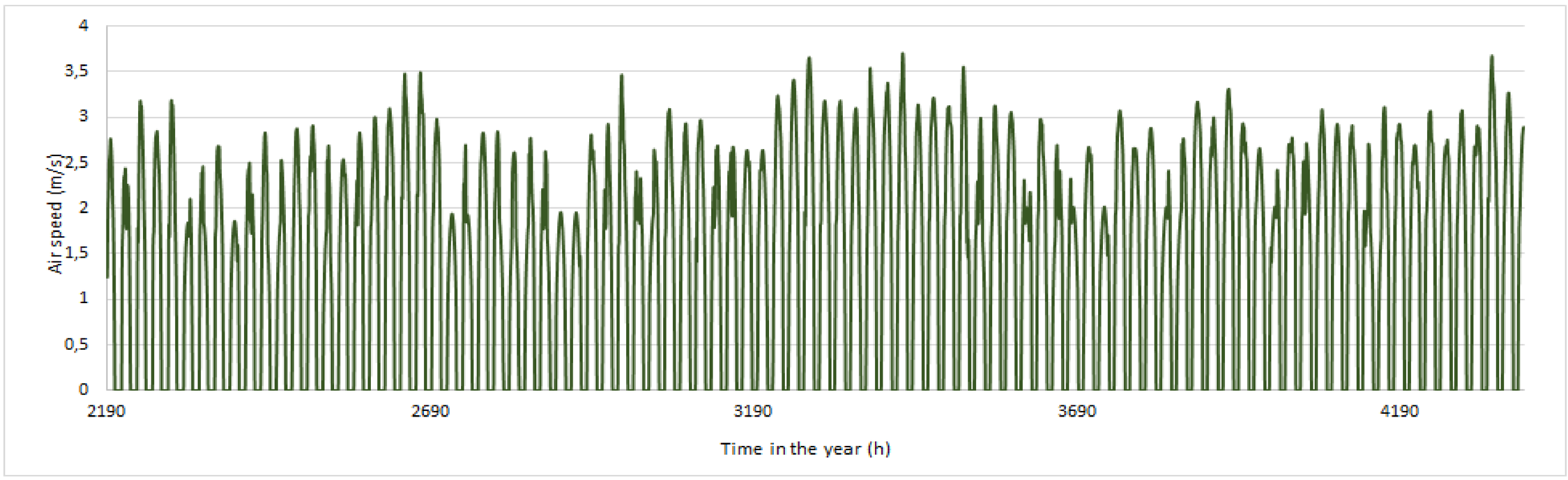
ANALYSIS OF THE ALL-YEAR OPERATION OF THE SOLAR CHIMNEY IN POLISCH CLIMATIC CONDITIONS

WYDZIAŁ ELEKTRYCZNY
POLITECHNIKA CZĘSTOCHOWSKA

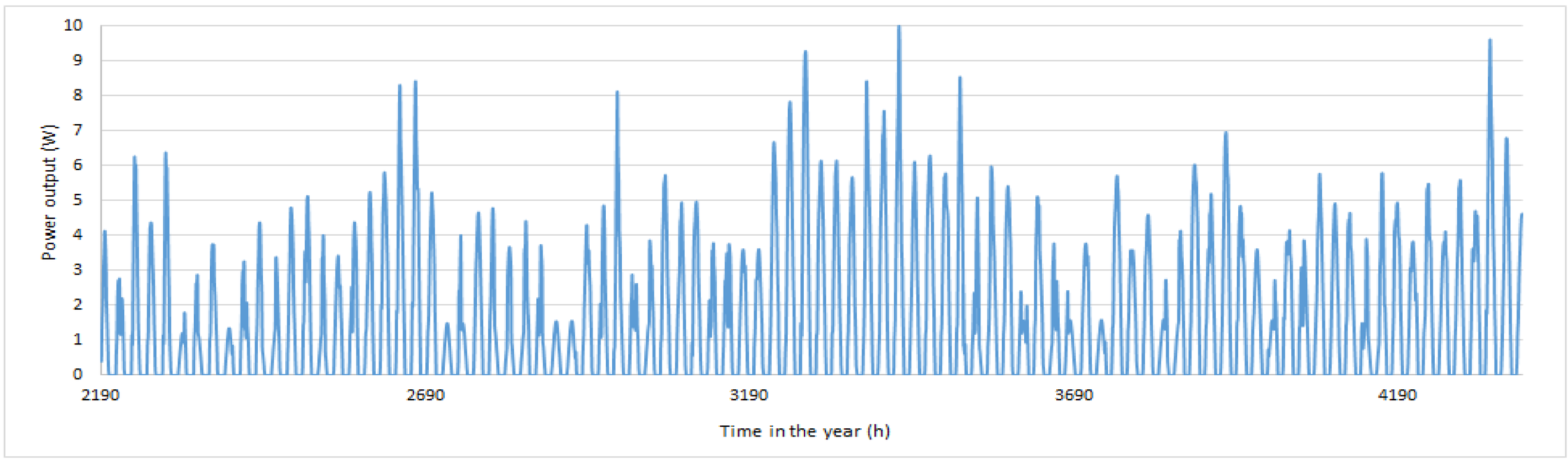
Sylwia Berdowska
Częstochowa University of Technology, Department of Power Engineering

