IBPC 2021 8th International Building Physics Conference Copenhagen Denmark

Impact of the type, orientation, and temperature of solar panels on observed efficiency in Latvian climate conditions

D. Heincis, J. Telicko and A. Jakovics,
University of Latvia, Institute of Numerical Modelling, Jelgavas 3, Riga, Latvia.

„Development and approbation of complex solutions for optimal inclusion of capillary heat exchangers in nearly zero energy building systems and reduction of primary energy consumption for heating and cooling “ Project No. 1.1.1.1/19/A/102

Abstract
To determine the efficiency of poly- and monocrystalline panels, depending on their spatial orientation and other parameters, a set of test panels was installed in Riga, Latvia in 2018 for long-term monitoring of their power output. This article summarizes the results for the first two years. In the autumn of the second year of monitoring, temperature sensors were installed on the solar panels to study the effects of temperature on panel’s efficiency. The data show that the panel's spatial positioning is a crucial element affecting the amount of energy produced, although the type of panels and climate conditions are also important.

1. Introduction

A system of 5 PC and 5 MC solar panels was installed in 2018 at the Botanical Garden of the University of Latvia. The panels were arranged in five different spatial orientations, which can be further classified into 2 groups:
• southward orientations with a 13°, 40° or 90° angle to the horizon (S13, S40, S90);
• orientations with a 13° angle to the horizon towards the south (S13), west (W13) and eastern (E13) directions.

The panels were mounted on building rooftops to avoid environmental shading, with system installation described in [2]. In August 2020, temperature sensors were installed on the panels to assess the impact of temperature on efficiency.

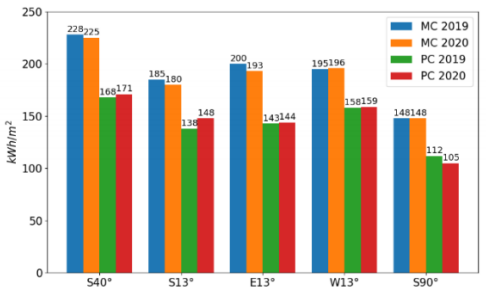
The solar panel system in the Botanical garden (University of Latvia, Riga).

3. Results and discussion

Data on the power generated by solar panels were analyzed, including the relationship with angle to horizon, total received solar radiation on a horizontal surface, and the temperature of the panels.
The S40 panel produces the most energy during the year (see figure 1); however, in the middle of summer, it can produce less energy than panels with 13° orientation.

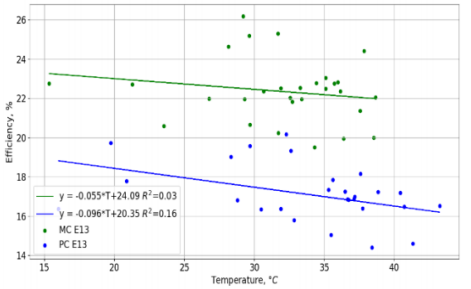
Comparing the data from 2019 and 2020, the overall trends remain unchanged. MC S40 panels on average generate 15.4% more energy than any MC 13° orientated and PC S40 on average generate 12.9% more energy than any PC 13°. On average, PC panels produce 20 – 30% less energy per year than MC panels with the same spatial orientation.
The technical specifications of the PC panels indicate that they lose 0.41% of their maximum power per degree above 25 °C and MC will lose 0.30%/C°. The observations do show that, when PC panels heat up, their efficiency is reduced slightly. MC panels, in turn, heat up less; their efficiency remains comparatively unchanged (see figure 2). On a perfectly sunny August day, the surface temperature of the panel exceeds 50 °C. Comparison of the data for the 2 observation years shows that S40 panels tend to exhibit a decrease in observed efficiency during the summer (see figure 3). This may be associated with heating up, but more observations are needed. Figure 3 does not display data for May 2019, as no data were available at the time.

Figure 1



Total energy produced by varied oriented panels during 2019 and 2020.

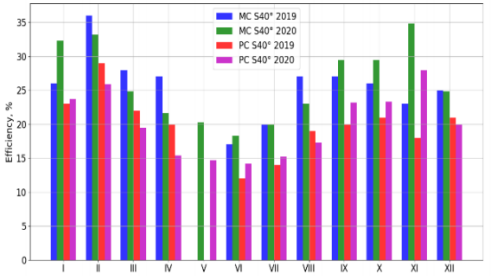
Figure 2



Actual efficiency of E13-oriented panels with respect to the maximum temperature of the panels surface, in September 2020.

In winter, the efficiency of the panels is also affected by snowfall, as panels with a small angle to the horizon tend to become fully covered in snow (as was the case in January 2021). The average actual efficiency of the S40 MC panel in the Latvian climate is 22.5% and PC efficiency is 17%. The average annual actual efficiency of solar panels is higher than value specified by the manufacturers, as observations show that actual efficiency is significantly higher during the winter months.

Figure 3



Actual efficiency of S40-oriented panels by month in 2019 and 2020.

Conclusion

After the second observation year, it can be concluded that the actual efficiency values in the Latvian climate are slightly higher than the standardized ones (20% for MC, 16% for PC). The tendency for panel efficiency to decrease (especially for PC panels) with rising temperature was observed, although a quantitative assessment of the impact of temperature will require further monitoring data.

References

[1] European Cort of Auditors Special Report No 08/2019: Wind and solar power for electricity generation.
[2] Telicko J, Heincis D, & Jakovics A 2020 A study of solar panel efficiency in Latvian climate