The installation of a solar chimney was analyzed. A solar chimney is a combination of two technologies: an air solar collector and a chimney in which a wind turbine is situated. The ambient air flowing into the installation is heated in the solar collector, which changes its density and, consequently, induces its movement caused by the chimney draft. After passing through the collector, the air is directed to the wind turbine system.
The analyzed system consists of a rectangular solar collector located on the southern side of the solar chimney. The surface of the solar collector is 30 m^2, while the chimney is 50 m high. Hourly changes in solar radiation were taken into account in the calculations. The simulation was made for the climatic conditions in Katowice.



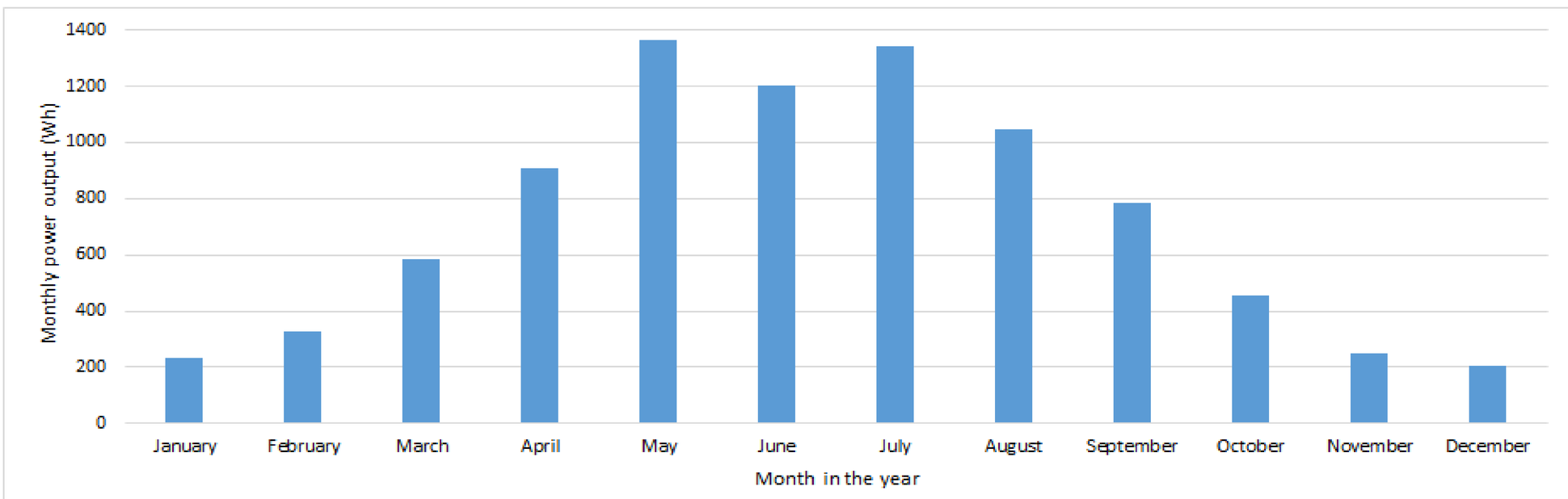
Air speed in the solar chimney in the second quarter of the year

The air speed in the solar chimney depends on the air temperature increase in the collector, therefore the highest air velocities can be observed in the second and third quarters, when the air temperature increase in the collector is the highest. In the second quarter, the maximum air speed is 3.70 m/s. The lowest air velocity values can be obtained in the first and fourth quarter of the year.



Electric power generation in the second quarter of the year

Solar chimney system can achieve the highest electric power in the second quarter of the year. The maximum power of 9.98 W was reached on May 23 at 11.00. The installation achieves the lowest power in the fourth quarter.



The amount of electricity produced in each month of the year

The installation can generate the most electricity in the amount of 1,366.84 Wh in May, and the lowest in December – 204.86 Wh. In the winter months: November, December and January, solar chimney produces the smallest amounts of electricity: 204.86 – 250.41 Wh. In May, June and July, the installation produces the largest amounts of electricity, amounting to 1,202.05 – 1,366.84 Wh.

Solar chimney can generate the most electricity in the second quarter and it is 3477.07 Wh, while the lowest in the fourth quarter – 912.35 Wh. In the fourth quarter, the solar chimney can generate 74% less electricity than in the second quarter.

The amount of electricity generated by a solar chimney depends on the intensity of solar radiation and weather conditions such as cloudiness, therefore in Polish climatic realities the maximum amount of energy may be generated in the spring and summer months, when the intensity of solar radiation reaches the highest values.